EELGRASS MANAGEMENT PLAN FOR THE PECONIC ESTUARY

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Laura B. Stephenson
Peconic Estuary Program Coordinator
New York State Department of Environmental Conservation

Peconic Estuary Program
Suffolk County Department of Health Services, Office of Ecology
360 Yaphank Avenue, Suite 2B, Yaphank, NY 11980, 631.852.5750
www.peconicestuary.org

The Peconic Estuary Program (PEP) is a unique partnership of governments, environmental groups, businesses, industries, academic institutions and citizens. It is the mission of the Peconic Estuary Program to protect and restore the Peconic Estuary system.

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Program Director
Vito Minei, P.E., Suffolk County Department of Health Services

Deputy Program Director
Walter Dawydiak, P.E., J.D., Suffolk County Department of Health Services

Coordinators
Federal: Richard Balla, United States Environmental Protection Agency
State: Laura Stephenson, New York State Department of Environmental Conservation
County: Kimberly Paulsen, Suffolk County Department of Health Services
Technical Outreach: Emily Fogarty, Suffolk County Department of Health Services
Marine Conservation Planner: Wayne Grothe, The Nature Conservancy
Public Outreach: Jennifer Skilbred, Group for the East End

Other Key Participants:
Seth Ausubel, United States Environmental Protection Agency, PEP Management Committee Chair
Karen Chytalo, New York State Department of Environmental Conservation
Martin Trent, Suffolk County Department of Health Services
Kim Shaw, Suffolk County Department of Health Services
East End Town and Village Supervisors, Mayors, Boards, Trustees, and Staff

Peconic Estuary Program Natural Resources Subcommittee
Laura Stephenson, Co-Chair
Wayne Grothe, Co-Chair

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EXECUTIVE SUMMARY

Eelgrass stabilizes bay bottom sediments, improves estuarine water quality, and provides critical habitat for a large number of varied species within the Peconic Estuary. Once bountiful throughout in pristine waters of the Estuary, eelgrass abundance has fell victim to a downward trend. The onset of a wasting disease *(Labyrinthula zostorae)* in the early 1930s was responsible for the disappearance of approximately 90% of eelgrass beds along the entire Atlantic seaboard. Extensive and prolonged brown tide blooms in the 1980s further decimated eelgrass populations throughout the Peconic Estuary. Historical analyses and current inventories suggest that since 1930 the Peconic Estuary has lost over 80% of its eelgrass. Only 1,552 acres of eelgrass remain in the Peconic Estuary, most east of Shelter Island.

Many activities and environmental conditions can threaten or stress the health and extent of eelgrass beds. Several simultaneous multiple stressors can be blamed for the significant loss of eelgrass in the Peconic Estuary and worldwide. Within the Peconic Estuary, eelgrass beds are negatively affected by fishing and shellfishing practices, pollution, disease and harmful algal blooms, bioturbation/competition/overgrazing, boating and personal watercraft activities, dredging and excavation, storms and ice scouring, shoreline stabilization structures, and global warming and sea level rise.

The goals the Eelgrass Management Plan for the Peconic Estuary include:
1. Protect current and future eelgrass populations and prevent current and future loss or degradation of eelgrass to the maximum extent practical.
2. Ensure existence of suitable habitat conditions for future natural eelgrass re-establishment and future restoration and enhancement initiatives.
3. Advance our understanding of eelgrass dynamics.
4. Restore and increase the abundance of eelgrass acreage by 10% over 10 years and increase density and health where applicable.

Management actions were developed to help achieve the goals of this Eelgrass Management Plan for the Peconic Estuary. Respective management actions and action steps are grouped under eight (8) larger overarching objectives.

Objective 1: Enhance protection of existing and future eelgrass beds from physical disturbances.

Objective 2: Increase stakeholder, user group, and public awareness of eelgrass and the importance of the species in an effort to foster responsible steward-like resource enjoyment.

Objective 3: Build an established, consistent and comprehensive eelgrass inventory program and sentinel monitoring program.

Objective 4: Improve our knowledge and understanding of eelgrass through research initiatives to ensure that efforts to protect and restore resources are successful and effective.

Objective 5: Increase eelgrass bed abundance and density through physical restoration efforts.

Objective 6: Ensure the existence of water quality conditions necessary for conserving, maintaining, and restoring eelgrass.

Objective 7: Minimize and mitigate the negative effects from the construction of new and previously placed of docks and other shoreline stabilization structures including but not limited to bulkheads, seawalls, groins, and jetties in and surrounding eelgrass beds or in areas where restoration or re-colonization is likely.

Objective 8: Prevent, if possible, and minimize shading and other negative impacts associated with the onset of future harmful algal blooms and Brown and Red tide episodes.

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LIST OF ACRONYMS

AEM:	Agricultural Environmental Management
AMI:	Association of Marine Industries
BB:	Bullhead Bay, Southampton
BMP:	Best Management Practice
CAC:	Citizen Advisory Committee
CCA:	Chromated Copper Arsenate
CCE:	Cornell Cooperative Extension of Suffolk County
CCMP:	Comprehensive Conservation and Management Plan
CNRA:	Critical Natural Resource Area
CWA:	Clean Water Act
CZARA:	Coastal Zone Act Reauthorization Amendments
ECL:	Environmental Conservation Law
EFH:	Essential Fish Habitat
EMP:	Eelgrass Management Plan
EPA:	Environmental Protection Agency
GB:	Gardiners Bay/Hay Beach, Shelter Island
LID:	Low Impact Development
LISS:	Long Island Sound Study
MLW:	Mean Low Water
MS4:	Municipal Separate Storm Sewer System
NADP:	National Atmospheric Deposition Program
NMFS:	National Marine Fisheries Service
NPDES:	National Pollutant Discharge Elimination System
NRCS:	Natural Resources Conservation Service
NRS:	Natural Resources Subcommittee (PEP)
NYS:	New York State
NYSDEC:	New York State Department of Environmental Conservation
NYS DMV:	New York State Department of Motor Vehicles
NYSDOS:	New York State Department of State
NWH:	Northwest Harbor, East Hampton
OH:	Orient Harbor, Southold
PEP:	Peconic Estuary Program
SAV:	Submerged Aquatic Vegetation
SB:	Southold Bay, Southold
SCDHS:	Suffolk County Department of Health Services
SCDPW:	Suffolk County Department of Public Works
SGA:	Shellfish Growing Area
SGD:	Submarine Groundwater Discharge
SPDES:	State Pollutant Discharge Elimination System
SSER:	South Shore Estuary Reserve
SSS:	Shoreline Stabilization Structure
STP:	Sewage Treatment Plant
SUNY:	State University of New York
TMH:	Three Mile Harbor, East Hampton
TNC:	The Nature Conservancy
TSS:	Total Suspended Solids
USEPA:	United States Environmental Protection Agency
USFWS:	United States Fish and Wildlife Service

I. INTRODUCTION

Eelgrass stabilizes bay bottom sediments, improves estuarine water quality, and provides critical habitat for a large number of varied species within the Peconic Estuary. Once bountiful throughout the pristine waters of the Estuary, eelgrass abundance has fell victim to a downward trend. Similar trends have been documented globally. It has been quoted that the onset of a wasting disease *(Labyrinthula zostorae)* in the early 1930s was responsible for the disappearance of approximately 90% of eelgrass beds along the entire Atlantic seaboard. Extensive and prolonged brown tide blooms in the 1980s further decimated eelgrass populations throughout the Peconic Estuary. Nutrient enrichment, algal blooms, water quality, fishing and shellfishing practices, recreational uses, and shoreline stabilization structures have all likely collectively affected the health and extent of eelgrass.

Despite ongoing research, monitoring, restoration, and management efforts, eelgrass populations are still declining in the Peconic Estuary. The absence of brown tide blooms and improved water quality has not triggered a natural rebounding population, and restoration efforts have seen limited success. Developing this separate management plan will provide a nesting ground for discussion, theories, and new actions necessary to minimize impacts to eelgrass and to provide a suitable environment for eelgrass to exist. The goals of the Eelgrass Management Plan (EMP) for the Peconic Estuary are presented below.

<u>Goals of the Eelgrass Management Plan (EMP) for the Peconic Estuary</u>:

1. Protect current and future eelgrass populations and to prevent current and future loss or degradation of eelgrass to the maximum extent practical.

2. Ensure existence of suitable habitat conditions for future natural eelgrass re-establishment and future restoration and enhancement initiatives.

3. Advance our understanding of eelgrass dynamics.

4. Restore and increase the abundance of eelgrass acreage by 10% over 10 years and increase density where applicable.

This EMP provides a brief summary of the functions and importance of eelgrass, status and distribution in the Peconic Estuary, and threats to its existence. Key ecological indicators for eelgrass survival are presented, as well as policies and regulations that directly or indirectly protect or affect eelgrass. Summaries of current monitoring, protection and restoration efforts and strategies are also provided. The most useful portion of this Plan, "Management Objectives and Actions", provides a guide for future Peconic Estuary Program management initiatives.

II. EELGRASS BACKGROUND

Eelgrass (*Zostera marina*) is a rooted, underwater vascular plant which lives in temperate estuarine areas throughout the world, including the Peconic Bays. This type of submerged aquatic vegetation (SAV) is most commonly found in shallow water areas of high light penetration, and is often used as an indicator of estuarine health and high water quality. Several previous Peconic Estuary Program (PEP) reports already extensively describe the importance and value of eelgrass and eelgrass communities; only a brief summary of its functions is presented below.

Eelgrass Functions

- Provides **essential habitat, breeding and nursery grounds, and shelter and protection** for many species of fish, invertebrates, and waterfowl. Notable Peconic Bay examples include: bay scallop *(Argopecten irradians),* blue crab *(Callinectes sapidus)* winter flounder *(Pleuronectes americanus),* and brant *(Branta bernicla).*
- Aides in nutrient cycling and ensures a balanced nutrient regime.
- Dampers wave actions to allow sediments to settle; therefore, increasing water clarity.
- Stabilizes bottom sediments.
- Oxygenates bottom waters.

