Recommendations of the Eelgrass Working Group to the CGA Environment Committee, February 2024.

This working group was established in response to Connecticut General Assembly Special Act No. 23-7, introduced in House Bill No. 6480, approved June 26, 2023.

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Executive Summary

The recommendations of the Working Group are designed to develop strategies for the preservation, restoration and expansion of eelgrass along the state's shoreline. The Long Island Sound Study has established a goal for eelgrass extent in Long Island Sound of 4,061 acres. Aerial imagery acquired in 2012 mapped 2,061 acres of eelgrass; an expansion of eelgrass extent by another 2,000 acres by 2035 was the target established in 2020.

Key aspects of the recommendations focus on:

- Protect Existing Eelgrass Resources
- Monitor the Health and Extent of Long Island Sound Eelgrass
- Improve and Maintain Water Quality
- Research Eelgrass in Support of Restoration Science
- Consider Barriers to Restoration
- Restore Eelgrass and Eelgrass Habitat
- Educate and Engage Connecticut Citizens

The Working Group met eight times between August 30, 2023 and January 24, 2024. During our first meeting, we covered the background on eelgrass as a habitat and decided on the topics we would discuss during subsequent meetings, based on the outline developed for the report. During each meeting, we reviewed our goals and plan for meetings, adding and adjusting topics as our discussions evolved. By the mid-point of our meetings, committee members were charged with leading sessions in their area of interest. These discussions typically included activities to engage the committee members in reviewing material or developing opinions and recommendations. This report documents the results of those discussions and activities.

The full report provides background and expanded rationale for each of the recommendations included below. The recommendations have been divided into three categories with subcategories:

- Legislative Recommendations
- Funding Needs and Recommendations
    - Tracking Progress
    - Restoration Research
    - Infrastructure and Workforce Development
    - Education
- Other Recommendations
    - Communication and Coordination
    - Addressing Stressors

Legislative Recommendations

> **Create a State-managed position for a Seagrass Coordinator** to oversee and interact with the various stakeholders associated with eelgrass in Connecticut, Long Island Sound, and the broader eelgrass community.

> Large scale restoration efforts will draw on relatively sparse acreage of existing Connecticut eelgrass beds as a seed source or source of adult plants. **Policies and/or incentives for sustainable use of those beds will be critical if and when the scaling of restoration increases**. The committee discussed the idea of leasing eelgrass beds for seed harvest, so that lease owners could control the harvest of seed or plants and thus ensure harvests are sustainable. This would require working with DEEP and researchers to determine what level of harvest is sustainable and how a leasing program would work.

> **Establish a Connecticut BMP (best management practices) when aquaculture is close to eelgrass**, to supplement the existing policies. This will provide guidance to restoration practitioners, managers, and aquaculture professionals.

> Institute a policy **requiring eco-friendly mooring systems in mooring fields with a high potential to host eelgrass**, as predicted by the Eelgrass Habitat Suitability Index model.

> **Add mention of eelgrass protection to MS4 permits** for communities located in coastal areas of southeastern and central CT to explicitly identify areas where mitigation of stormwater impacts on coastal water quality will benefit existing eelgrass meadows and/or expansion.

> The working group suggests the Connecticut General Assembly's Environmental Committee either **reconvene this working group in January 2025** to review the output of the Eelgrass Collaborative related to permitting and policies surrounding restoration in Connecticut or review the report that will be generated by the Eelgrass Collaborative on this topic. Specifically, a review of the existing regulations under the U.S. Army Corps of Engineers permits should be evaluated for potential modification in the future, with DEEP and DABA policies to follow similar modifications.

Funding Needs and Recommendations

TRACKING PROGRESS

> **Collaborate with the Long Island Sound Study and U.S. Fish and Wildlife Service to support more frequent aerial mapping** of eelgrass extent in Long Island Sound. Annual tracking of extent is the industry standard for assessing success of restoration and protection efforts. Long Island Sound eelgrass is currently monitored every 3 to 5 years. A dedicated commitment to financially support the mapping would increase the frequency of surveys.

> **Provide financial and administrative support for detailed surveys at index sites** which are representative of eelgrass throughout Long Island Sound in order to assess additional eelgrass metrics such as coverage, density, biomass, habitat and eelgrass health.

> **Provide financial support to MS4 communities located in coastal areas of southeastern and central CT** to increase data collection/analyses, which can be used to identify areas where mitigation will benefit existing eelgrass meadows and/or expansion. Such financial support should also account for a management agency to provide guidance and oversight to the MS4 community.

RESTORATION RESEARCH

> Support research to **characterize the timing of seagrass flowering and seeding** in Long Island sound, to maximize efficiency of harvesting stock for restoration.

> Support research on restoration techniques to **determine which restoration techniques are viable for and highly successful** in Long Island Sound. Results should suggest pros and cons of restoration methodology, including past history and current methods.

> Support research into **innovative methods to increase eelgrass transplant success** (examples of recent efforts tested in Long Island Sound include gluing seeds to clams as a planting and anchoring method, and testing soil amendments introduced at the time of planting to improve transplant success rates. Past efforts include innovations in seed dispersal (BuDS) and planting techniques.)

> Support **common garden experiments which test genetic stock** from neighboring regions to determine if seeds from other areas **exhibit greater resilience** in the face of changing habitat and climatic conditions.

> Support completion of a **literature review** to determine **what is known regarding levels** of harvest of seeds or adult shoots **that can be maintained under an annually occurring harvest**.

> Support field studies to **assess the locally relevant harvest rate** for seeds or adult shoots that can be maintained under an annually occurring harvest.

> Support development of a **systematic approach to gauging efficacy of restoration efforts** which leads to appropriate expectations on outcomes.

> Support development of a **set of metrics which can be used to justify any state-supported efforts** for restoration and **calibrate expectations appropriately on the time horizon** for return on investment.

INFRASTRUCTURE, & WORKFORCE DEVELOPMENT

> Invest in **infrastructure development in support of field aspects** (e.g., harvesting, planting) of restoration.

> Invest in **infrastructure upgrades for housing and preparation of eelgrass** seeds and adult plants. For example, flow-through tanks / raceways, centrifuge set-up for seed separation.

> Establish a **pilot program to support workforce development** for supporting restoration as a viable industry in CT. This could occur under a number of different structures, from a University-based structure similar to Cornell Cooperative Extension of Suffolk County, to fully private companies conducting restoration on a fee-for-service basis.

> Fund the **creation of a State-managed position for a Seagrass Coordinator** to oversee and interact with the various stakeholders associated with eelgrass in Connecticut, Long Island Sound, and the broader eelgrass community.

EDUCATION

> Recommend funding and ongoing **support for a website** detailing all eelgrass efforts in CT. Potentially in combination with the Cornell Cooperative Extension of Suffolk County outreach site. The site should include educational material on the importance of eelgrass and how to help, print materials/fact sheets for use at boat ramps/marinas/yacht clubs, and announcements of volunteer opportunities. Maintenance of the website could be a task assigned to Connecticut Seagrass Coordinator.

> Support **early communication with and opportunities to provide input from local communities and stakeholder groups** surrounding any new restoration efforts.

> Support **programs to educate boaters about the importance of eelgrass** and the proper **techniques to avoid damaging eelgrass** with anchors and propellers.

Other Recommendations

COMMUNICATION and COORDINATION

> Connecticut should **coordinate closely with the Eelgrass Collaborative, the Long Island Sound Study, Cornell Cooperative Extension of Suffolk County, and Fishers Island Seagrass Management Coalition** to best coordinate and expand eelgrass restoration in Long Island Sound.

ADDRESSING STRESSORS

> Support the **purchase of eco-moorings** through a state fund to incentivize the transition from traditional moorings to eco-friendly mooring systems, such as those with helix anchors or floating docks, to minimize seabed disturbance.

> **Develop a program or add to the “Clean Marina” certification** offered by the Connecticut Marine Trades Association **incorporating eco-friendly mooring systems** in mooring fields where eelgrass is likely to occur.

> Continue to **encourage and support nutrient reduction efforts** relative to stormwater, onsite wastewater treatment systems, and wastewater conveyance and treatment associated with publicly owned treatment plants. These actions will contribute to **achieving excellent water quality** which is a critical component of eelgrass success.

> Provide **financial and administrative support to advance the installation of nitrogen-reducing onsite wastewater treatment systems for mitigation purposes only**. This will involve the development and management of a program focused in areas where nitrogen impacts to eelgrass are greatest, as well as areas with high potential for eelgrass restoration success.

Table of Contents

Cover image: Snorkeler (Evan Childs) in an eelgrass bed on the east side of Ram Island, south of Mystic Harbor, CT. Photo courtesy of the Connecticut National Estuarine Research Reserve; photographer: Nathan Robinson, 2023.

Acronyms and Abbreviations

°C	degrees Celsius
°F	degrees Fahrenheit
BuDS	Buoy Deployed Seeding System
CCE	Cornell Cooperative Extension of Suffolk County
CCMA	Connecticut Coastal Management Act
CCMP	Comprehensive Conservation and Management Plan
CGA	*Connecticut General Assembly*
CGS	Connecticut General Statute
CT	Connecticut
CT NERR	Connecticut National Estuarine Research Reserve
CZM	Coastal Zone Management
DABA	Department of Agriculture Bureau of Aquaculture
DEEP	Connecticut Department of Energy and Environmental Protection
Dr.	Doctor
ECL	Environmental Conservation Law
e.g.	for example
EHSI	Eelgrass Habitat Site Suitability Index
ENGO	Environmental Non-Governmental Organization
EPA	U.S. Environmental Protection Agency
ESA	Ecologically Significant Areas
et al.	and others
etc.	the rest
MassBays NEP	Massachusetts Bays National Estuary Program
Mass CZM	Massachusetts Coastal Zone Management
MassDEP	Massachusetts Department of Environmental Protection
MS4	Municipal Separate Storm Sewer System
NEP	National Estuary Program
NOAA	National Oceanic and Atmospheric Administration
NY	New York
NYS	New York State
NYSDEC	New York State Department of Environmental Conservation
RI	Rhode Island
RI CRMC	Rhode Island Coastal Resources Management Council
RICRMP	RI Coastal Resources Management Program
SAV	Submerged Aquatic Vegetation
SEQR	State Environmental Quality Review
TERFS™	Transplanting Eelgrass using Remote Frames System
U.S.	United States
USACE	U.S. Army Corps of Engineers

1. Background

This working group was convened by the Connecticut General Assembly, Environment Committee in response to Connecticut General Assembly Special Act No. 23-7 (https://www.cga.ct.gov/2023/act/sa/pdf/2023SA-00007-R00HB-06480-SA.pdf), introduced in House Bill No. 6480, approved June 26, 2023. The charge to the group was to "develop strategies for the preservation, restoration and expansion of eel grass along the state's shoreline." In developing such strategies, the working group was charged with reviewing and synthesizing information from studies performed by the states of New York and Rhode Island, including, but not limited to, Tier 1 mapping of *Zostera marina* in Long Island Sound and change analysis performed by the University of Rhode Island."