Eelgrass and eelgrass habitat is of biological, ecological, and economic importance. Because eelgrass beds provide habitat for numerous fish and shellfish species, many commercial and recreational fisheries depend upon healthy eelgrass populations. The role and functions eelgrass serves extend well beyond its natural aquatic environment.

III. STATUS, DISTRIBUTION, AND TRENDS IN THE PECONIC ESTUARY

Knowing and understanding where eelgrass once existed and where it currently exists is of utmost importance. Past and present eelgrass geographic distribution inventories and quantitative and qualitative assessments provide useful information that can support effective management of the species.

An historical analysis of eelgrass in the Peconic Estuary conducted by Cornell Cooperative Extension (CCE) of Suffolk County, Marine Program, the lead PEP partner in eelgrass monitoring and restoration, serves as a baseline for comparative purposes. CCE used 1930 Suffolk County aerials, personal communication, and historically documented cases of eelgrass presence to delineate estuary-wide distribution and quantify historical acreage. It is estimated that in 1930 the Peconic Estuary contained approximately 8,720 acres of eelgrass (Figure 1).

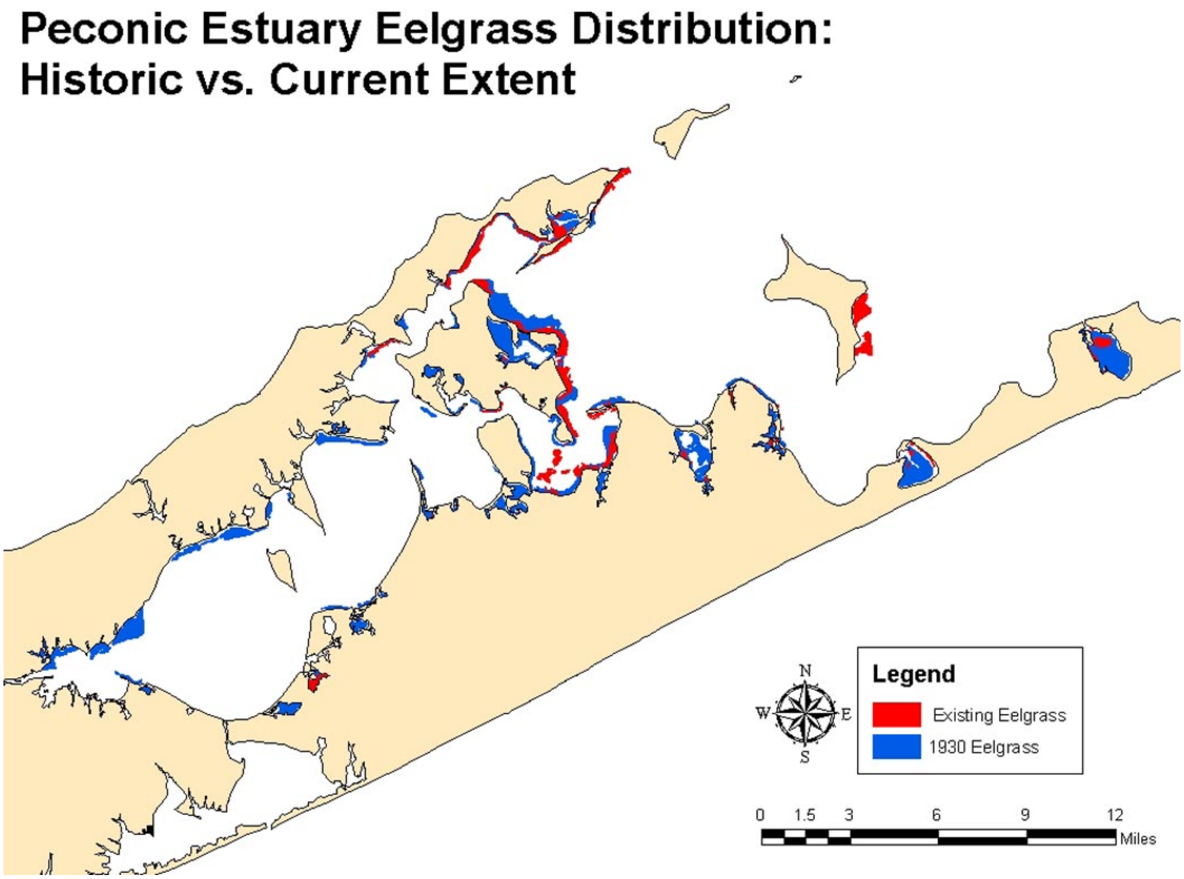


Figure 1: Peconic Estuary Eelgrass Distribution: Historic vs. Current Extent
Approximately 1,552 acres of existing eelgrass documented by Tiner, et al, 2003, using 2000 aerials, as compared to approximately 8,720 acres of 1930 eelgrass.
Source: CCE

In 1989 Dennison et al used black and white aerial photography to map the distribution of eelgrass in the Peconic Estuary in an effort to understand the effects of brown time bloom on the species (the Peconic Estuary was hit hard by brown tide blooms in the mid 1980's). Then in 1996, Cashin Associates used 1994 black and white aerial photography and field surveys to map the distributional extent of several species of SAVs, including eelgrass, in the Peconics. However, no quantitative acreage estimate of eelgrass alone was produced by either of these efforts.

The only true comprehensive distribution and acreage inventory of eelgrass in the Peconic Estuary was conducted by Tiner, et al. in 2003. Eelgrass bed polygons were digitized using 2000 aerial photography, and bed and edge locations were further refined by groundtruthing. This comprehensive survey estimated that only 1,552 acres of eelgrass remained in the Peconic Estuary, most of which inhabited the eastern most section of the Estuary, east of Shelter Island (Figure 1). This survey, when compared to CCE's 1930 historical analysis suggests that within a period of 70 years, when the Peconic Estuary was struck with wasting disease, brown tide and a multitude of other stressors, over 80% of the Estuary's eelgrass was lost.

CCE has also conducted several intermediate Peconic Estuary eelgrass distribution analyses, using any partial piecemealed aerial photography sets. Sets of aerial photography are used to assist in eelgrass bed delineations at PEP monitored sites. Some East End Towns have also re-mapped eelgrass beds within their respective Town waters.

The PEP Submerged Aquatic Vegetation Long-Term Eelgrass Monitoring Program, which closely monitors 8 eelgrass beds/sites in the Peconic Estuary and described in detail later, has shown an overall decline in eelgrass shoot density and coverage at most closely monitored sites and stations. All monitored stations in Southold Bay, Three Mile Harbor, and Northwest Harbor no longer support eelgrass (Figure 2). An interesting trend to note is that the shoot density in nearly every single monitored bed decreased between 2002 and 2004; it is hypothesized that this may be attributed to harsh winters and ice scouring. The complete PEP 2007 Eelgrass Long-Term Monitoring Program Report can be found in Appendix F.

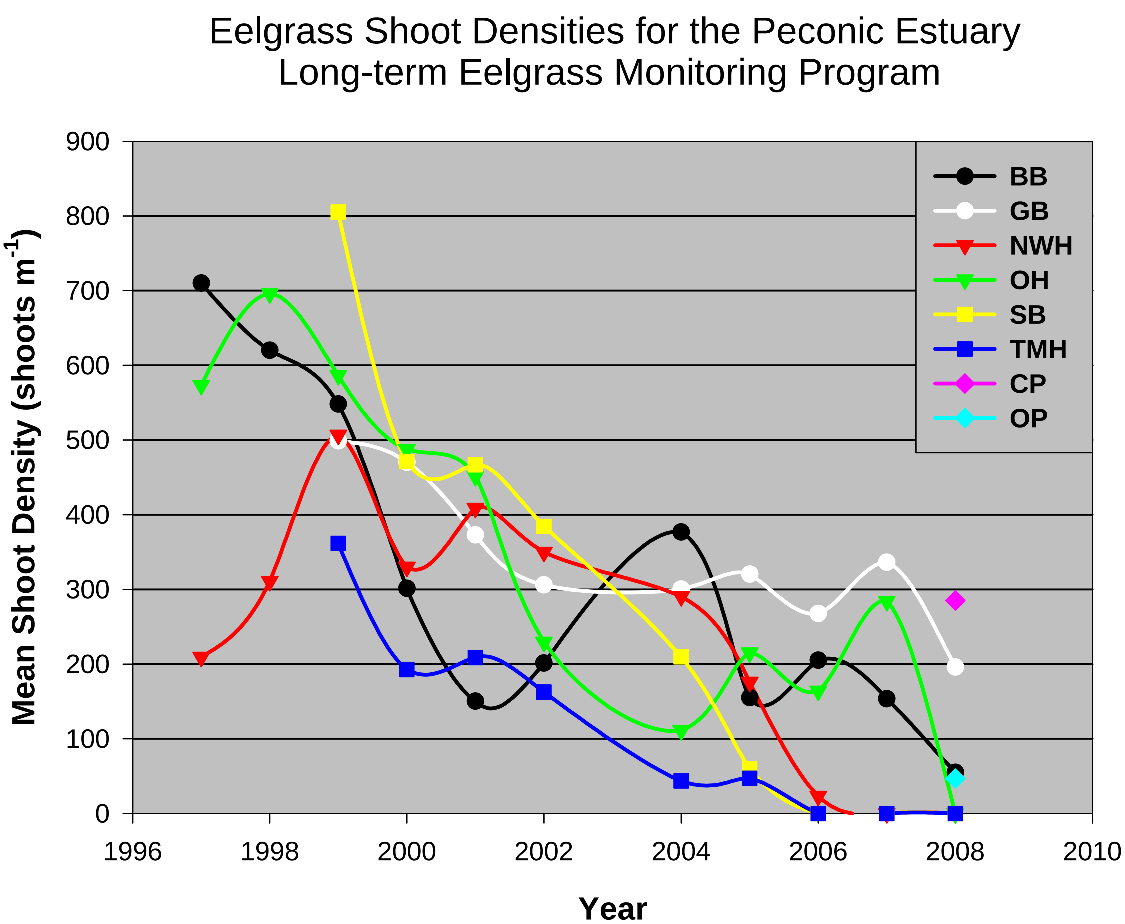


Figure 2: Eelgrass Shoot Densities for the Peconic Estuary Long-Term Eelgrass Monitoring Program
Density at the 8 monitored beds continue to decline; many reference sites and stations supporting little if any eelgrass. BB= Bullhead Bay, Southampton; GB= Gardiners Bay/Hay Beach, Shelter Island; NWH= Northwest Harbor, East Hampton; OH= Orient Harbor, Southold; SB= Southold Bay, Southold; and, TMH= Three Mile Harbor, East Hampton; CP= Cedar Point, East Hampton; OP= Orient Point, Southold.
Source: CCE

The last full inventory of eelgrass completed nearly nine (9) years ago is quickly becoming an outdated representation Peconic Estuary eelgrass populations. The PEP has coordinated with the New York State Seagrass Task Forces Seagrass Mapping Workgroup and partnered with the New York State Department of State, Division of Coastal Resources, Sewall Corp and PhotoScience to undertake a new eelgrass inventory. This inventory is to be done simultaneously with the new eelgrass survey for the Long Island South Shore Estuary Reserve (SSER). While originally planned for Fall 2008, poor water clarity in the SSER has now pushed the survey back to Spring 2009, when the Long Island Sound Study (LISS) anticipates undertaking their next survey as well.

IV. KEY ECOLOGICAL INDICATORS AND HABITAT CRITERIA

The difficulty in determining specific ecological indicators, ideal conditions, and habitat criteria is that they all can vary based on location. For example, guidelines used in different estuarine systems like Long Island Sound or the Chesapeake Bay may not be entirely applicable in the Peconic Estuary. Nor can we expect these indicators and criteria to be exactly the same throughout the entire Estuary. Additionally, eelgrass beds may migrate to areas previously uninhabited and may actually adapt to environmental stresses and pressures and establish themselves in areas not exhibiting "ideal conditions". We can however, make the general assumption that eelgrass presence is positively influenced by the following environmental conditions:

- Presence of sunlight
- Availability of high water clarity
- Saline waters
- Cool water temperatures
- Balanced nutrient regime
- Sediment size and characteristics
- Size, acreage, and density of eelgrass beds to support perpetuity

The effective management, protection, and restoration of eelgrass must rely on site-specific habitat criteria information and data. The Peconic Eelgrass Restoration Site Suitability Index Model developed by CCE, discussed later in this document, does just that. The model uses Suffolk County Department of Health Services (SCDHS) Peconic Estuary water quality, PEP eelgrass bed monitoring data, and years of field experience to identify ideal environmental and areas where eelgrass could likely exist and where restoration projects should be attempted. The full suite of the models parameters will be presented later in this document, but some of the parameters include:

- Water depth between 1.0- 3.25 meters
- Water temperature less than 28.0C
- Total Phosphate concentrations less than or equal to 0.08 mg/l
- Areas at least 15m away from hardened shoreline
- Total water column Nitrogen concentrations less than or equal to 0.05 mg/l
- Light Extinction (Kd) less than or equal to 0.46
- Substrate composition (course sediment texture and organic-inorganic ratio)
- Presence of macroalgae
- Wind exposure

V. IMPACTS AND DISTURBANCES IN THE PECONIC ESTUARY

Many activities and environmental conditions can threaten or stress the health and extent of eelgrass beds. It is likely that several simultaneous multiple stressors can be blamed for the significant loss of eelgrass and lack of re-colonization in the Peconic Estuary (a Peconic Estuary Eelgrass Threats Assessment Diagram can be found in Appendix A). Healthy eelgrass beds are designed to withstand some level of disturbance and can often naturally rebound. Highly stressed, unhealthy, and less dense beds do not respond well to stressors or fragmentation. A brief summary of impacts and disturbances is provided below, in no particular order. Examples of eelgrass beds monitored under the PEP SAV Long-Term Eelgrass Monitoring Program that have experienced these types of impacts are also provided.

Fishing and Shellfishing Practices

Utilization of certain fishing and shellfishing gear and methods in or in close proximity to eelgrass beds can be particularly harmful to the structure of the eelgrass plant and eelgrass bed. The use of rakes, tongs, dredges (including mechanical dredges) for oysters, scallops, and hard clams can cause direct removal or structural damage, stir up bottom sediments and bury eelgrass or increase water turbidity and decrease light penetration. Finfish trawls and nets, when used incorrectly, also have the potential to cause structural damage.

Pollution

Nutrients, sediments, and toxic substances enter the Peconic Estuary through point sources such as sewage treatment plants (STPs) and municipal separate storm sewer systems (MS4s), as well as nonpoint sources such as groundwater inflow, stormwater runoff and atmospheric deposition. Nonpoint nutrient sources for nitrogen include atmospheric deposition, fertilizer use, onsite disposal systems, and to a lesser extent, pet and animal wastes. Eutrophication, the over-enrichment of nutrients, can cause direct metabolic harm to eelgrass, and foster phytoplankton and algal blooms and epiphyte growth; all decreasing the amount of light available for eelgrass. Sediments from construction sites, roadways, and unstabilized lands, once in the water column may bury existing eelgrass beds and cloud water preventing further light penetration. Toxic substance such as heavy metals, pesticides, herbicides, chemicals and solvents are known to affect survivorship and reproductive capabilities of aquatic plants. Temperature pollution caused by poorly flushed creek systems or heated stormwater/road runoff and water temperature regimes also greatly affect the growth and health of eelgrass.

Disease and Harmful Algal Blooms

The onset of a wasting disease cause by the slime mold *Labyrinthula zostorae* in the early 1930's was responsible for the disappearance of approximately 90% of eelgrass beds along the entire Atlantic seaboard. The Peconic Estuary was not sparred and suffered widespread die offs. Wasting disease is almost always present, but only becomes a major threat to existing eelgrass when plants and beds are severely stressed. The occurrence of Brown Tide (*Aureococcus anophagefferens*) beginning in 1985 and occurring periodically thereafter further decimated eelgrass populations throughout the Peconic Estuary. Increased concentrations of brown tide cells can prevent light from reaching eelgrass.

Bioturbation/Competition/Overgrazing

Benthic fauna, marine mammals, and waterfowl (geese and swan) feed on eelgrass leaves and flowers; others inhabit around eelgrass beds and can trample the plant structure or even alter the surrounding sediment regime. Crabs, specifically spider crabs, and whelks have damaged thinner, low density and stressed eelgrass beds in the Peconic Estuary and can lead to less resilient, fragmented beds. Macroalgae may serve as a substitute for eelgrass, as it has been found to occupy nutrient enriched areas where eelgrass once existed and can prevent eelgrass re-colonization.

Boating and Personal Watercraft Activities
Boats, jet skis and wave runners that are used in shallow waters of the Peconic Estuary, where eelgrass beds are often found, can either directly damage existing eelgrass or create conditions unsuitable for healthy growth. Boat propellers and anchors can damage and cut eelgrass leaves, stems and flowers. Unfamiliarity of the shallow waters may result in a vessel running aground in eelgrass beds. Watercraft taking shortcuts around buoys or hauling out on shallow sandbars could also negatively impact eelgrass beds, if present. Water turbulence resulting from boat and personal watercraft traffic can suspend mucky bottom sediments into the water column and thus increase turbidity and decrease light penetration.

Dredging and Excavation
Harbors, inlets, and boat channels in the Peconic Estuary often require maintenance navigational dredging. Removing bottom sediments may require the direct removal of rooted vegetation. Dredged channels can result in fragmented eelgrass beds and serve as a barrier for growth and migration. The sides or edges of dredged channels may also subside back into the excavated areas and slowly cause disruptions in suitable habitable areas for eelgrass and sediment budgets. Releasing or disposing of dredged materials in waters may bury extant beds and increase the amount of total suspended solids (TSS) in the water column, hampering light penetration. While uninformed and misguided dredging can be particularly harmful to eelgrass, not all dredging is bad. Some eelgrass beds can benefit from inlet maintenance dredging projects and dredging projects intended to increase tidal flushing; dredging projects can improve water quality parameters necessary to support eelgrass.

Storms and Ice Scouring
Strong storm events can often cause severe damage to even the healthiest and most dense eelgrass beds. CCE documented extensive damage to the Orient Point and Cornelius Point beds after a very strong mid September 2007 storm hit the East End of Long Island. Storms may also suspend sediments in the water column and can bury eelgrass once settled or block out the sunlight. When ice forms and retreats from the shoreline during winter months, ice scouring can cause damage and removal of eelgrass.

Shoreline Stabilization Structures
Shoreline stabilization structures (SSS), including docks, piers, bulkheads, seawalls, groins, jetties and the like have the ability to directly and indirectly impact eelgrass beds. During construction and placement of SSS, eelgrass beds may be directly removed or damaged. Increased construction activity within the water column suspends bottom sediments, increasing turbidity and decreasing light penetration. SSS may prevent/limit the amount of sunlight reaching beds (the shading effect is most pronounced when structures are east-west oriented), and also have the ability to change current and wave energy patterns, altering sediment characteristics. Materials used to construct SSS, sometimes wood treated with toxic chemicals, can leach into the water surrounding eelgrass beds. Shoreline stabilization structures may also prevent the landward migration or shoreline retreat of eelgrass beds necessitated by sea level rise.

Global Warming and Sea Level Rise
Higher water temperatures are expected to lead to changes in eelgrass distribution and possibly large, slow die-off events. Sea level rise will likely require eelgrass to retreat landward toward shallower waters. In the case where SSS exist, they may actually prevent and restrict retreat and migration.

Bed-Specific Disturbances
Through the PEP SAV Long-Term Eelgrass Monitoring Program, CCE has been able to identify bed-specific disturbances which have been noted in annual monitoring reports. The dramatic losses at many of these monitored beds cannot be attributed solely to the witnessed disturbance(s) noted below. It is likely that these impacts have stressed the beds, such that when combined with a multitude of other stressors, significant losses occurred.