1.1. Other Eelgrass-related Groups

A number of working groups and staff positions focused on eelgrass (*Zostera marina* L.) have been established in recent years. These groups generate reports, assessments, research, and communication efforts that provide additional context on eelgrass in Long Island Sound. Examples include:

- Long Island Sound Eelgrass Collaborative (detailed below), https://estuarineresearchreserve.center.uconn.edu/lis-eelgrass-collaborative/
- Fishers Island Seagrass Management Coalition, https://www.fiseagrass.org/
- Fishers Island Seagrass Management Coordinator, https://www.fiseagrass.org/
- Seagrass.LI, Long Island's Seagrass Conservation Website, hosted by Cornell Cooperative Extension of Suffolk County, http://www.seagrassli.org/
- Seagrass Coordinator, New York State Department of Environmental Conservation, https://dec.ny.gov/nature/waterbodies/oceans-estuaries/seagrass-management
- East Coast SAV (Submerged Aquatic Vegetation) Collaborative, https://www.eastcoastsavcollaborative.com/

Long Island Sound Eelgrass Collaborative

Following the establishment of the Connecticut General Assembly's Working Group, a bi-state eelgrass working group was formed, bringing together scientists, practitioners, managers, and other stakeholders over a 2-year process, to evaluate eelgrass management in Long Island Sound and to advance the knowledge of and practical application of restoration in the region.

The Long Island Sound Eelgrass Collaborative was formed in 2023 to implement elements of the 2022 Eelgrass Management and Restoration Strategy (Long Island Sound Study, 2022). The Strategy provides guidance for short and long-term actions that should be taken to manage and restore eelgrass meadows in Long Island Sound and acts as a resource for other estuaries in the region facing similar issues. The Collaborative is funded by the Long Island Sound Study and facilitated by the Connecticut National Estuarine Research Reserve at the University of Connecticut.

The existence of the Eelgrass Collaborative is an important resource for Connecticut as it convenes many types of stakeholders interested in eelgrass restoration. Beginning in October 2023, the Collaborative will have four meetings a year for two years, with three being virtual and one hosted in-person each year (Connecticut National Estuarine Research Reserve, 2024). These meetings will convene local stakeholders to share updates and offer continuing education to attendees on best management practices and current research results related to eelgrass restoration by inviting expert speakers from around the nation.

1.2. Benefits of Eelgrass Habitat

Eelgrass habitat provides a number of ecosystem services (Orth et al., 2010), defined as the direct and indirect benefits that ecosystems provide to humans. These benefits include:

- Nursery area, shelter, and a home for many commercially and recreationally important fish, crabs, bivalve shellfish (mussels, oyster, scallops, etc.).
- Dense seagrass beds trap sediment and nutrients entering coastal waters from the land, thus improving water quality.
- The presence of eelgrass slows water currents that flow through the beds and can reduce the impact of waves on the shoreline, reducing erosion.
- Eelgrass absorbs the climate-warming greenhouse gasses carbon dioxide and methane and stores them in its root system in solid form. Dense beds can lock these gasses into the sediment as old roots are buried over time.
- Eelgrass beds are hot spots for primary productivity. The plant matter generated by eelgrass and the other plant-like organisms (seaweed, microscopic phytoplankton) living in the beds provide a source of food and energy to a wide variety of marine animals. Many of those mobile animals venture out of the eelgrass beds (e.g., fish, crabs), transferring these resources to other areas of Long Island Sound.
- Eelgrass beds support a wide array of wildlife that draws visitors to the coast, fueling the economy of the region.

Snorkeler (Nathan Robinson) in an eelgrass bed on the east side of Ram Island, south of Mystic Harbor, CT. Photo courtesy of the Connecticut National Estuarine Research Reserve; photographer: Evan Childs, 2023.

1.3. Stressors to Connecticut Eelgrass

Stressors are factors whose influence impacts productivity, reproductive success, ecosystem development, or general health of individual organisms (such as eelgrass plants). Stressors to Connecticut's eelgrass include:

- Nutrient Pollution, especially nitrogen input to coastal waters from human sources
    - Excess nitrogen in the water stimulates the growth of seaweed and microscopic plant-like organisms (phytoplankton). These plants collect as thick mats at the base of eelgrass (seaweed), reduce the clarity of the water (phytoplankton), and attach directly to the eelgrass leaves (both). All of these reduce the amount of light received by the plant, adversely impacting growth and survival of eelgrass.
    - Nutrient-rich waters tend to have richly organic sediments. At the extreme end of high organic matter, sediments are anoxic (lacking oxygen) and take on a black color as organic matter collects and is decomposed by beneficial bacteria. When sediments are lacking oxygen, the beneficial bacteria decomposing the organic matter produce hydrogen sulfide, the source of the "rotten-egg" smell sometimes encountered in coastal waters and marshes. Sulfide is toxic to eelgrass and the eelgrass must expend energy and resources to combat the influence of the sulfide; it does this by pumping oxygen out of its' roots, creating a very thin layer of oxygenated sediment around each rootlet which prevents the sulfide from reaching the plant.
- Rising Temperatures
    - As with all plants and animals, eelgrass has a range of acceptable water temperatures - the temperatures in which it is able to grow and reproduce. The optimal water temperature for eelgrass growth is 59-68° (15-20°C) (Lee et al., 2007). The lethal limit in Long Island Sound is considered to be around 77°F (25°C), though plants further to the southern end of eelgrass' range can survive short periods of exposure to water temperatures >86°F (>30°C) (McRoy and McMillan, 1970; Hammer et al., 2018).
    - High temperatures in some of Long Island Sound's shallow bays already surpass the lethal limit for our local eelgrass, though waters along the open coast of Connecticut are typically cool enough for our local eelgrass to succeed. Projections for rising temperatures related to climate change have stimulated interest in importing eelgrass strains from further south where the lethal limit in eelgrass populations is higher than in Connecticut.

Mooring scars in eelgrass bed in Mystic Harbor, circa 1985. Image is looking west, towards the western shore of the lower Mystic Harbor. The docks on the left (south) are the current location of the Noank Shipyard. Note the halos of sand around each mooring, resulting from the anchor chain scouring away the eelgrass. Photo courtesy of DEEP.

- Physical Damage
  - Physical damage from human sources includes:
    - Mooring chains at the base of mooring buoys located in eelgrass beds create a “halo” around the anchor point, as the chain sweeps the ground, removing eelgrass.
    - Anchors can pull up eelgrass, including the roots. Fishers Island, NY has a “look before you drop” education campaign, to encourage boaters to avoid anchoring in eelgrass.
    - Boat propellers can rip out eelgrass and create troughs through the sediment, if running full speed through a shallow area. Boaters are encouraged to idle with the engine trimmed up in shallow areas.
    - Dredging to deepen areas or for construction purposes may damage eelgrass beds. This action requires permits from the Department of Energy and Environmental Protection (DEEP) and from the US Army Corps of Engineers (USACE). During the permitting process, procedures and locations are reviewed to assess potential impacts. Methods and locations may be modified to reduce risks to all critical habitats (including eelgrass). If damage is unavoidable, a plan to mitigate the damage is developed.
    - Aquaculture activities have the potential to damage eelgrass, but policies are in place to avoid such damage to eelgrass beds. Dredging or trawling through eelgrass will confer direct damage to eelgrass and should be avoided. The impact of shellfish aquaculture gear placed in eelgrass beds is variable; evaluation of the potential and actual impact is conducted on a case-by-case basis. The general rule is that gear must be a minimum of 25 feet from eelgrass. When eelgrass encroaches into existing shellfish

aquaculture leases, an exception to this rule may be made by the US Army Corps of Engineers working with the Department of Energy and Environmental Protection and the Department of Agriculture Bureau of Aquaculture. See the section on eelgrass-aquaculture interactions in this report for more details.

    - Physical damage from natural sources include:
        - In shallow areas, wave action from storms may uproot eelgrass. These areas typically recover, with plants spreading from the deeper edge of the bed protected from the storm scour or regrowing from seeds remaining in the sediment.
        - Following storms, eelgrass may be temporarily buried by sand and finer sediments. When this has been observed in Connecticut, the eelgrass returns within a few weeks.

- Poor Water Clarity
    - Eelgrass requires a high degree of light, needing light received by the plant at a level of 11% to 25% of the light received by the surface of the water (Dennison and Alberte, 1985; Koch and Beer, 1996; Moore, 1991; Short et al., 1993).
    - Poor water clarity can be caused by high phytoplankton levels (plant-like microscopic organisms), high levels of suspended sediment, or both. These particles in the water block light from reaching the eelgrass.
        - High phytoplankton levels are found in areas with high nutrient availability, especially where high nitrogen levels are delivered to the water from land. Restricted flow in shallow waters may also create a situation where high phytoplankton levels build up in the restricted area.
        - High turbidity levels may be found in areas with a heavy load of suspended solids in the freshwater entering the coastal waters; this may be associated with stormwater systems, which can transport high levels of suspended sediment from roadways and other paved areas. Some rivers have naturally high turbidity levels, if they drain a watershed with fine sediments. High turbidity may also occur when storms, currents, or other physical disturbance stirs up sediment from the bottom of the water body.

- Predation / Invasive Species (swans, green crabs, etc.)
    - Some waterbirds feed on eelgrass directly, including brant, Canada geese, widgeon ducks, redhead ducks, and black ducks. Eelgrass supplements the food source for local and migratory birds. While eelgrass is a source of food for waterbirds, recent studies indicated these birds can consume 16% of the

biomass of dense eelgrass beds; and up to 40% of sparse eelgrass beds (Balsby et al., 2017).

  - In other states, the invasive mute swan depletes eelgrass beds in shallow waters, where the swans are able to reach the eelgrass. The impact of the invasive mute swans and the native Canada geese on Connecticut eelgrass is still unknown, but grazing of eelgrass by both species has been observed (Johnson et al., 2007).
  - Any marine invasive species may impact the structure of communities and have the potential to negatively impact eelgrass as a habitat and the individual eelgrass plants. For example, the invasive green crab is known to destroy eelgrass habitats (NOAA Fisheries, 2023) and has been witnessed "clipping" eelgrass plants in Niantic Bay with their claws (Vaudrey, *pers. comm.*), a common behavior for this crab (Malyshev and Quijón, 2011).

The impact of these stressors are evidenced by:

- Reduction in the overall area occupied by eelgrass.
- Decrease in the density of plants (fewer plants per area).
- Smaller plant size.
- Higher levels of epiphytes (plants and animals) growing on the eelgrass blades.
- Higher incidence of wasting disease on the plants.

Overall genetic diversity increases resilience of eelgrass to stressors. Previous research has identified some eelgrass populations in southern New England that are more resilient to stressors (Short et al., 2012). Additional work is planned by the research community to assess genetic diversity and resilience to stressors along the Atlantic Coast, from Maine to North Carolina: (1) the National Park Service will be assessing genetic diversity in National Seashores from Maine to Maryland, (2) a number of proposals have been submitted to conduct experiments examining genetic diversity and whether moving southern strains of eelgrass to the north improves eelgrass success. In such efforts, plants are moved one degree of latitude or less; this limit is a constraint in seed science for both aquatic and terrestrial plants, reflecting that plant populations are typically adapted for their local conditions and it can take time for plants to adapt to new conditions. If funded, these efforts will provide guidance to identify the populations of eelgrass that would make good sources for future restoration efforts, to improve the resilience of eelgrass.

2. Current Efforts Related to Restoration and Preservation

A number of efforts are underway, assessing the extent of eelgrass. The aerial overflights mapping eelgrass extent in Long Island Sound are detailed in Section 2.1. Additional efforts are underway to assess the use of drones and the use of satellites for mapping eelgrass. Drone mapping technology is being explored by DEEP, with Beebe Cove in Groton being used as a test site. Environmental Protection Agency (EPA) Region 1 has a project exploring the use of satellites for mapping the extent of eelgrass; Connecticut test sites include Beebe Cove and Mumford Cove, both in Groton.

To support restoration efforts, site suitability models are used to identify areas where restoration is most likely to be successful. Results of an existing site suitability are provided in Section 2.2 and plans for updating the model are reviewed.

Restoration of eelgrass in Long Island Sound has been attempted in numerous locations using a variety of methods. An overview of these efforts is provided in Section 2.3.

2.1 Eelgrass Mapping Surveys and Change Analysis

Eelgrass along the Connecticut coastline currently occurs east of the Connecticut River and is largely found along the open coastline (Figure 1). A small bed of stunted eelgrass may still exist along the Duck Island breakwater, in Westbrook, CT; it was last observed by the aerial survey in 2009. There are sparse clumps of eelgrass still growing at this location observed floating and growing (D. Hudson 2023, *pers. obs.*).

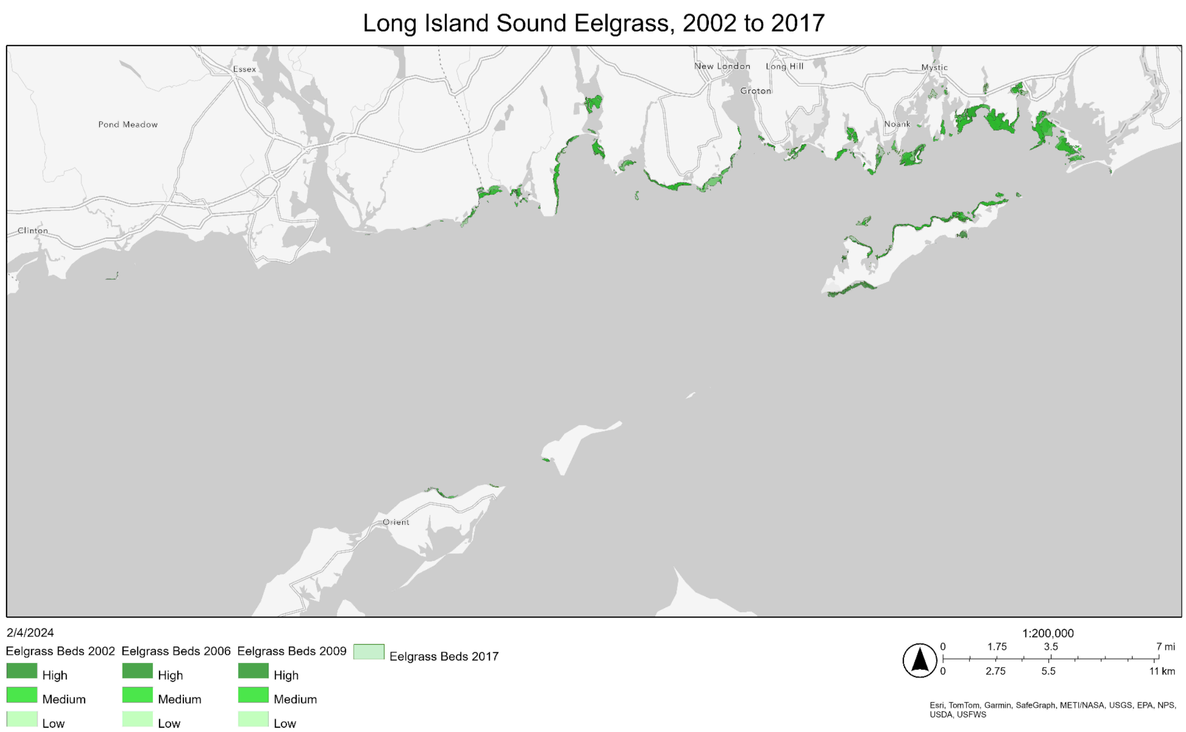

Figure 1: Recent Distribution of Eelgrass in Long Island Sound.
Results of recent aerial surveys of eelgrass distribution. Data from 2012 were not included as data were not field verified due to storms and are known to contain some areas incorrectly identified as eelgrass. Map was generated using the Map Viewer hosted by DEEP (2019).

Eelgrass was last mapped in 2017 and yielded an estimate of 1,465 acres of eelgrass in Long Island Sound (Figure 2). This represents an 8.8% decline relative to 2012; Bradley and Paton (2018) corrected the 2012 data to allow for comparison to 2017 (2012 had not been field verified due to storms that season). This loss is comparable to the losses reported in Narragansett Bay, RI during this same time frame (Bradley et al., 2017).

Bradley and Paton (2018) identified areas of eelgrass expansion and loss. Eelgrass gain occurred along the eastern shore of the Groton Long Point neighborhood and north of Mason's Island in Mystic Harbor, gaining a total of 103 acres in these two areas. The largest losses occurred north of the train bridge in Niantic River and east of Latimer Point in Stonington, CT, losing a total of 430 acres in these two areas. Bradley and Paton (2018) suggested the losses could have been related to warmer temperatures, as these areas are shallow and water flow is restricted.

2017 Eelgrass Distribution - Aerial Overflight Data

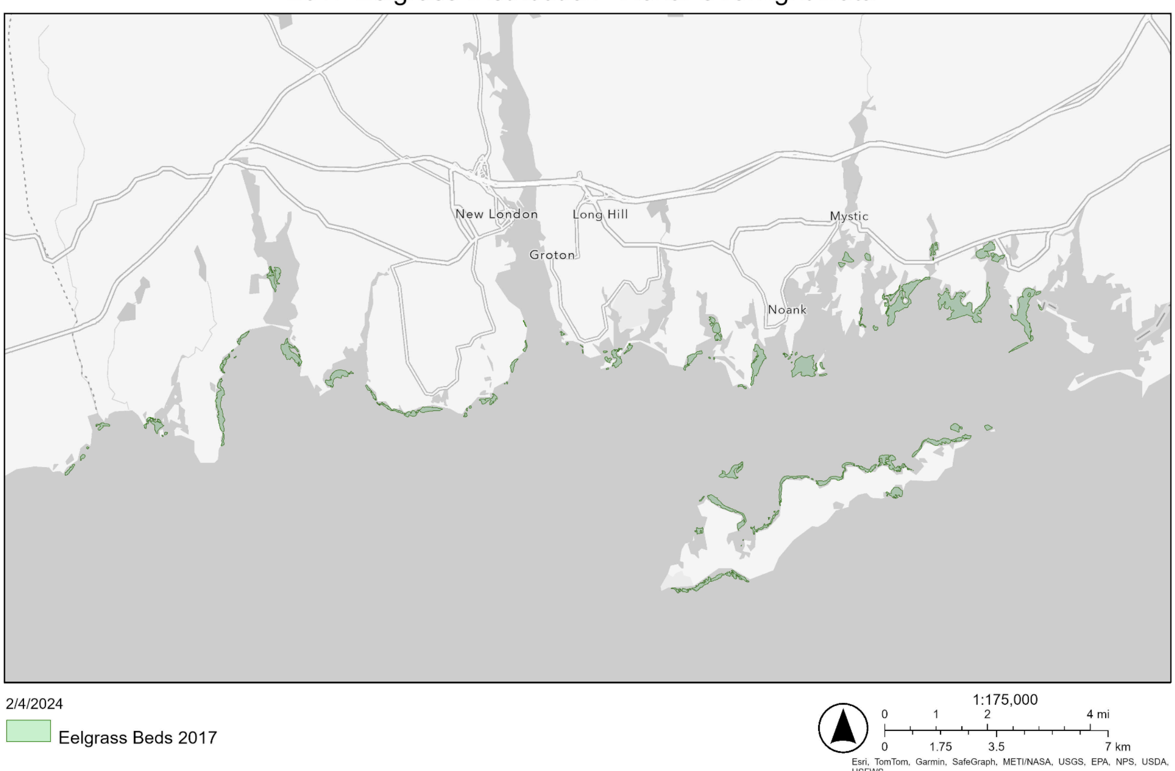

Figure 2: 2017 Distribution of Eelgrass in Long Island Sound.
Results of the most recent (2017) aerial survey of eelgrass distribution. Density of beds was not assessed. Eelgrass was still present north of Duck Island breakwater in Clinton, CT but not mapped in this survey as field efforts were focused on the larger beds in Long Island Sound. Map was generated using the Map Viewer hosted by DEEP (2019).

Eelgrass was once a common aquatic plant found along the shores of Long Island Sound, extending west to New York Harbor (Rozsa, 1994). A survey of historic reports and herbarium specimens (pressed plants stored in centralized locations) collected between 1873 and 1996 confirms the anecdotal observations of eelgrass summarized by Rozsa (Rozsa, 1994; Yarish et al., 2006) (Figure 3). The density of points in the eastern Long Island Sound represent more recent observations; as a plant becomes more rare, observations of the plant become more frequent. Many of the observations that overlap with current day distribution since 1980. Observations made in 1947 were the last to indicate eelgrass was present west of Clinton, CT.