Fishing and Shellfishing Practices
- Southold Bay, Southold (clamming and scalloping)
- Gardiners Bay/Hay Beach, Shelter Island (clamming)
- Northwest Harbor, East Hampton (clamming)

Pollution
- Southold Bay, Southold (nutrient and temperature pollution from Hashamomuck Pond flushing)

Bioturbation/Competition/Overgrazing
- Northwest Harbor, East Hampton (crabs and whelks)

Boating and Personal Watercraft Activities
- Gardiners Bay/Hay Beach, Shelter Island (prop scars)
- Three Mile Harbor, East Hampton (mooring field and water ski area expansion, mooring chains)
- Southold Bay, Southold (boat channel turbidity)

Dredging and Excavation
- Southold Bay, Southold (dredging of channels and placement of dredged material)

Storms and Ice Scouring
- Bullhead Bay, Southampton*
- Gardiners Bay/Hay Beach, Shelter Island*
- Northwest Harbor, East Hampton*
- Orient Harbor, Southold*
- Southold Bay, Southold*
- Three Mile Harbor, East Hampton*
(All sites experienced losses between 2002 and 2004. Hypothesis: harsh winters and ice scouring)*

VI. CURRENT MANAGEMENT STRUCTURE

A. EXISTING REGULATIONS

Various levels of government may have jurisdiction or regulatory authority over activities that may affect the existence and health of eelgrass and eelgrass beds; including, but not limited to, public recreation structures, dredging and dredged material placement, stormwater management, water quality, and fishery harvesting techniques.

Federal Regulations

Magnuson-Stevens Fishery Conservation and Management Act

The Magnuson-Stevens Fishery Conservation and Management Act requires consultation with the National Marine Fisheries Service (NMFS) on actions that may adversely affect Essential Fish Habitat (EFH), and supports minimizing adverse effects on habitat caused by fishing and non fishing activities. EFH is defined as "waters and substrate necessary to a fish for spawning, breeding or growth to maturity" and includes seagrasses.

Clean Water Act

The Clean Water Act (CWA), administered by the United States Environmental Protection Agency (USEPA), requires significant water pollution control programs. Under the CWA National Pollutant Discharge Elimination System (NPDES), it is unlawful for industrial, municipal, and other facilities to discharge any pollutant from a point source into navigable waters without an approved permit, and requires management and abatement practices. The NPDES program also addresses stormwater discharges from select Municipal Separate Storm Sewer Systems (MS4s) and construction activities. Section 303(d) of the CWA requires the identification of impaired waters (use designations are impaired) and develop Total Maximum Daily Loads *(TMDL)*. Many states, including New York, have been delegated the regulatory authority to implement these programs.

New York State Regulations

There are no state regulations designed to specifically protect submerged aquatic vegetation (SAV) or SAV habitat. Nevertheless, some of the current regulations can protect eelgrass and eelgrass habitats indirectly. When taken individually, however, they do not provide effective, sufficient protection. These include water quality protection programs and resource (not habitat) focused fish and shellfish regulations.

New York State Environmental Conservation Law (ECL):

- Article 13-0309: Taking, handling and importation of shellfish; general provisions.
  Mechanical harvesting methods are prohibited for oysters and hard clams.
  (Mechanical methods can be especially harmful to eelgrass beds.)

- Article 13-0327: Scallops; prohibited acts.
  Scallop season is permitted only between the months of November-March.
  (It is during these cooler water temperature months that eelgrass blades, if disturbed, are likely to slough-off naturally when exposed to harvesting by scallop dredges.)

- Article 13-0341: Trawls; Use prohibited in certain waters.
  Trawls are prohibited west of Shelter Island.
  (While this may protect Peconic eelgrass west of Shelter Island, it would not protect eelgrass beds east of Shelter Island, where the majority of Peconic eelgrass thrives.)

• Article 15; Protection of Waters.
Regulates the construction, reconstruction, or expansion of docks, wharfs, groins, moorings or other structures in or above waters in state-owned underwater lands.
(These regulated activities can impact eelgrass beds.)

• Article 25: Tidal Wetlands.
Regulations are designed to avoid and minimize impacts to tidal wetland habitats. Regulatory control extends to six (6) feet below mean low water.
(These regulations can protect eelgrass within six (6) feet below mean low water (MLW); however, due to high water clarity in the Peconic Estuary, eelgrass can thrive at much greater water depths, beyond the 6' MLW line.)

New York State Navigational Law

• Article 3 Navigable Waters of the State, Section 33-e. Marine sanitation devices aboard vessels in vessel waste no-discharge zones. It is unlawful to discharge sewage from marine toilets into waters designated as no-discharge zones (NDZ).
(In 2002, the entire Peconic Estuary was formally designated a NDZ. NDZs can protect water quality essential to support eelgrass.)

Local Municipal Regulations

Several of Long Island's East End Towns in the Peconic Estuary watershed have adopted regulations which seek to directly or indirectly protect and restore eelgrass. Many East End Towns hold ownership of underwater lands and have the regulatory authority to regulate activities in Town waters and on Town owned lands. Municipalities have a heightened interest in protecting municipal resources and increased enforcement and oversight capabilities. Local regulations and regulatory review processes do provide a good opportunity to build in efforts supporting eelgrass management. A few examples are noted below. Appendix B includes a listing of Local Management Affecting Eelgrass.

Examples Town Codes Affecting Eelgrass:

The Town of East Hampton Town Code 255-5-50:
"In considering whether to issue a natural resources special permit for a dock, the Board of Appeals shall consider whether the dock will have any of the following harmful effects…..Whether the dock will result in the destruction of beds of eel grass (Zostera marina) or shellfish".

The Town of Southold Town Code 275-11:
Prohibits the use of lumber treated with chromated copper arsenate (also known as "CCA"), creosote, penta products or homemade wood preservatives in coastal structures
"Before issuing a permit for a dock structure, the Trustees shall consider whether the dock will have any of the following harmful effects… Whether the dock will result in the destruction of or prevent the growth of vegetated wetlands, seagrasses including eelgrass (Zostera marina) and widgeon grass (Ruppia maritima) or shellfish"

Town of Riverhead Town Code 47-21:
"In considering the issue of a dock permit by the Conservation Advisory Council, the following impacts shall be weighed…The potential for destruction of beds of eel grass (Zostera marina) or shellfish"

B. NEW YORK STATE MANAGEMENT STRATEGIES

New York State has made significant strides in recent years to better manage eelgrass and eelgrass habitat, including the creation of the New York State Seagrass Task Force and supporting and funding more effective management tools and research.

New York State Seagrass Task Force

Recognizing the importance of seagrasses to the health of local waters, the natural resources they support, and the subsequent need to research, monitor, and restore these valuable habitats, on July 26th 2006 Governor Pataki enacted Chapter 404 of the Laws of 2006**,** establishing a Seagrass Task Force chaired by the NYSDEC. The NYS Seagrass Task Force consists of five voting members and ten non-voting members, representing a diverse set of stakeholder interests and knowledge, and is charged with developing management and regulatory recommendations to the Governor and State officials by December 31, 2009. The NYS Seagrass maintains a website at: www.seagrassli.org. NYS legislation creating the NYS Seagrass Task Force can be found in Appendix C.

New York Seagrass Experts Meeting

On Tuesday May 22nd, 2007, invited seagrass researchers from around the country gathered at the NYSDEC Bureau of Marine Resources in East Setauket, NY. Long Island experts presented background information and data to a scientific panel of seagrass experts. This information allowed the experts to identify and prioritize efforts for NY to more efficiently and effectively preserve and restore seagrass habitat in each of Long Island's estuaries: Peconic Estuary, Long Island Sound, and the South Shore Estuary Reserve. Proceedings from the Experts Meeting are available online (http://www.peconicestuary.org/NY%20Seagrass%20Experts%20Meeting_FinalProceedings.pdf) New York seagrass protection, restoration, research and monitoring recommendations resulting from the meeting are presented in Appendix D. This effort was supported by the PEP, NYSDEC, New York Sea Grant, The Nature Conservancy, and CCE of Suffolk County, among others.

C. PECONIC ESTUARY PROGRAM MANAGEMENT STRATEGIES

The PEP has undertaken several initiatives to advance the management of eelgrass in the Peconic Estuary. Described in more detail below, these include: an estuary-wide eelgrass mapping and inventory program; the PEP SAV Long Term Monitoring Program; eelgrass restoration initiatives; select eelgrass and SAV research projects; and, the PEP Long Term Water Quality Monitoring Program. PEP has also supported several water quality improvement and management projects which seek to maintain, restore and protect high water quality needed by eelgrass.

The PEP Comprehensive Conservation and Management Plan (CCMP) sets clear measurable quantifiable goals and objectives for eelgrass protection and restoration. These include:

- Maintaining current eelgrass acreage through protection and prevention of further loss due to water quality degradation, physical damage, and disruption of the sedimentary environment by controlling the type, extent, intensity and duration of impacts
- Achieving water and habitat quality objectives which will result in the restoration of naturally occurring eelgrass meadows
- Increasing eelgrass acreage by ten percent over ten years (10% over 10 years), giving special consideration to historical distribution records and estimates of potentially suitable habitats.

The PEP CCMP also outlines several management actions aimed at protecting and restoring eelgrass (Figure 3).