Historic Distribution

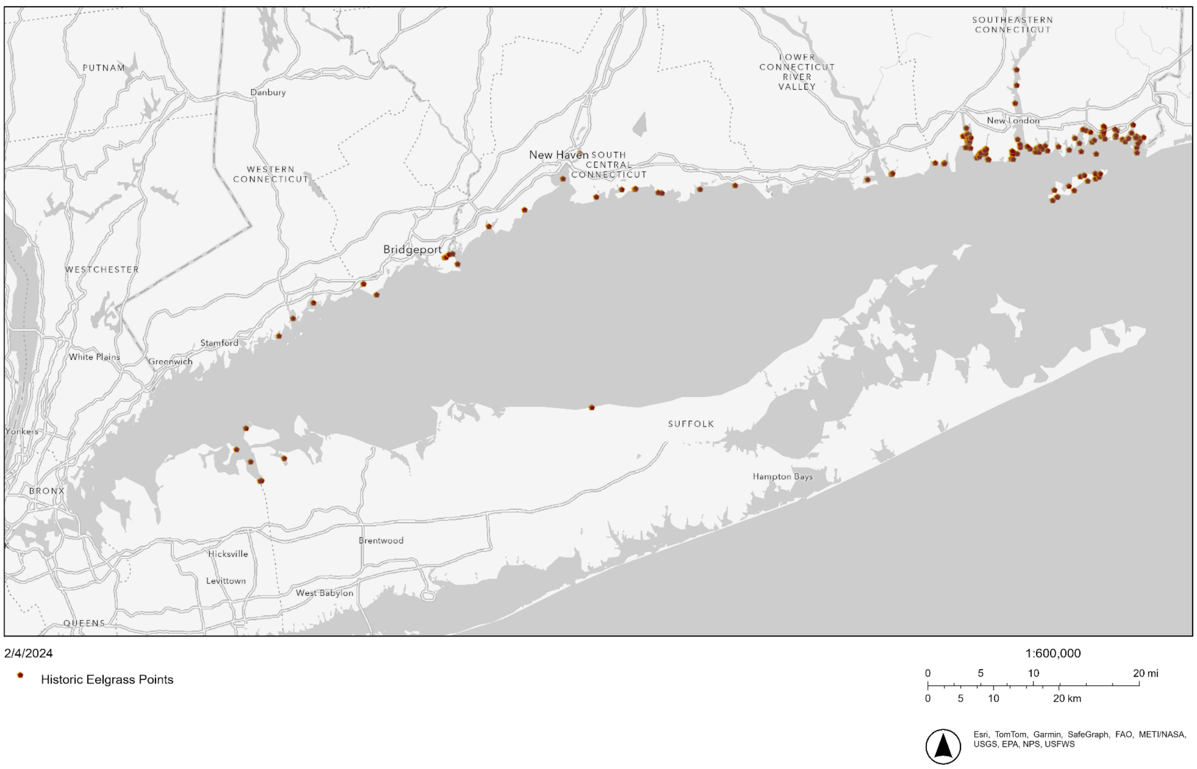

Figure 3: Historic Distribution of Eelgrass in Long Island Sound.
Each point represents an observation of eelgrass recorded in the botanical literature or preserved as a pressed plant in an herbaria. Map was generated using the Map Viewer hosted by DEEP (2019).

A recent effort was conducted in Massachusetts, comparing a variety of eelgrass mapping methods (Carr and Callaghan, 2023) which is accompanied by a StoryMap interpreting the project results (MassBays NEP and Mass CZM, 2023). Their recommendations as presented in the StoryMap (MassBays NEP and Mass CZM, 2023) are included here as they are especially relevant to the future of mapping in Connecticut (text copied without alteration):

- For site- or embayment-level mapping, **use high-resolution imagery sources such as drone and side scan sonar as the most accurate and eelgrass-inclusive mapping tools** (which can be significantly enhanced with diver ground-truthing of the edge).
- **For greater spatial coverage, use imagery acquired from airplane or high-resolution satellites.** However, since these methods miss more eelgrass, resources should be allocated to enhance ground-truthing of the edge.
- Regardless of remote sensing survey method used, **apply a management buffer** if precise diver-measured edge surveys are not conducted. At a minimum, the mean edge error for each survey method at each depth could be used, however this is not a fully protective buffer. **The maximum edge error observed—approximately 120 m across all survey methods—is recommended for the most protective buffer.**
- Mapping programs should **collect eelgrass canopy height and distribution data** during ground-truthing efforts to help track meadow change and detectability over time.
- For eelgrass mapping programs using aerial imagery, it is strongly recommended that **sub-meter resolution satellite imagery be further explored**, given that MassDEP's 0.25 m resolution aerial imagery performed similarly to satellite imagery or coarser (3 m) resolution.
- Site-specific conditions greatly influenced results. **Sites with a high degree of macroalgae, and those with expansive, diffuse patchy edges are best surveyed by SCUBA divers.**
- **Drop-frame photo ground-truthing is not reliable in detecting very low-density eelgrass and should be augmented by SCUBA diver surveys.**
- This study did not investigate the ability of remote sensing methods to detect and map new or previously unmapped meadows—it specifically targeted the edge of known meadows. Given that all remote sensing methods in this study performed poorly in patchy, low density, and shorter areas of the meadow, mapping programs are likely to consistently miss these eelgrass areas. **Thus, diver, video transects, and/or dropframe ground-truthing surveys should be implemented in places where eelgrass was previously mapped via remote sensing but has since disappeared, or where impacts to highly suitable habitat are proposed.**

2.2. Understanding the Habitat Requirements of Eelgrass in Connecticut

Efforts to preserve and restore eelgrass in Connecticut should focus on areas where we are most likely to be successful. Unsurprisingly, that geographic setting is in the eastern stretch of the Connecticut shoreline extending eastward from Guilford to the Rhode Island border, an area where all of the current eelgrass beds exist (Figure 1). The best locations for eelgrass are consistent with the best water quality found in Long Island Sound (DEEP, 2023a; DEEP 2023b;

Save the Sound, 2022). Additional factors such as depth, historic eelgrass coverage, and current eelgrass coverage further dictate the suitability of an area for eelgrass survival (Figures 1 and 3). From a restoration perspective, it is unlikely that eelgrass can be restored over the next few decades to all locations in Connecticut that historically supported healthy beds prior to the beginning of the 20th century (Figure 3). The greatest return for unit effort for both preservation of existing beds and restoration of beds will be realized in areas located along the eastern end of Long Island Sound.

In 2020, DEEP contracted an analysis of Connecticut estuarine embayment characteristics to support modeling of water quality (RESPEC, 2022). "Estuarine Embayments" means a protected coastal body of water with an open connection to the sea in which saline sea water is measurably diluted by fresh water including tidal rivers, bays, lagoons and coves (CGS Section 22a-93(7)(G)). As part of this project, the 73 embayments along the Connecticut coastline were assessed for their ability to support eelgrass based on depth and the light received by the bottom of the embayment. In some cases, an embayment may be too shallow to support eelgrass, which needs sufficient depth to stay protected from storms and other surface disturbances (Koch, 2001). Of the 73 embayments in Connecticut, 32 (44%) are unlikely to support eelgrass due to depth alone. As demonstrated in the figures in Section 2.1, the majority of eelgrass occurs along the open coast of Long Island Sound. Eelgrass is currently found in only five embayments: Stonington Harbor in Stonington, Quiambog Cove in Stonington, Mystic Harbor (and the sub-embayment, Beebe Cove) in Stonington and Groton, Mumford Cove in Groton, and Niantic River in Waterford and East Lyme. In addition to the issues of depth and light availability, embayments are likely to exhibit warmer water temperatures relative to the adjoining Long Island Sound. For this reason, restoration efforts are likely to focus on the open coastal areas and not in the estuarine embayments.

In 2013, the Long Island Sound Eelgrass Habitat Site Suitability Index (EHSI) was created using funding from the Long Island Sound Study, passed through NEIWPCC (Vaudrey et al., 2013). This model used a variety of environmental factors to map out the most suitable locations for eelgrass in Long Island Sound. The model domain (the colored areas in Figure 4) was determined by depth. Parameters evaluated in the final model included:

- percent light to the bottom
- Temperature
- dissolved oxygen
- sediment grain size as % silt & clay
- sediment organic content

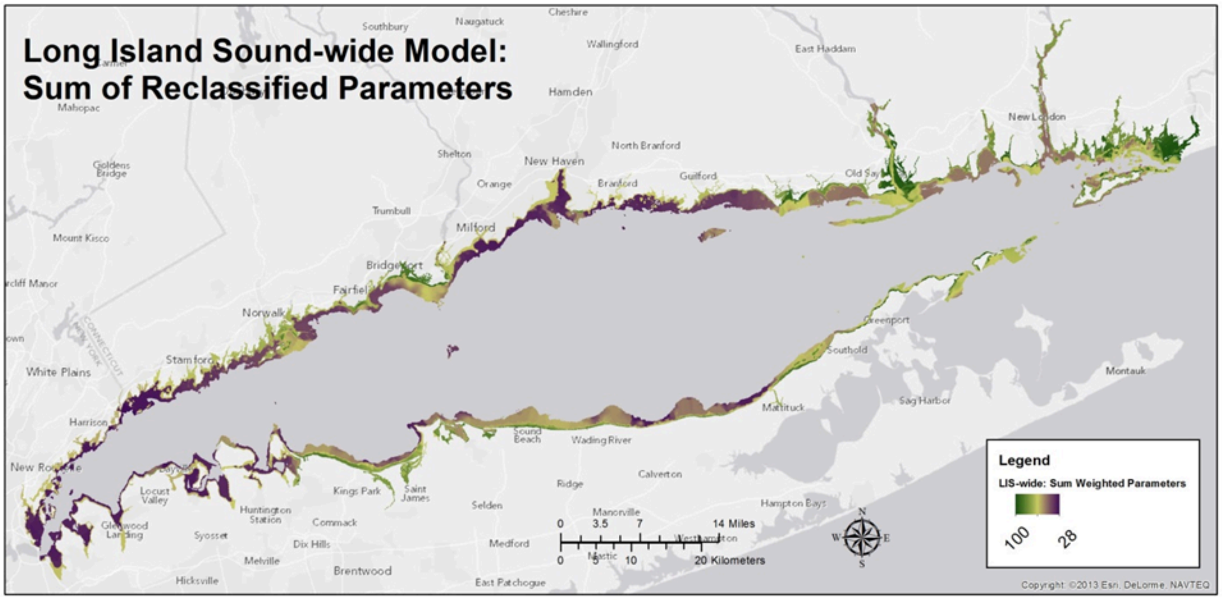

Figure 4: Site Suitability Score (Vaudrey et al., 2013)
The ranking results of the five selected parameters which were weighted and then summed to a maximum score of 100. A score of 100 is considered most ideal for eelgrass and 0 is least ideal. The lowest score within the exclusive band is 28. Eelgrass restoration should be targeted in areas with a score >88% and eelgrass is not expected to occur in areas with a score ≤50%.