PEP CCMP Management Actions and Strategies Affecting Eelgrass Management **Please note- Additional specific action steps under each management action are outlined in the CCMP* http://www.peconicestuary.org/CCMP.html	
Brown Tide Management	
B-1	Ensure continued brown tide monitoring, research, coordination and information sharing
Nutrients Management	
N-1	Continue to use and refine water quality standards and guidelines
N-4	Control point discharges from STPs and other dischargers
N-5	Implement nonpoint source control plans
N-6	Use land use planning to control nitrogen loading associated with new development
Habitat and Living Resources Management	
HLR-1	Use Critical Natural Resource Areas (CNRAs) to develop and Implement Management strategies to protect High Quality Habitats and Concentration of Species of Special Emphasis
HLR-2	Manage shoreline stabilization, docks, piers, and flow restriction structure to reduce or prevent additional hardening and encourage restoration of hardened shorelines to a natural state
HLR-3	Assess the Impacts of Dredging Activities on Habitat and Natural Resources and Develop Recommendation and Guidelines for Reducing those Impacts
HLR-4	Examine and Promote Methods of Shellfish harvesting that are Most Compatible with Establishment and Growth of Eelgrass Beds and Vegetated Salt Marshes
HLR- 5	Implement, enforce, encourage continuation of wetland policies and regulations
HLR-6	Evaluate the Effectiveness of Current Policies in Preserving Eelgrass Habitat and Develop Ways to Provide Increased Protection for all Extant Eelgrass
HLR-7	Develop and implement an Estuary-wide Habitat Restoration Plan (HRP)
HLR- 8	Develop and implement specific restoration projects
HLR-10	Develop an Aquaculture Plan for the Peconic Estuary
HLR-12	Foster sustainable recreational and commercial finish and shellfish uses in the Peconic Estuary that are compatible with biodiversity protection
HLR-14	Protect sea turtles and marine mammals
HLR-15	Utilize Land Use Planning, BMPs, and Other Management Measures to Reduce the Negative Impacts of Human Uses and Development on the Estuary System
HLR-16	Develop and implement a living resource research, monitoring, and assessment program
Toxics Management	
T-1	Review historical monitoring data and conduct new monitoring studies where needed to further characterize sources, loadings and impacts of toxic contaminants
T-4	Reduce loadings of pesticides and herbicides within the Peconic Estuary
T-6	Adopt requirements for controlling toxic loadings in stormwater runoff and activities in developed areas
T-7	Explore management strategies that emphasis the elimination or reduction of toxic substances
T-8	Ensure that dragged material is managed and placed in such a way as to reduce toxic impacts associated with contaminated sediments
Critical Lands Protection Strategy	
CLPP-6	Identify a process for using smart growth tools, sustainable development initiatives, and ordinance modifications, etc. to assist communities in assigning development to appropriate areas
CLPP-7	Develop a strategy for the management of underwater lands which conserves and enhances the region's natural resources

Public Education and Outreach Management Plan	
PEO-3	Develop and implement new programs and continue and expand existing programs for the estuary stakeholders about controlling the introduction of pathogens into the Peconic Estuary Program
PEO-4	Develop and implement new programs for estuary stakeholders about controlling the introduction of nutrients into the estuary system
PEO-5	Develop new and continue or expand existing education and outreach efforts related to toxics in the estuarine system
PEO-6	Develop and implement public education programs for the protection of habitat and living resources in the estuary and the sustainable use of estuary resources
CCMP Financing	
F-2	Effectively use NEP Funding, the NYS Bond Act, the Suffolk County ¼% Sales Tax Program, and Base Programs to Implement the CCMP

Figure 3: PEP CCMP Management Actions and Strategies Affecting Eelgrass Management
Management action identified in the 2001 Peconic Estuary Program Comprehensive Conservation and Management Plan directly and indirectly affecting eelgrass health and extent.

Estuary-wide Seagrass Mapping and Inventory

Knowing and understanding where eelgrass once existed and where it currently exists is of utmost importance to protecting this critical estuarine species. A 1930 historical analysis of eelgrass in the Peconic Estuary, conducted by CCE, serves as a comparative baseline. In 1989, Dennison et al. mapped the distribution of eelgrass, and in 1996 the PEP funded Cashin Associates to map the distributional extent of several species of SAVs, including eelgrass; no quantitative acreage was estimated for either. The only true comprehensive distribution and acreage assessment inventory of eelgrass in the Peconics was conducted by Tiner et al. of the USFWS in 2003. Eelgrass bed polygons were digitized using 2000 aerial photography, and bed and edge locations were further refined by groundtruthing. This inventory, which estimated that only 1,552 acres remained of the previous 1930 conservative estimate of 8,720 acres, was completed nearly nine (9) years ago and is quickly becoming an outdated representation Peconic Estuary eelgrass populations. The PEP has coordinated with the NYS Seagrass Task Forces Seagrass Mapping Workgroup and partnered with the NYS Department of State, Division of Coastal Resources, Sewall Corp., and PhotoScience to undertake a new inventory. This inventory is to be done simultaneously with the new eelgrass survey for the Long Island South Shore Estuary Reserve (SSER). While originally planned for Fall 2008, poor water clarity in the SSER has now pushed the survey back to Spring 2009; when the Long Island Sound Study (LISS) anticipates undertaking their next survey as well.

PEP Submerged Aquatic Vegetation Long-Term Monitoring Program

Under the PEP SAV Long-Term Monitoring Program initiated in 1997, CCE closely monitors eight (8) eelgrass beds/sites within the Peconic Estuary: Bullhead Bay, Southampton; Southold Bay, Southold; Hay Beach/Gardiners Bay, Shelter Island; Orient Harbor, Southold; Northwest Harbor, East Hampton; Three Mile Harbor, East Hampton; Cedar Point, East Hampton; and, Orient Point, Southold (Figure 4). Each of the eight (8) sites includes six (6) monitoring stations. Parameters measured and assessed include shoot density, observed biodiversity of animals, water temperature, water quality, and percent macroalgal coverage. CCE produces annual monitoring reports describing changes in status and are available on the PEP website. The most recent monitoring report ("Peconic Estuary Program 2007 Eelgrass Long-Term Monitoring Program Report") can be found in Appendix E. CCE also maintains detailed information on these monitored sites on their website: http://counties.cce.cornell.edu/suffolk/habitat_restoration/seagrassli/conservation/monitoring/monitoring_our_estuaries.html.

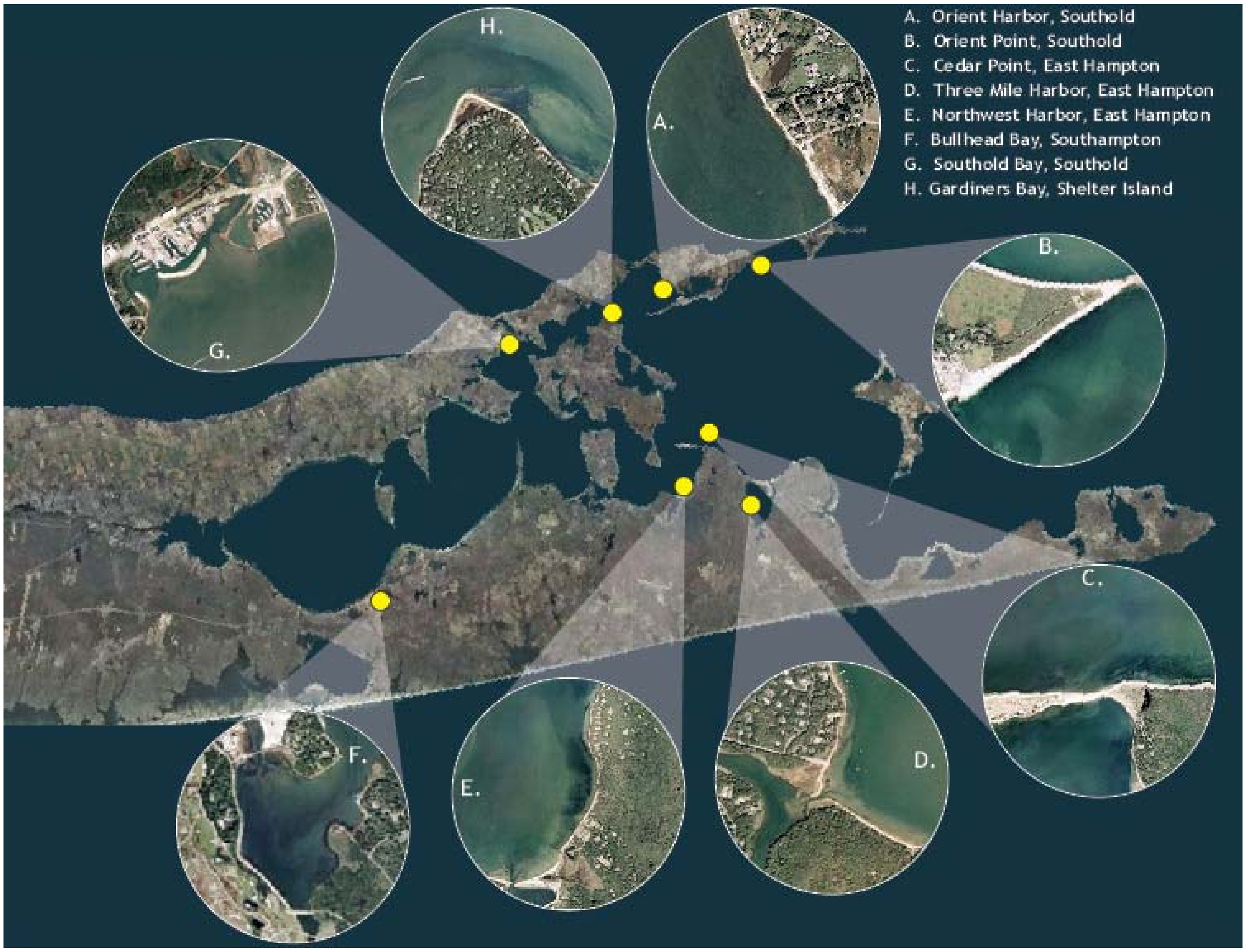


Figure 4: PEP Submerged Aquatic Vegetation Long-Term Monitoring Program Sites
Source: CCE, 2009

Peconic Estuary Eelgrass Restoration

Management efforts should strive to restore water quality and habitat conditions necessary to support current eelgrass beds and to allow for natural re-colonization. Natural eelgrass re-vegetation and re-colonization, however, are relatively slow processes and often need a jumpstart through human induced restoration efforts such as seeding, free-plantings, rock plantings, and Transplanting Eelgrass using Remote Frames System (TERFS). CCE has experimented with several of these methods in the Peconic Estuary and has identified the most appropriate methods through in-field experiments and restoration test plots. Full scale (1 acre) restoration projects have been initiated at successful test plots locations. These efforts have been funded by entities like the PEP, USEPA, Suffolk County, and the Natural Resources Conservation Service (NRCS) (Figure 5). CCE maintains an extensive database of Peconic Estuary restoration sites on their website which provides projects details such as objectives and background, methods utilized and work completed: http://counties.cce.cornell.edu/suffolk/habitat_restoration/seagrassli/restoration/projects/projects_pe.html

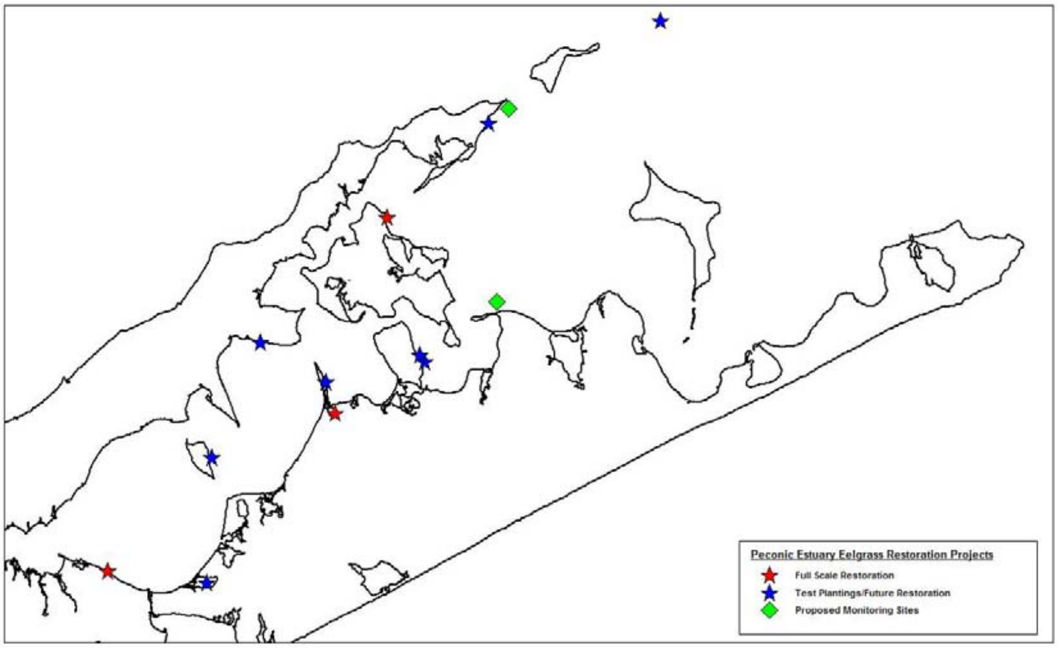


Figure 5: Peconic Estuary Eelgrass Restoration Projects

Peconic Eelgrass Restoration Site Suitability Index Model

Attempting to identify locations where eelgrass beds are likely to exist or areas where eelgrass restoration has the highest potential for success are difficult tasks. The Peconic Eelgrass Restoration Site Suitability Index Model, developed by CCE, is a Geographic Information System model developed using water quality and eelgrass bed monitoring data and years of field experience. The first set of site selection criteria parameters assessed include:

- Water depth between 1.0- 3.25 meters
- Areas at least 100m from an existing eelgrass bed
- Water temperature less than 28.0C
- Total Phosphate concentrations less than or equal to 0.08 mg/l
- Within 100m of a historically pre-existing eelgrass bed
- Areas at least 15m away from hardened shoreline
- Total water column Nitrogen concentrations less than or equal to 0.05 mg/l
- Light Extinction (Kd) less than or equal to 0.46

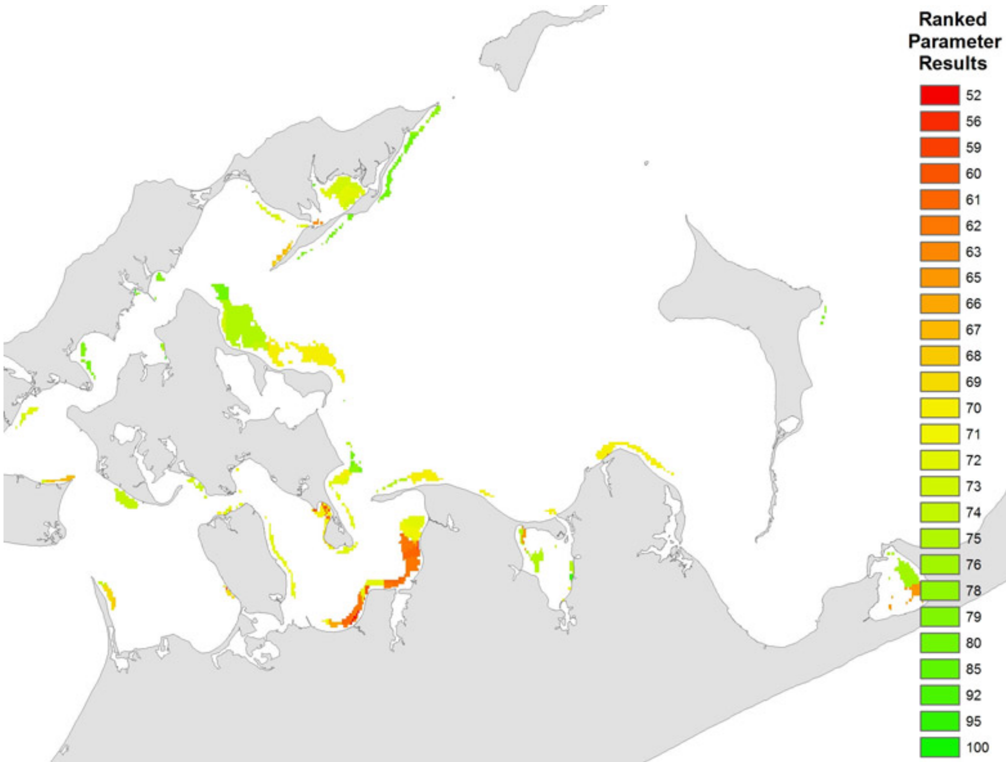


Figure 6: Peconic Eelgrass Restoration Site Suitability Index Model
GIS model developed by Cornell Cooperative Extension identifies and prioritizes locations where eelgrass restoration is most feasible. Higher scores (green shades) indicate ideal areas.
Source: CCE

Once areas meeting those criteria are determined, they are analyzed further for additional weighted parameters which assign scores to allow for ranking to determine restoration feasibility potential:

- Proximity to Shellfish Growing Area (SGA) closures
- Substrate composition
- Water temperature
- Total Phosphates
- Present macroalgae
- Wind exposure
- Total Nitrogen
- Light extinction

Once "suitable" restoration sites are identified by the model (Figure 6), they are even further evaluated based on field expertise and test plots. This adaptive model is updated as needed to reflect new research results and newly identified environmental criterion and is consistent with the PEP CCMP Habitat and Living Resources management action HLR-8.4 which calls for identifying and prioritizing locations where restoration of eelgrass is most feasible based on water quality and environmental criteria. The model is further explained and sample results are available for viewing at: http://counties.cce.cornell.edu/suffolk/gis/sampleProject1.html

Peconic Estuary Eelgrass and Submerged Aquatic Vegetation Research Initiatives

In 2008 The New York State Seagrass Task Force funded an "Experimental Assessment of Multiple Stressors on Groundwater Herbicide Toxicity for Eelgrass" in the Peconic Estuary to determine lethal and sub-lethal effects of submarine groundwater discharge (SGD) herbicide concentrations on eelgrass survival and to further asses the impact of light availability and water temperature on these lethal and sub-lethal effects. In 2009 the PEP will be funding an in-depth groundwater investigation at PEP's Long term monitored eelgrass sites to pinpoint if and how groundwater chemical and physical characteristics affect, or have affected, the extent and density trends we have been monitoring at those sites since 1997. In 2009, the PEP will also be funding the purchase and deployment of light loggers which will help to identify light requirements of Peconic eelgrass and expedite the identification of potential restoration candidate sites. Currently, deep water edge boundaries are identified by use of test plantings. The PEP has also funded a small scale project to identify the level of genetic diversity in Peconic eelgrass populations. CCE has also conducted several small scale investigations and research initiatives in or pertinent to the Peconic Estuary including effects of grazers, planting methods, wasting disease and genetic variation. Additional research projects conducted in the Peconic Estuary can be found in Appendix F. Future research efforts are needed to understand and explore factors affecting growth, re-colonization and restoration in the Peconic Estuary.

Public Education and Outreach

CCE maintains an interactive website (www.seagrassli.org) and publishes a seagrass newsletter ("Seagrass.LI") twice a year to increase local, regional, national and international awareness. The website and newsletter provide appropriately detailed information for a wide ranging audience on the importance of conserving eelgrass, restoration efforts, threats to eelgrass and the like. Peconic and PEP efforts are highlighted.

Peconic Estuary Program Long Term Water Quality Monitoring Program

The water quality monitoring program conducted by the Suffolk County Department of Health Services (SCDHS) Office of Ecology, funded in part by the PEP, includes monthly monitoring at 38 Peconic Estuary surface water quality stations throughout the year, periodic monitoring of 30 point source and stream stations, and weekly monitoring at the National Atmospheric Deposition Program (NADP) rain gauge. Since 2002, SCDHS has also operated two continuous monitoring stations in the western Peconic Estuary. An additional continuous monitoring device was deployed in West Neck Bay, Shelter Island in the summer of 2005. In addition to surface water quality data, Suffolk County groundwater and submarine groundwater discharge (SGD) monitoring data is also extremely useful and important to understanding eelgrass distribution and dynamics.

VII. MANAGEMENT OBJECTIVES AND ACTIONS

Management actions were developed after a thorough Peconic Estuary eelgrass threat assessment was conducted and are designed to help achieve the goals of this Eelgrass Management Plan for the Peconic Estuary. The goals are to:

1. Protect current and future eelgrass populations and to prevent current and future loss or degradation of eelgrass to the maximum extent practical.
2. Ensure existence of suitable habitat conditions for future natural eelgrass re-establishment and future restoration and enhancement initiatives.
3. Advance our understanding of eelgrass dynamics.
4. Restore and increase the abundance of eelgrass acreage by 10% over 10 years and increase density where applicable.