The Eelgrass Habitat Suitability Index was updated in 2023 as part of an EPA ORISE Fellowship hosted by the Long Island Sound Study (Lawton, 2023). Improved temperature forecasts were applied to the embayments included in the model, using new temperature data available for the embayments. The temperature in the embayments had been identified as a weakness in the previous EHSI model, as temperature data were only available in the main stem of Long Island Sound and extrapolated into the embayments using a conservative approach - meaning that the embayments were modeled as being cooler than would realistically be expected, so that areas were not erroneously ruled out due to a lack of data. This update confirmed the general assessment provided earlier in this Section that embayments are likely to be too warm to warrant attempts at restoring eelgrass.

A new update to the Eelgrass Habitat Suitability Index is expected to be funded in 2024. This new version of the model will incorporate additional data now available for Long Island Sound, including improved bathymetry (depth), temperature data, and new results on sediment characteristics.

2.3. Eelgrass Habitat Restoration in Connecticut

Eelgrass restoration requires a series of steps:

1. Evaluate a site for suitability using a model, if available.
2. Field visit to evaluate the site and assess for habitat suitability. Aspects to evaluate include:
    a. Proximity to existing beds
    b. Historical presence of eelgrass
    c. Water clarity / light penetration
    d. Depth
    e. Temperature
    f. Sediment type – grain size and chemical composition
    g. Flushing and currents
    h. Nutrient impairment status
    i. Competing ecosystem factors such as beneficial vs. detrimental seaweed
    j. Known conflicting uses (e.g., mooring fields, intense use)
3. Pilot planting, to confirm the site will accommodate a full-scale restoration.
4. After a suitable waiting period (varies depending on which season the plants were installed), confirm plant survival.
5. Scale up with additional large-scale planting efforts.

In Long Island Sound, the Marine Program at Cornell Cooperative Extension of Suffolk County has been the leader in restoration efforts (CCE, 2023). As part of the development of the Eelgrass Habitat Suitability Index model development, they planted test plots in a number of sites to assess the validity of the model, including in Clinton, Groton, and Stonington (Vaudrey et al., 2013). This group has the facilities and staff to support large scale restoration efforts. Additional efforts have been undertaken by Save the Sound in various locations around Long Island Sound, and by Save the Bay in Little Narragansett Bay.

Several different restoration methods have been performed in Connecticut and elsewhere. All approaches generally fall into one of two categories: planting seeds or transplanting adult plants. Both require access to suitable donor beds from which to collect the seeds or adult plants. A variety of methods have been used to plant eelgrass, with the variety reflecting that some methods work best under certain environmental conditions (Orth et al., 2007).

As stated on the Cornell Cooperative Extension of Suffolk County website (CCE, 2023): "*Adult shoot work normally involves harvesting plants from an existing meadow and transplanting them to the restoration site as there is no readily available source of nursery grown eelgrass. In most cases, some means of anchoring the shoots to the bottom is necessary until the roots can take hold (root into the bottom). Seeding involves hand, or in some regions (e.g., MD & VA) machine, harvest of mature reproductive shoots from natural meadows and holding them in flowing seawater tanks until the seeds are released naturally. In the fall, the seeds are broadcast.*"

Adult plants can be harvested from the eroded edges of existing beds, where eelgrass is already becoming uprooted; shoots with a few inches of attached rhizome are collected.

Alternatively, plants may be harvested from dense beds at a rate of one shoot per square meter with little impact on the existing beds. Seeds are harvested by collecting reproductive shoots, which often host 30 to 50 seeds per shoot. The reproductive shoots are held in seawater tanks and seeds are harvested as they drop from the shoots; a variety of methods have been developed to facilitate seed separation and collection.

A few of the methods for restoration planting are reviewed here:

ADULT PLANTS

Free Planting: Divers press the rhizomes of individual plants into the sediment without anchoring. This method works only in moderate to low-energy sites with soft sediment. Otherwise, anchoring of the plants is required.

Rock Planting: When rocks are available, Cornell Cooperative Extension of Suffolk County divers press the rhizomes of individual plants into the sediment and use rocks already present in the environment to anchor the plants. Multiple plants can be anchored with a single rock, if the rock is large enough.

Burlap Disc Planting: This method was developed by Cornell Cooperative Extension of Suffolk County and has been very successful in Long Island Sound. A burlap disc approximately ten inches in diameter is prepared with a series of holes pressed into the fiber. Ten eelgrass plants are woven by volunteers into the disc, with roots oriented towards the center of the disc. In the water, divers press a plastic ring into the sediment, remove some sediment, place the disc, then replace the sediment and remove the form.

Researchers at the University of Connecticut are working with CCE to test the effectiveness of adding soil amendments under the burlap discs in increasing the survival rate of newly transplanted eelgrass.

TERFS™: Transplanting Eelgrass using Remote Frames System (TERFS) is a method developed at the University of New Hampshire by Short et al. (2002). Fifty eelgrass shoots in pairs (i.e., 25 planting units) are attached to a weighted rubber-coated wire frame with biodegradable paper twine. This method avoids SCUBA diving for planting, as the weighted frames are lowered to the seafloor from a boat. The TERFS and eelgrass remain in place for three to five weeks to allow the plants to root into the sediment, then divers return and collect the frames, leaving the eelgrass in place. Modifications of this method have been attempted by MA Marine Fisheries where the metal frame is replaced by a plastic frame creating the outer rim (1m x 1m) and jute netting within the interior affixed to the plastic frame with cable ties (Evans, 2015). A diver returns and clips the jute netting free of the frame, leaving the net in place to continue anchoring the plants and eventually biodegrading.

SEEDING

Broadcasting: This method requires planters to throw seeds into the desired planting area by hand. This method is one of the least labor intensive methods. Seeds are typically broadcast at seed densities of 100,000 to 200,000 per acre (Orth et al, 2006a).

Bottom anchored burlap bags: Seeds are placed in small burlap bags with a bit of fine sediment and anchored in lines along the bottom. This method has generated high rates of seedling establishment as the seeds are anchored and protected (Orth et al., 2006b).

Seed injection: seeds are suspended in gel and injected into the sediment by a diver using a sealant gun (Gräfnings et al., 2023).

Mechanical sowing: seeds are suspended in gel and sowed into the sediment using a specially designed mechanical seed planter which sows a number of rows simultaneously (Traber et al., 2003).

BuDS: Buoy Deployed Seeding System (BuDS) was developed to reduce time in handling the reproductive shoots and sorting seeds from shoot material (Pickerell et al., 2005, 2006). Reproductive shoots are placed in bags which are floated at the desired restoration site. As the seeds mature, they are released from the shoots and drop from the bag into the desired restoration area.

Clam Planting: Save the Sound is working with Rob Vasiluth to assess the effectiveness of gluing seeds to small quahog clams. The clams bury and anchor the seeds, allowing the plants to stay in the area and to take root. As the plants grow, the rhizome extends the plant away from the clam and the plant detaches from the clam.

2.4. Existing Infrastructure and Future Needs to Support Restoration

INFRASTRUCTURE

While Cornell Cooperative Extension of Suffolk County has facilities and staff to support restoration efforts, no similar facilities exist in Connecticut. Expanding areas to hold adult eelgrass plants, process reproductive shoots, and store eelgrass seeds is necessary to support restoration efforts. A work force is required to support restoration. This could occur under a number of different structures: from University-based similar to Cornell Cooperative Extension of Suffolk County, to fully private companies conducting restoration on a fee-for-service basis. In all cases, coordinating closely with Cornell Cooperative Extension of Suffolk County is recommended, to best coordinate and grow restoration in Long Island Sound.

FUTURE NEEDS AND CONSIDERATIONS

A commonality among seeding and transplanting adult shoots is that they require existing beds, supplying either seeds or adult plants. Both methods involve the same challenges: maintaining a sustainable harvest and making a choice between 'local' beds or selecting stock from more distant and possibly more resilient genetically diverse beds. Genetic diversity of local beds may limit their utility to support restorations from the perspective of climate change stressors.

Existing beds that have adapted to local climatic conditions (e.g., water temperature) over the past few decades might not be the best plants to serve as the next generation that will have to thrive in unpredictably warmer conditions. Restorations in other states have incorporated inclusion of seeds harvested from eelgrass growing in warmer, more southerly, regions. This type of approach can be similarly applied to donor plants for transplants and should be considered as part of a concerted Connecticut effort for restoration. Such an approach comes with additional challenges associated with introduction of organisms but it is likely essential for building a diverse genetic stock best suited for surviving multiple stressors.

The second challenge associated with relying on local beds to supply seed or donor plants, is one of sustainability. Large scale restoration efforts would draw on relatively sparse acreage of existing Connecticut eelgrass beds. Policies and/or incentives for sustainable use of those beds will be critical if and when the scaling of restorations increases. More practical considerations for doing restorations on a meaningful scale include adequate personnel and infrastructure for harvesting and maintaining seeds or transplants as well as executing the restoration. Finally, there needs to be a systematic approach to gauging efficacy of restorations which leads to appropriate expectations on outcomes. In other words, establish clear criteria for what 'success' looks like, and support efforts to make the measurements necessary for that evaluation. Criteria for success used in some restorations is whether a restored bed exists three years following restoration. Other metrics beyond survival that might be considered are size, rate of expansion, and suitability as a new donor site. Regardless of the specific criteria, Connecticut should derive a set of metrics in order to justify any state supported efforts for restoration and calibrate expectations appropriately on the time horizon for return on investment.

3. Existing Policy, Legislation, and Recommendations

A number of organizations in Long Island Sound and in neighboring areas have set goals for eelgrass preservation and restoration. This summary was largely adapted from the work of Emily Watling and Katie Lund of the Connecticut National Estuarine Research Reserve, developed for the Eelgrass Collaborative.

3.1. Local EPA National Estuary Programs and NOAA National Estuarine Research Reserves

Long Island Sound Study 2015 Comprehensive Conservation and Management Plan (CCMP) - The CCMP includes actions calling for an increase in eelgrass extent and to support healthy eelgrass communities. Such actions call for improved water clarity by 2035 and reduced nitrogen pollution in the Sound. Long Island Sound Study has established a goal for eelgrass extent in Long Island Sound of 4,061 acres. Based on aerial imagery acquired in 2012, 2,061 acres currently exist. Therefore, an expansion of eelgrass extent by another 2,000 acres by 2035 is the target. The target goal will be achieved with water quality protections, reductions in land-based input of nutrients, and replanting efforts. The Long Island Sound Study developed the Habitat Restoration and Stewardship Work Group, which tracks and identifies areas for eelgrass restoration projects.

Peconic Estuary Program 2020 Comprehensive Conservation and Management Plan (CCMP) - The goals of the Peconic Estuary Partnership are to restore and protect key habitats and species diversity in the Peconic Estuary and its watershed including monitoring, protecting, restoring, and enhancing eelgrass beds. Since 2000 there have been ongoing eelgrass restoration projects in the estuary, including the protection of the westernmost eelgrass beds through the Bullhead Bay Eelgrass Sanctuary project in 2009. The Peconic Estuary Program has been utilizing tools such as the Seagrass Bio-Optical and Habitat Suitability Model to understand light and temperature requirements of eelgrass in the Peconic estuary, and established 2020 goals to build scientific understanding and support decision-making to address threats to eelgrass beds. Specific research and monitoring priorities will include impacts to eelgrass habitats by groundwater, pesticides, and cooling effects, as well as research into eelgrass traits and population genetics.

Long Island South Shore Estuary Reserve 2022 Comprehensive Management Plan - The South Shore Estuary Program focuses on estuary protection and eelgrass restoration, with a goal to maintain an eelgrass distribution inventory to identify key locations for conservation. This project is supported by periodic surveys in Long Island Sound and the Peconic Bays, utilizing benthic mapping from aerial imagery and surface level verification. The program works with other groups such as the Shinnecock Bay Restoration program to reduce harmful algal blooms and the Cornell Cooperative Extension of Suffolk County to organize volunteer programs to restore and monitor eelgrass beds through adult shoot transportation and seeding programs. Much of the South Shore Estuary Program's work also involves the 2012 New York State Seagrass Protection Act, which directs the designation of seagrass management areas, as well as the development of a seagrass management plan across coastal waters and the bays within the Reserve.

Narragansett Bay Estuary Program 2012 Comprehensive Conservation and Management Plan - Due to such factors as poor water quality and wasting disease, the Narragansett Bay Estuary, which once had a widespread eelgrass population, is now limited to a 400-acre bed in the lower part of the Bay. The Narragansett Bay Estuary Program has worked alongside many partners, including the Greenwich Bay transplant project, to restore eelgrass population in the Bay since 1995. Other partners include the University of Rhode Island, Save the Bay, Rhode Island Department of Environmental Management, Rhode Island Coastal Resources Management Council (RI CRMC), and NOAA. Efforts for restoration have included seeding and planting by hand, with Save the Bay specifically helping to lead shoot transplanting projects. Water quality improvement will be the next issue addressed in the restoration of habitat within the Narragansett Bay.

Connecticut National Estuarine Research Reserve (CT NERR) - The Reserve focuses on collaboration between groups working on ongoing restoration projects, reviewing the ecological effects of restoration, and developing long-term monitoring projects to establish a baseline understanding of sensitive habitat in coastal Connecticut. Within the first five years of the development of the Reserve (established in July 2022), projects will focus on tidal marsh restoration and eelgrass monitoring in the Reserve boundaries in eastern Connecticut, eastern Long Island Sound, and western Fishers Island Sound. The Reserve will also address public access issues in Reserve properties.

3.2. Neighboring States

NEW YORK

New York State Law and Regulations (From [Report of the New York State Seagrass Task Force](#) p. 20-21). New York State does not currently have any regulations or laws specifically protecting seagrass, however many laws, mandates and regulations apply to areas where seagrass may be found. These regulations either indirectly or directly affect seagrass beds, but do not specifically protect seagrass or seagrass habitat.

Environmental Conservation Law (ECL):

- 6NYCRR Part 49: Shellfish Management- Gives New York State Department of Environmental Conservation (NYSDEC) authority to develop regulations on manner and method of taking and gear restrictions for harvest of hard clams, soft clams, razor clams, oysters and scallops.

- ECL Article 13 restricts the use of mechanical harvest on public or unleased underwater land except for the taking of certain species defined in law. Both the ECL and 6NYCRR are generally resource-based and should be amended to afford protection of seagrass habitat that may be impacted by shellfish harvesting activities.

- ECL Article 25 & 6NYCRR Part 661: Tidal Wetlands Land Use Regulations- Gives NYSDEC jurisdiction over tidal wetlands up to 6 feet below Mean Low Water (MLW), which includes some, but not all of the seagrass habitats in NY. It does not give the DEC authority to restrict activities that may negatively affect seagrasses.

- 6NYCRR Part 46: Public Use of State-Owned Tidal Wetlands – This regulation protects tidal wetlands, requiring permits for use and outlines public-use criteria, however this is exclusive of seagrass.
- ECL Article 15 & 6NYCRR Part 608: Protection of Waters, Article 15- Provides authority for docking rules and regulations, water quality, and disturbance of tidal wetlands by filling water with materials. Seagrass is not mentioned in this act.
- 6NYCRR Part 617: State Environmental Quality Review (SEQR)- Process requires that any project or activity proposed by the state or other local government agency undergo an environmental impact assessment to identify and mitigate the significant environmental impacts of proposed projects. New York State Coastal Management Program Policies require the protection of habitats that support commercially and recreationally important species (see Table 2) and habitats that are essential to the survival of a large portion of a fish or wildlife population. New York State Navigation Law requires that boaters maintain three feet of depth (low water mark) when navigating shallow areas. This helps reduce boat-induced damage in seagrass habitats, but is not a habitat based management tool.

RHODE ISLAND

RI Coastal and Estuarine Land Conservation Plan w/ regulations*: Rhode Island Coastal and Estuarine Land Conservation Plan

Title 650 Coastal Resources Management Council: Chapter 20-Coastal Management Program*: https://risos-apa-production-public.s3.amazonaws.com/CRMC/REG_12984_20230713145031502.pdf

- **Exact wording** "Proposed aquaculture leases may not be sited where eelgrass (*Zostera marina*) or widgeon grass (*Ruppia maritima*) exists."

From RI Coastal Resources Management Council page on Submerged Aquatic Vegetation - The goal of CRMC is to preserve, protect, and where possible, restore SAV habitat. The following activities under CRMC jurisdiction are required to avoid and minimize impacts to SAV habitat under Section 300.18 of the RI Coastal Resources Management Program (RICRMP):

- Residential, Commercial, Industrial, and Public Recreational Structures, Section 300.3
- Recreational Boating Facilities, Section 300.4
- Sewage Treatment and Stormwater, Section 300. 6
- Dredging and Dredged Materials Disposal, Section 300.9
- Filling in Tidal Waters, Section 300.10
- Aquaculture, Section 300.11
- Activities undertaken in accordance with municipal harbor regulations, Section 300.15

From Title 650 – Coastal Resources Management Council Chapter 20: Coastal Management Program

- The Council's goal is to preserve, protect and where possible, restore SAV habitat. In cases where the Council determines that SAV may be altered or grants a special exception to a prohibition listed in § 1.3.1(R)(2) of this Part, the Council shall require the mitigation of all impacts to SAV. Such activities requiring mitigation include, but are not limited to, marina expansions, dredging, filling in tidal waters, construction of commercial docks and/or structures and any other activity determined by CRMC that has not significantly or appropriately avoided impacts to SAV. Permanently lost or significantly altered SAV shall be replaced through the restoration of an historical SAV habitat or the creation of a new SAV habitat at a site approved by the Council. The ratio of restoration to loss shall be 2:1.

- Activities under CRMC jurisdiction, including residential, commercial, industrial, and public recreational structures (§ 1.3.1(A) of this Part), recreational boating facilities (§ 1.3.1(D) of this Part), sewage treatment and stormwater (§ 1.3.1(F) of this Part), dredging and dredged materials disposal (§ 1.3.1(I) of this Part), filling in tidal waters (§ 1.3.1(J) of this Part), aquaculture (§ 1.3.1(K) of this Part), and activities undertaken in accordance with municipal harbor regulations (§ 1.3.1(O) of this Part), shall avoid and minimize impacts to SAV habitat.
- Floats, and float and platform lifts (including grate-type structures) associated with residential docks are prohibited over SAV as defined herein (See § 1.1.2(A)(157) of this Part).
- Boat lifts having the capacity to service vessels larger than a tender (vessels greater than twelve (12) feet long and greater than one thousand two hundred (1,200) lbs) are prohibited over SAV.
- The long-term docking of vessels at a recreational boating facility shall be prohibited over SAV.

3.3. Management in Connecticut

At present, the current approach to the managing and/or expanding eelgrass acreage is a tripartite effort that includes regulations, education, and more recently, restoration. Regulations for preserving existing beds largely derive from the Connecticut Coastal Management Act G.C.S. Sec 22a-93(15)(G).

The Connecticut Coastal Management Act (CCMA), related Connecticut legislation, and trickle down policies at Connecticut Department of Agriculture Bureau of Aquaculture (DABA) and Connecticut DEEP provide guidance on shading from structures and intentional disturbance from conflicting uses. Such uses include but are not limited to aquaculture, boating, and other marine operations. Some regulations and policies are accompanied by enforcement and penalties while others are not. Additional implementation of regulations that deal with potential conflicts is exerted through the U.S. Army Corps of Engineers (USACE) which oversees permitting of activities that fall under the Federal Statute of the Rivers and Harbors Act of 1910.

Through the CCMA, eelgrass protection is extended into landside activities in the form of sediment and nutrient management (e.g., silt fencing, setbacks, etc.) fully recognizing that what goes on in the watershed is critical to being able to maintain existing eelgrass habitat or setting the stage for restoration.

Table 1: Regulations, Relevant Legislation IDs, Policy Document IDs, Agency Responsible or Origin of Policy

Regulation or Policy	Conflict	Origin or Agency	Actions covered
C.G.S Section 22a-361	Mooring	CT DEEP Local Municipality	Placement of mooring fields
Reg Section #	Aquaculture	DABA	Shading from surface gear Setback distance of bottom gear from beds
C.G.S. Sections 22a-359 – 22a-363f	Shoreline construction / general marine ops	USACE / CT DEEP	Dredging Dock / pier siting
C.G.S. Sections 22a-90 – 22a-113	Watershed Activities	CT Legislature	Septic / wastewater management Development suitability Sediment management
Town Shellfish Management Plans	Recreational Shellfishing	Local Municipality	Harvesting in grass beds??

LONG ISLAND SOUND BLUE PLAN

As part of a marine spatial planning activity, the Long Island Sound community developed the Blue Plan. The Long Island Sound Blue Plan provides an inventory of the natural resources and uses of Long Island Sound and establishes a spatial plan to guide future use of the Sound's waters and submerged lands, including eelgrass habitat. The purpose of the Blue Plan is to facilitate a transparent, science-based decision-making process for the preservation of Long Island Sound's ecosystems and resources and the protection of traditional uses, while maximizing their compatibility and minimizing conflicts between them now and in the future. Organizational teams and working groups were developed to create and identify criteria for Ecologically Significant Areas (ESAs), which include areas where Submerged Aquatic

Vegetation (SAV), including eelgrass, is or has been found in the past. The Blue Plan identifies policies that regulatory agencies use in decision making under their existing authority.