Respective management actions and action steps are grouped under eight (8) larger overarching objectives and are provided in tabular format in "Figure 7". These overarching objectives include:

Objective 1:
Enhance protection of existing and future eelgrass beds from physical disturbances.

Objective 2:
Increase stakeholder, user group, and public awareness of eelgrass and the importance of the species in an effort to foster responsible steward-like resource enjoyment.

Objective 3:
Build an established, consistent and comprehensive eelgrass inventory program and sentinel monitoring program.

Objective 4:
Improve our knowledge and understanding of eelgrass through research initiatives to ensure that efforts to protect and restore resources are successful and effective. [Impacts of climate change and sea level rise are to be addressed under this objective].

Objective 5:
Increase eelgrass bed abundance and density through physical restoration efforts.

Objective 6:
Ensure the existence of water quality conditions necessary for conserving, maintaining, and restoring eelgrass.

Objective 7:
Minimize and mitigate the negative effects from the construction of new and previously placed of docks and other shoreline stabilization structures including but not limited to bulkheads, seawalls, groins, and jetties in and surrounding eelgrass beds or in areas where restoration or recolonization is likely. [Sea level rise is addressed under this objective].

Objective 8:
Prevent, if possible, and minimize shading and other negative impacts associated with the onset of future harmful algal blooms and Brown and Red tide episodes.

Objective 1:
Enhance protection of existing and future eelgrass beds from physical disturbances.

This objective and subsequent management actions and action steps will:

- Maximize protection of eelgrass from fishing, shellfishing, boating, personal watercraft, dredging, and excavation.
- Help maintain currently existing acreage.
- Continue to secure important habitat and nursery ground for aquatic life.
- Continue to provide a source of seeds, flowers and shoots for future eelgrass restoration efforts.
- Close loopholes in the current regulatory regime that don't sufficiently/adequately protect eelgrass.
- Avoid creating turbulence and scouring which increases total suspended solids.
- Avoid altering sediment characteristic through removal, subsidence and disposal in a way unsuitable for eelgrass existence.
- Avoid direct removal and physical disturbance of eelgrass through the removal or placement of dredged materials.

Management Action 1.1: Identify and promote new protection measures (regulatory mechanisms at all level of government). Particular attention immediately directed to areas where eelgrass beds recently disappeared, such that disturbances can be limited to allow for natural re-vegetation.

Action Step 1.1.1: Designate appropriate eelgrass and eelgrass habitat areas as "shellfish spawner sanctuaries", "eelgrass sanctuaries", "eelgrass management areas", "habitat management areas" and limit activity in and around said areas.
Responsible entity: NYSDEC, Town Board/Trustees
Timeframe: Immediate and Ongoing

Action Step 1.1.2: Implement area restrictions, gear restrictions, activity restrictions in and/or near eelgrass beds.
Responsible entity: NYSDEC, Town Board/Trustees
Timeframe: Long Term (10 years)

Action Step 1.1.3: Adopt new, New York State regulations (legislation if necessary) specific to the protection and conservation of eelgrass.
Responsible entity: NYSDEC
Timeframe: Long Term (10 years)

Management Action 1.2: Identify areas where eelgrass and maintenance navigational dredging or excavation activities are needed and co-exist; in those cases implement a dredging window and material placement strategy that maximizes eelgrass protection.
**Please note that dredging for purposes of increasing flushing may also be beneficial to eelgrass beds. See Management Action 6.3.*
Responsible entity: PEP NRS, Town Board/Trustees
Timeframe: Short Term (5 years)

Objective 2:
Increase stakeholder, user group, and public awareness of eelgrass and the importance of the species in an effort to foster responsible steward-like resource enjoyment.

This objective and subsequent management actions and action steps will:
- Create sense of stewardship.
- Teach modified behaviors and induce change to less harmful practices.
- Decrease the number and severity of the multiple stresses to eelgrass.

Management Action 2.1: Build awareness of eelgrass bed locations and the importance of eelgrass through a public education/outreach campaign; special attention to identifying and promoting citizens/stakeholder/user group actions.

Action Step 2.1.1: Design and install signs at waterfront public access points, including marinas and boat ramps.
Responsible entity: PEP NRS, PEP CAC, NYSDEC, Town Board/Trustees, Marina operators
Timeframe: Immediate and Ongoing

Action Step 2.1.2: Work with boating and fishing associations to promote less harmful practices to eelgrass habitat and incorporate educational materials with boat registrations and fishing, shellfishing and access permits, passes and licenses.
Responsible entity: PEP NRS, PEP CAC, NYSDEC, NYS DMV, AMI, Town Trustees, Fishing and Boasting Assoc.
Timeframe: Immediate and Ongoing

Action Step 2.1.3: Develop and distribute up-to-date education materials that will improve public understanding of the value, habitat requirements, status, and trends of eelgrass.
Responsible entity: PEP CAC, CCE, NY Sea Grant
Timeframe: Immediate and Ongoing

Objective 3:
Build an established, consistent and comprehensive eelgrass inventory program and sentinel monitoring program.

This objective and subsequent management actions and action steps will:
- Track progress of achieving/meeting goals.
- Ensure heightened protection of current populations.
- Measure distribution and abundance and identify trends.

<u>Management Action 3.1</u>: Perform eelgrass inventories and mapping efforts in the Peconic Estuary every two (2) years.
Responsible entity: PEP NRS (lead), NYSDEC, NYSDOS, USFWS, CCE
Timeframe: Immediate and Ongoing

<u>Management Action 3.2</u>: Coordinate efforts with other Long Island seagrass mapping initiatives to support consistency through the New York State Seagrass Task Force.
Responsible entity: PEP NRS, NYSDEC, NYS Seagrass Taskforce, LISS, SSER
Timeframe: Ongoing

<u>Management Action 3.3:</u> Ensure results are reported to and easily accessible by stakeholders, local governments, and other permitting government agencies in the Peconic Estuary.
Responsible entity: PEP Program Office
Timeframe: Ongoing

Objective 4:
Improve our knowledge and understanding of eelgrass through research initiatives to ensure that efforts to protect and restore resources are successful and effective. [Impacts of climate change and sea level rise are to be addressed under this objective].

This objective and subsequent management actions and action steps will:

- Identify and further our knowledge and understanding of potential threats.
- Answer why eelgrass is unable to re-colonize/reestablish itself and why populations continue to decline in areas with suitable water quality and nutrient levels.

Management Action 4.1: Establish a Peconic Estuary Program Eelgrass Workgroup to provide a forum for discussion and coordinate with New York State Seagrass Task Force efforts.
Responsible entity: PEP NRS
Timeframe: Immediate and Ongoing

Management Action 4.2: Formulate and test hypotheses through research initiatives to identify threats and factors affecting eelgrass existence, health, and restoration efforts.
Responsible entity: New PEP Eelgrass Workgroup, NY Sea Grant, TNC, SUNY
Timeframe: Ongoing

Management Action 4.3: Implement an adaptive eelgrass management and restoration program reflective of research results, conclusions and recommendations.
Responsible entity: PEP NRS, New PEP Eelgrass Workgroup and all partners
Timeframe: Ongoing

Objective 5:
Increase eelgrass bed abundance and density through physical restoration efforts.

This objective and subsequent management actions and action steps will:
- Increase eelgrass acreage.
- Increase eelgrass bed density to increase resiliency to stresses.

Management Action 5.1: Assess the current quantitative restoration goal (a 10% increase in current acreage in 10 years) and set a new goal, if applicable, using the new 2009 Peconic Eelgrass Inventory and level of restoration success in the Peconic Estuary as justification.
Responsible entity: New PEP Eelgrass Workgroup
Timeframe: Short Term (5 years)

Management Action 5.2: Develop an up-to-date Peconic Estuary eelgrass restoration tracking database (past and current) to identify restoration test plot and full scale restoration attempts, locations, restoration method used, results, etc..
Responsible entity: New PEP Eelgrass Workgroup, CCE
Timeframe: Short Term (5 years) and Ongoing

Management Action 5.3: Implement restoration efforts.

Action Step 5.3.1: Continue to use and refine the Peconic Eelgrass Restoration Site Suitability Index Model to identify and prioritize potential restoration locations. Adapt the model on an as needed basis as additional information becomes available (e.g. light logger data) and technologies evolve.
Responsible entity: CCE (lead), New PEP Eelgrass Workgroup
Timeframe: Ongoing

Action Step 5.3.2: Continue to monitor success of restoration efforts.
Responsible entity: CCE, Towns
Timeframe: Ongoing

Action Step 5.3.3: Identify and undertake new restoration efforts based upon results of restoration site monitoring.
Responsible entity: New PEP Eelgrass Workgroup, CCE, Towns
Timeframe: Ongoing

Objective 6:
Ensure the existence of water quality conditions necessary for conserving, maintaining, and restoring eelgrass.

This objective and subsequent management actions and action steps will:
- Reduce pollutant generation in the Peconic Estuary watershed that adversely affects eelgrass and eelgrass habitat.
- Prevent the overgrowth of algae, epiphytes and macrophytes; thereby increasing light penetration.
- Create a balanced nutrient environment/regime suitable for eelgrass existence.
- Decrease stormwater runoff volumes carrying harmful sediments, nutrients, and toxic loadings.
- Mitigate the negative effects of polluted submarine groundwater discharges, direct stormwater discharges, other point source discharges, and nonpoint source land runoff.

Management Action 6.1: Reduce and minimize pollutant loading to the Peconic Estuary.