4. Potential Barriers to Restoration

Barriers to restoration can be classified into three general categories:

1. *Availability of Funding* - Funding is required for conducting the act of restoration, from plant collection and storage to planting. Additionally, support for research to investigate the best methods to apply in Long Island Sound and to innovate new and cost-effective methods for large-scale restoration are necessary, And finally, funds to support monitoring to assess the efficacy of restoration efforts are instrumental to assessing which effort should be supported in the future.

2. *Site and Permitting of Harvesting and Planting* - Understanding which sites are most suitable for restoration will make efforts more successful and increase cost effectiveness. Confirming permitting requirements for harvesting and planting will support restoration success while maintaining control over and coordination of restoration efforts.

3. *Competing Uses of the Environment* - Identifying potential competing uses of the environment and allaying fears of community members is critical to long-term success and support for restoration. Collaborating with DEEP, DABA, and USACE in creating a restoration strategy for Connecticut will identify concerns and allow restoration practitioners to understand and address any issue or requirements in a speedy fashion, especially with regards to the interactions between aquaculture and eelgrass.

4.1. Siting and Permitting of Harvesting and Planting

In terms of the harvesting and planting of eelgrass seeds to adult plants, the working group was not able to identify any permitting requirements. However, the Eelgrass Collaborative is conducting a much more thorough literature search combined with interviews with agency officials to determine what policies or permit requirements might apply. The working group suggests the Connecticut General Assembly's Environmental Committee either reconvene this working group in January 2025 to review the output of the Eelgrass Collaborative or review the report that will be generated by the Eelgrass Collaborative on this topic.

One concern related to the large-scale harvest of eelgrass adult plants or seeds to support restoration efforts is the possibility to over-harvest our existing beds. Research is needed to understand how repeated harvesting of eelgrass beds impacts the long-term health of the harvested beds. This type of harvest has been occurring in the Chesapeake Bay region and other areas around the world. Funds are needed to support a literature review and field studies in Connecticut and Long Island Sound should be encouraged. Dr. Torrance Hanley at Sacred Heart University is leading a NOAA National Estuarine Research Reserve System Science Collaborative-funded proposal to bring together restoration scientists and practitioners from around the nation to discuss and share lessons learned on seed-based restoration. Proceedings from this meeting could inform Connecticut's policies on harvesting of seeds in local beds. This event should occur in late 2024 or early 2025. Finally, the working group suggested exploring the idea of leasing eelgrass beds as harvest sites. Lease owners would be incentivized to ensure their beds were not over-harvested, in order to maintain an annual harvest of seeds or adult shoots. This idea could be investigated by examining how shellfish leases are currently handled throughout the State and determining if such a mechanism could work for eelgrass harvest.

Importing eelgrass from areas outside of Long Island Sound in seed form should be investigated with the state agencies. While no permit is required and there does not seem to be a legislative prohibition against importing seeds, developing policies around the import of seeds from outside of Long Island Sound would reduce the risk of unwanted consequences from importing seed stock. In particular, certain stakeholders have expressed concern related to introduction of bioinvasions or disease with the import of non-Long Island Sound eelgrass plants. Such risk is hard to mitigate when transporting adult plants. However, seeds can be sterilized using a 1% solution of liquid bleach (e.g., Tanner and Parham, 2010), which may provide sufficient removal of biological contaminants. Bleaching of seeds is a common disinfection technique in the cultivation of land plants.

4.2. Co-location of Restoration and Aquaculture

The interaction between eelgrass and aquaculture can be mutually beneficial, as eelgrass provides valuable ecosystem services that can enhance the sustainability and productivity of aquaculture operations. Here are some key aspects of the interaction between eelgrass and aquaculture:

Habitat and Biodiversity Support:

- Eelgrass beds serve as an important habitat for various marine species, including juvenile fish and invertebrates.
- Aquaculture facilities located near eelgrass beds can benefit from increased biodiversity, as these habitats attract and support a diverse range of marine life.

Water Quality Improvement:

- Eelgrass plays a role in improving water quality by absorbing nutrients and stabilizing sediments.
- Aquaculture systems can benefit from the water-filtering capacity of eelgrass, which helps maintain better water quality conditions.

Stabilization of Sediments:

- Eelgrass roots help stabilize sediments, preventing erosion and maintaining sediment structure.
- This stabilization can be beneficial for aquaculture sites by reducing sediment disturbance and enhancing the stability of the seafloor.

Nutrient Cycling:

- Eelgrass contributes to nutrient cycling by taking up nutrients from the water and releasing oxygen during photosynthesis.
- Nutrient cycling can be important for aquaculture systems by mitigating nutrient imbalances and promoting overall ecosystem health.

Fisheries Enhancement:

- Eelgrass beds are important nurseries for many commercially important fish species.
- The presence of eelgrass can enhance nearby fisheries, potentially benefiting aquaculture operations that rely on healthy fish populations.

It's essential to carefully manage the interaction between eelgrass and aquaculture to avoid negative impacts. Practices such as selecting suitable sites, implementing sustainable aquaculture practices, and considering the ecological needs of eelgrass can help maintain a positive and mutually beneficial relationship between eelgrass and aquaculture.

5. Engaging the Community

Community engagement is key to promoting and advancing eelgrass restoration in Long Island Sound. Key goals of an engagement plan should include:

- Address concerns related to eelgrass restoration and expansion across the board range of community members and stakeholders.
- Allay fears related to competing uses of the environment.
- Share successes across all efforts, including research, monitoring, restoration, and efforts which set the stage for successful restoration (e.g., water quality improvements, workforce development, infrastructure upgrades).
- Highlight the benefits achieved through eelgrass expansion.

All aspects of advancing eelgrass protection and restoration would benefit from the creation of a State-managed position for a Seagrass Coordinator to oversee and interact with the various stakeholders associated with eelgrass in Connecticut, Long Island Sound, and the broader eelgrass community. This person would be a vital resource for researchers, restoration practitioners, funding agencies, and stakeholders. They would be ideal for managing and advancing engagement and education activities.

A robust community engagement plan requires education. Education is largely divided into public education and policymaker education with some overlap. Public education efforts may take the form of efforts to limit physical disturbance and raise awareness of mitigating nutrient pollution (e.g., septic and sewer inputs, lawn fertilization, stormwater management). While these educational efforts related to watershed activities are often not targeted towards eelgrass, by reducing inputs that cause coastal eutrophication, they are, by extension, educational efforts for managing eelgrass. Making these linkages clear could be added into watershed education.

Policy level education is designed to soundly evaluate what competing uses, land or waterside activity, may intentionally or unintentionally degrade eelgrass coverage. That information is used to identify actionable changes to create or modify policy implemented at either state or local levels. Currently conflicting uses are obvious, such as anchoring in beds, while others are presumed to be conflicts with limited evidence of negative consequences for eelgrass. These data gaps should be identified and addressed in a systematic way to provide policy makers with sound actionable information. The educational and regulatory efforts surrounding eelgrass are largely designed to either reduce damage or to provide space or time for the natural recovery of beds that have become impaired.

PLANNING FOR COMMUNITY ENGAGEMENT

The working group identified a number of stakeholder types, their primary concern or motivation, and key messages for each group. Additionally, thoughts were provided on the relationships with these stakeholders, and the challenges and opportunities available when interacting with them. The following table summarizes our discussions. The table represents the opinions of our working group—we did not engage with the stakeholders to determine if our impression of their concerns and motivation were accurate. Vetting these messages with stakeholders should be a next step.

Stakeholder Type	**(Their) Concerns | Motivations**	**(Our) Key Messages**	**Relationship | Challenges | Opportunities**
Researchers	Understand the factors influencing eelgrass decline	Develop monitoring programs and evaluate best habitat restoration techniques for CT coastline	Weak ⚪ ⚪ ⚪ ⚪ ⚫ Strong Easy to get them into a meeting

Stakeholder Type	**(Their) Concerns | Motivations**	**(Our) Key Messages**	**Relationship | Challenges | Opportunities**
State / federal regulators	Protection of existing eelgrass, encouraging expansion of eelgrass, all with consideration of existing regulations around shoreline development, navigation, shellfish, etc. | mandate to protect the environment while allowing sustainable development and industry	Current knowledge of restoration science, keeping people up-to-date; sharing concerns of the various communities and stakeholders defined in this table (may have existing connections with these groups)	Weak ⚪ ⚪ ⚪ ⚪⚫ Strong Easy to get them into a meeting
Environmental Non-governmental Organizations (ENGOs)	Environmental sustainability, education and outreach, restoring ecosystems, can depend on what the focus of the NGO is.	Best practices / techniques when restoring eelgrass, how to get involved, what else is going on in the state. Blue Carbon - an acre of eelgrass has more than double the carbon sequestration value of forested land	Weak ⚪ ⚪ ⚪ ⚫ ⚪ Strong Easy to get into a meeting, but we are not always aware of their efforts/existence. Encourage them to include outreach messages and materials and activities at events.
Community water quality monitoring groups	Clean water for public recreation use. Use of upland areas that contribute pollutants.	Eelgrass as an indicator of good water quality. Best land use practices that promote clean water and eelgrass health.	Weak ⚪ ⚪ ⚫ ⚪ ⚪ Strong Possible to get into a meeting; few paid positions. Engagement - can they observe eelgrass in their habitats of interest.

Stakeholder Type	(Their) Concerns | Motivations	(Our) Key Messages	Relationship | Challenges | Opportunities
Shell-Fishermen	Present regulatory policy prohibits shellfish activity within 50 feet Eelgrass (clump, bunch, patch)	Dense eelgrass stands could potentially enhance the ability of oyster spawn to stay within a specific area rather than be pulled or pushed on tidal exchanges, enhancing recruitment in the greater area.	Weak ⚪ ⚫ ⚪ ⚪ ⚪ Strong Difficult to get into a meeting. Coordinate with people already tied into this community (e.g., Connecticut Sea Grant staff) to increase opportunities for engagement.
Aquaculturists	Identifying sustainable practices to minimize negative impacts to eelgrass	Develop educational material to inform the public on the ecological significance of eelgrass and restoration efforts	Weak ⚪ ⚫ ⚪ ⚪ ⚪ Strong Difficult to get into a meeting. Coordinate with people already tied into this community (e.g., Connecticut Sea Grant staff) to increase opportunities for engagement. Potential to develop eelgrass cultivation / harvest may be of interest to this group.
Recreational boaters	Limitations or restrictions on their access to areas of Long Island Sound, limitations on their ability to anchor. Most want a healthy LIS to support recreation.	Fishers Island has a “look before you drop” campaign - encouraging boaters to not anchor in eelgrass. This seems like a key message. Also - informing people as to the benefits of eelgrass and why it is a good thing - perhaps encourage people to snorkel or fish in these areas, to highlight the benefits and encourage familiarity?	Weak ⚫⚪ ⚪ ⚪ ⚪ Strong Difficult to get into a meeting. The group is broadly distributed - there is no central organization through which you can reach these people.

Stakeholder Type	(Their) Concerns | Motivations	(Our) Key Messages	Relationship | Challenges | Opportunities
Kayakers, paddle boarders, swimmers SCUBA divers, snorkelers	Like to get out into nature and sometimes haul out (potential to contact / impact eelgrass). Contact with eelgrass (seaweed) when swimming.	Importance of eelgrass to a healthy Long Island Sound. Best practices to protect eelgrass. Education on what to see and do in and around eelgrass beds.	Weak ⚪ ⚫ ⚪ ⚪ ⚪ Strong Difficult to get into a meeting. The group is broadly distributed - there is no central organization through which you can reach these people. With training, they can help with monitoring, flowering studies, restoration
Recreational anglers / shellfish harvesters	Ability to fish/clam from shore (access) and boats and to have a high quality experience - May wonder: eelgrass is good for fishing?	Catching stripers over eelgrass meadows in clear water is a goal of restoring these meadows - healthy habitat means more fish.	Weak ⚫ ⚪ ⚪ ⚪ ⚪ Strong Difficult to get into a meeting Could reach through CT Surfcasters/ CT DEEP Fish Advisory Committee
Commercial anglers/ party boats	Ability to have enough fish (& quality fishing) to attract clients.	Eelgrass habitat provides fluke habitat as well as nursery function for other species and structure for forage fish	Weak ⚪ ⚪ ⚫ ⚪ ⚪ Strong Difficult to get into a meeting Work through DEEP meetings with charter boat captains. DEEP Marine Resource Advisory Group (MRAG)
shoreline restoration practitioners; coastal engineers	Similar to ENGOs, goal is usually restoration of specific areas; in the future these could be independent businesses.	Best practices, current knowledge of restoration science; training in carbon credit trading, grant opps, networking etc.	Weak ⚪ ⚪ ⚪ ⚫ ⚪ Strong Easy to get into a meeting, but we are not always aware of their efforts/existence.
Conservation, Shellfish, and Harbor Management Commissions	Clean water for shellfish harvest (recreational and commercial). Abundant harvest. They may be concerned with competing uptake of nutrients. Competition for space.	Once eelgrass is established, it continues to absorb nutrients. Potential for beneficial relationship between scallops and eelgrass.	Weak ⚪ ⚪ ⚫ ⚪ ⚪ Strong Possible to get into a meeting; most are volunteers.

Stakeholder Type	(Their) Concerns | Motivations	(Our) Key Messages	Relationship | Challenges | Opportunities
coastal property owners	How will this affect my ability to construct a dock or seawall; access to water from home; property values? Want to be involved in decisions that may affect their property.	Eelgrass is an important and federally-protected habitat; riparian rights are protected; water quality improvements may benefit them; tax abatement? Storm surge absorption / property protection	Weak ? ⚫⚪ ⚪ ⚪ ⚪ Strong May be tough to get contact information to access large numbers; work through home-owners associations
marina operators / yacht clubs / public boat ramps and launches	How will this affect my ability to expand my dock/facility? Property values. Want to be involved in decisions that may affect their property.	Eelgrass is an important and federally-protected habitat; must consider the potential for impacts. Storm surge absorption confers property protection. Proof that marinas can be productive marine habitats.	Weak ⚪ ⚪ ⚫ ⚪ ⚪ Strong These sites could be great places to communicate messages about eelgrass habitat via signage or outreach presentations. Outreach to CT Marine Trades Association.

6. Working Group Recommendations

The recommendations of the Working Group are designed to develop strategies for the preservation, restoration and expansion of eelgrass along the state's shoreline. The Long Island Sound Study has established a goal for eelgrass extent in Long Island Sound of 4,061 acres. Aerial imagery acquired in 2012 mapped 2,061 acres of eelgrass; an expansion of eelgrass extent by another 2,000 acres by 2035 was the target established in 2020.

Key aspects include:

- Protect Existing Eelgrass Resources
- Monitor the Health and Extent of Long Island Sound Eelgrass
- Improve and Maintain Water Quality
- Research Eelgrass in Support of Restoration Science
- Consider Barriers to Restoration
- Restore Eelgrass and Eelgrass Habitat
- Educate and Engage Connecticut Citizens

6.1. Legislative Recommendations

> **Create a State-managed position for a Seagrass Coordinator** to oversee and interact with the various stakeholders associated with eelgrass in Connecticut, Long Island Sound, and the broader eelgrass community.

> Large scale restoration efforts will draw on relatively sparse acreage of existing Connecticut eelgrass beds as a seed source or source of adult plants. **Policies and/or incentives for sustainable use of those beds will be critical if and when the scaling of restoration increases**. The committee discussed the idea of leasing eelgrass beds for seed harvest, so that lease owners could control the harvest of seed or plants and thus ensure harvests are sustainable. This would require working with DEEP and researchers to determine what level of harvest is sustainable and how a leasing program would work.

> **Establish a Connecticut BMP (best management practices) when aquaculture is close to eelgrass**, to supplement the existing policies. This will provide guidance to restoration practitioners, managers, and aquaculture professionals.

> Institute a policy **requiring eco-friendly mooring systems in mooring fields with a high potential to host eelgrass**, as predicted by the Eelgrass Habitat Suitability Index model.

> **Add mention of eelgrass protection to MS4 permits** for communities located in coastal areas of southeastern and central CT to explicitly identify areas where mitigation of stormwater impacts on coastal water quality will benefit existing eelgrass meadows and/or expansion.

> The working group suggests the Connecticut General Assembly's Environmental Committee either **reconvene this working group in January 2025** to review the output of the Eelgrass Collaborative related to permitting and policies surrounding restoration in Connecticut or review the report that will be generated by the Eelgrass Collaborative on this topic. Specifically, a review of the existing regulations under the U.S. Army Corps of Engineers permits should be evaluated for potential modification in the future, with DEEP and DABA policies to follow similar modifications.

6.2. Funding Needs and Recommendations

TRACKING PROGRESS

> **Collaborate with the Long Island Sound Study and U.S. Fish and Wildlife Service to support more frequent aerial mapping** of eelgrass extent in Long Island Sound. Annual tracking of extent is the industry standard for assessing success of restoration and protection efforts. Long Island Sound eelgrass is currently monitored every 3 to 5 years. A dedicated commitment to financially support the mapping would increase the frequency of surveys.

> **Provide financial and administrative support for detailed surveys at index sites** which are representative of eelgrass throughout Long Island Sound in order to assess additional eelgrass metrics such as coverage, density, biomass, habitat and eelgrass health.

> **Provide financial support to MS4 communities located in coastal areas of southeastern and central CT** to increase data collection/analyses, which can be used to identify areas where mitigation will benefit existing eelgrass meadows and/or expansion. Such financial support should also account for a management agency to provide guidance and oversight to the MS4 community.

RESTORATION RESEARCH

> Support research to **characterize the timing of seagrass flowering and seeding** in Long Island sound, to maximize efficiency of harvesting stock for restoration.

> Support research on restoration techniques to **determine which restoration techniques are viable for and highly successful** in Long Island Sound. Results should suggest pros and cons of restoration methodology, including past history and current methods.

> Support research into **innovative methods to increase eelgrass transplant success** (examples of recent efforts tested in Long Island Sound include gluing seeds to clams as a planting and anchoring method, and testing soil amendments introduced at the time of planting to improve transplant success rates. Past efforts include innovations in seed dispersal (BuDS) and planting techniques.)

> Support **common garden experiments which test genetic stock** from neighboring regions to determine if seeds from other areas **exhibit greater resilience** in the face of changing habitat and climatic conditions.

> Support completion of a **literature review** to determine **what is known regarding levels** of harvest of seeds or adult shoots **that can be maintained under an annually occurring harvest**.

> Support field studies to **assess the locally relevant harvest rate** for seeds or adult shoots that can be maintained under an annually occurring harvest.

> Support development of a **systematic approach to gauging efficacy of restoration efforts** which leads to appropriate expectations on outcomes.

> Support development of a **set of metrics which can be used to justify any state-supported efforts** for restoration and **calibrate expectations appropriately on the time horizon** for return on investment.

INFRASTRUCTURE, & WORKFORCE DEVELOPMENT

> Invest in **infrastructure development in support of field aspects** (e.g., harvesting, planting) of restoration.

> Invest in **infrastructure upgrades for housing and preparation of eelgrass** seeds and adult plants. For example, flow-through tanks / raceways, centrifuge set-up for seed separation.

> Establish a **pilot program to support workforce development** for supporting restoration as a viable industry in CT. This could occur under a number of different structures, from a University-based structure similar to Cornell Cooperative Extension of Suffolk County, to fully private companies conducting restoration on a fee-for-service basis.

> Fund the **creation of a State-managed position for a Seagrass Coordinator** to oversee and interact with the various stakeholders associated with eelgrass in Connecticut, Long Island Sound, and the broader eelgrass community.

EDUCATION

> Recommend funding and ongoing **support for a website** detailing all eelgrass efforts in CT. Potentially in combination with the Cornell Cooperative Extension of Suffolk County outreach site. The site should include educational material on the importance of eelgrass and how to help, print materials/fact sheets for use at boat ramps/marinas/yacht clubs, and announcements of volunteer opportunities. Maintenance of the website could be a task assigned to Connecticut Seagrass Coordinator.

> Support **early communication with and opportunities to provide input from local communities and stakeholder groups** surrounding any new restoration efforts.

> Support **programs to educate boaters about the importance of eelgrass** and the proper **techniques to avoid damaging eelgrass** with anchors and propellers.

6.3 Other Recommendations

COMMUNICATION and COORDINATION

> Connecticut should **coordinate closely with the Eelgrass Collaborative, the Long Island Sound Study, Cornell Cooperative Extension of Suffolk County, and Fishers Island Seagrass Management Coalition** to best coordinate and expand eelgrass restoration in Long Island Sound.

ADDRESSING STRESSORS

> Support the **purchase of eco-moorings** through a state fund to incentivize the transition from traditional moorings to eco-friendly mooring systems, such as those with helix anchors or floating docks, to minimize seabed disturbance.

> **Develop a program or add to the "Clean Marina" certification** offered by the Connecticut Marine Trades Association **incorporating eco-friendly mooring systems** in mooring fields where eelgrass is likely to occur.

> Continue to **encourage and support nutrient reduction efforts** relative to stormwater, onsite wastewater treatment systems, and wastewater conveyance and treatment associated with publicly owned treatment plants. These actions will contribute to **achieving excellent water quality** which is a critical component of eelgrass success.

> Provide **financial and administrative support to advance the installation of nitrogen-reducing onsite wastewater treatment systems for mitigation purposes only**. This will involve the development and management of a program focused in areas where nitrogen impacts to eelgrass are greatest, as well as areas with high potential for eelgrass restoration success.

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