Action Step 6.1.1: Implement regulatory and voluntary measures and initiatives to reduce nutrient pollution and create a balanced nutrient regime. These may include: turf grass (including golf courses) and landscape fertilizer management; onsite wastewater disposal system management (e.g., inspections, mandatory upgrades of substandard systems, and incentives); the use of new nitrogen removing technologies and alternative uses for Sewage Treatment Plant (STP) effluent; Clean Air Act standards to minimize nitrogen loadings from atmospheric deposition; implementation of the Peconic Nitrogen Total Maximum Daily Load (TMDL); implementation of the NYSDEC Municipal Separate Storm Sewer Systems (MS4s) stormwater permit; agricultural stewardship activities; open space preservation; and shellfish restoration initiatives.
Responsible entity: Private land and property owners (including homeowners, golf courses, agricultural operators), SCDHS, Towns, STPs, NYSDEC, USEPA
Timeframe: Ongoing

Action Step 6.1.2: Implement regulatory and voluntary measures and initiatives to reduce toxic pollution. These may include: pesticide and herbicide management; agricultural stewardship activities; and implementation of the NYSDEC Municipal Separate Storm Sewer Systems (MS4s) and Industrial Multi-Sector stormwater permits.
Responsible entity: Private land and property owners (including homeowners, golf courses, agricultural operators), Towns, NYSDEC
Timeframe: Ongoing

<u>Management Action 6.2</u>: Reduce and intercept stormwater and urban runoff.

Action Step 6.2.1: Reduce runoff volumes by decreasing impervious surfaces, increasing infiltration areas, and installing detention and infiltration technologies.
Responsible entity: Towns, private property owners, NYSDEC, NYSDOT, SCDPW
Timeframe: Ongoing

Action Step 6.2.2: Incorporate the use of Low Impact Development (LID) practices, including but not limited to conservation landscaping, rain gardens, permeable pavements, and green roofs, into new and existing development.
Responsible entity: SC Planning, Towns, private property owners, PEP
Timeframe: Ongoing

<u>Management Action 6.3</u>: Protect and restore vegetated buffers, wetland, and open space.
Responsible entity: Towns, private property owners, NYSDEC, Suffolk County, TNC
Timeframe: Ongoing

<u>Management Action 6.4:</u> Explore and investigate, on a case-by-case, as needed basis, the use of inlet maintenance dredging to increase flushing capacity to improve water quality conditions for eelgrass.
**Please note that dredging activities may also be harmful to eelgrass beds. See Management Action 1.2.*
Responsible entity: New PEP Eelgrass Workgroup
Timeframe: Short Term (5 years)

Objective 7:
Minimize and mitigate the negative effects from the construction of new and previously placed docks and other shoreline stabilization structures, including but not limited to bulkheads, seawalls, groins, and jetties in and around eelgrass beds or in areas where restoration or re-colonization is likely. [Sea level rise is addressed under this objective].

This objective and subsequent management actions and action steps will:
- Allow for eelgrass beds to migrate/retreat landward in response to sea level rise, and prevent seaward expansion of hardened shorelines which may also negatively affect migration patterns.
- Minimize direct shading of eelgrass beds and enhance light penetration.
- Avoid creating turbulence and scouring which increases TSS and sediment re-suspension.
- Avoid changing current and wave energy patterns which may alter sediment characteristics (grain size) in a way unsuitable for eelgrass existence.
- Avoid direct removal and physical disturbance of eelgrass.

Management Action 7.1: Minimize the effect of docks and other SSS on sensitive eelgrass beds through existing permitting processes or other regulatory measures, including but not limited to a restoration mitigation strategy, promoting dock construction (or reconstruction) that allows for maximum light penetration, a no-net increase policy, and, if possible a net decrease policy.
Responsible entity: NYSDEC, Towns, TNC, public and private waterfront businesses/owners
Timeframe: Ongoing

Objective 8:
Prevent, if possible, and minimize shading and other negative impacts associated with the onset of future harmful algal blooms and Brown and Red Tide episodes.

This objective and subsequent management actions and action steps will:
- Decrease the probability of extreme and severe eelgrass die off events.

Management Action 8.1: Support existing and expand Brown Tide monitoring, research, and management initiatives to help identify environmental factors responsible for blooms. Implement initiatives to prevent and alleviate the effects of Brown tide blooms, including but not limited to nutrient management plans (*See Management Objective 6).
Responsible entity: NY Sea Grant, SUNY, SCDHS, PEP
Timeframe: Ongoing

Management Action 8.2: **S**upport existing and expand phytoplankton and other harmful algal species monitoring, research, and management initiatives to help identify environmental factors responsible for blooms. Implement initiatives to prevent and alleviate the effects of phytoplankton and other harmful algal species blooms, including but not limited to nutrient management plans (*See Management Objective 6).
Responsible entity: NY Sea Grant, SUNY, SCDHS, PEP
Timeframe: Ongoing

FIGURE 7:
EELGRASS MANAGEMENT PLAN FOR THE PECONIC ESTUARY:
MANAGEMENT OBJECTIVES AND ACTIONS

<u>Objective 1:</u> **Enhance protection of existing and future eelgrass beds from physical disturbances.**		
	<u>Management Action 1.1</u>: Identify and promote new protection measures (regulatory mechanisms at all level of government). Particular attention immediately directed to areas where eelgrass beds recently disappeared, such that disturbances can be limited to allow for natural re-vegetation.	
		Action Step 1.1.1: Designate appropriate eelgrass and eelgrass habitat areas as "shellfish spawner sanctuaries", "eelgrass sanctuaries", "eelgrass management areas", "habitat management areas" and limit activity in and around said areas. *Responsible entity: NYSDEC, Town Board/Trustees* *Timeframe: Immediate and Ongoing*
		Action Step 1.1.2: Implement area restrictions, gear restrictions, activity restrictions in and/or near eelgrass. *Responsible entity: Responsible entity: NYSDEC, Town Board/Trustees* *Timeframe: Long Term (10 years)*
		Action Step 1.1.3: Adopt new, New York State regulations (legislation if necessary) specific to the protection and conservation of eelgrass. *Responsible entity: NYSDEC* *Timeframe: Long Term (10 years)*
	<u>Management Action 1.2</u>: Identify areas where eelgrass and maintenance navigational dredging or excavation activities are needed; in those cases implement a dredging window and material placement strategy that maximizes eelgrass protection. **Please note that dredging for purposes of increasing flushing may also be beneficial to eelgrass beds. See Management Action 6.3.* *Responsible entity: PEP NRS, Towns Board/Trustees* *Timeframe: Short Term (5 years)*	
<u>Objective 2:</u> **Increase stakeholder, user group, and public awareness of eelgrass and the importance of the species in an effort to foster responsible steward-like resource enjoyment.**		
	<u>Management Action 2.1</u>: Build awareness of eelgrass bed locations and the importance of eelgrass through a public education/outreach campaign; special attention to identifying and promoting citizens/stakeholder/user group actions.	
		Action Step 2.1.1: Design and install signs at waterfront public access points, including marinas and boat ramps. *Responsible entity: PEP NRS, PEP CAC, NYSDEC, Town Board/Trustees, Marina operators* *Timeframe: Immediate and Ongoing*

		Action Step 2.1.2: Work with boating and fishing associations to promote less harmful practices to eelgrass habitat and incorporate educational materials with boat registrations and fishing, shellfishing and access permits, passes and licenses. *Responsible entity: PEP NRS, PEP CAC, NYSDEC, NYS DMV, AMI, Town Trustees, Fishing and Boasting Assoc.* *Timeframe: Immediate and Ongoing*
		Action Step 2.1.3: Develop and distribute up-to-date education materials that will improve public understanding of the value, habitat requirements, status, and trends of eelgrass. *Responsible entity: PEP CAC, CCE, NY Sea Grant* *Timeframe: Immediate and Ongoing*
Objective 3: **Build an established, consistent and comprehensive eelgrass inventory program and sentinel monitoring program.**		
	Management Action 3.1: Perform eelgrass inventories and mapping efforts in the Peconic Estuary every two (2) years. *Responsible entity: PEP NRS (lead), NYSDEC, NYSDOS, USFWS, CCE* *Timeframe: Immediate and Ongoing*	
	Management Action 3.2: Coordinate efforts with other Long Island seagrass mapping initiatives to support consistency through the New York State Seagrass Task Force. *Responsible entity: PEP NRS, NYSDEC, NYS Seagrass Taskforce, LISS, SSER* *Timeframe: Ongoing*	
	Management Action 3.3: Ensure results are reported to and easily accessible by stakeholders, local governments, and other permitting government agencies in the Peconic Estuary. *Responsible entity: PEP Program Office* *Timeframe: Ongoing*	
Objective 4: **Improve our knowledge and understanding of eelgrass through research initiatives to ensure that efforts to protect and restore resources are successful and effective. [Impacts of climate change and sea level rise are to be addressed under this objective].**		
	Management Action 4.1: Establish a Peconic Estuary Program Eelgrass Workgroup to provide a forum for discussion and coordinate with New York State Seagrass Task Force efforts. *Responsible entity: PEP NRS* *Timeframe: Immediate and Ongoing*	
	Management Action 4.2: Formulate and test hypotheses through research initiatives to identify threats and factors affecting eelgrass existence, health, and restoration efforts. *Responsible entity: New PEP Eelgrass Workgroup, NY Sea Grant, TNC, SUNY* *Timeframe: Ongoing*	
	Management Action 4.3: Implement an adaptive eelgrass management and restoration program reflective of research results, conclusions and recommendations. *Responsible entity: PEP NRS, New PEP Eelgrass Workgroup and all partners* *Timeframe: Ongoing*	

<u>Objective 5:</u> **Increase eelgrass bed abundance and density through physical restoration efforts.**		
	<u>Management Action 5.1</u>: Assess the current quantitative restoration goal (a 10% increase in current acreage in 10 years) and set a new goal, if applicable, using the new 2009 Peconic Eelgrass Inventory and level of restoration success in the Peconic Estuary as justification. *Responsible entity: New PEP Eelgrass Workgroup* *Timeframe: Short Term (5 years)*	
	<u>Management Action 5.2</u>: Develop an up-to-date Peconic Estuary eelgrass restoration tracking database (past and current) to identify restoration test plot and full scale restoration attempts, locations, restoration method used, results, etc.. *Responsible entity: New PEP Eelgrass Workgroup, CCE* *Timeframe: Short Term (5 years) and Ongoing*	
	<u>Management Action 5.3</u>: Implement restoration efforts.	
		Action Step 5.3.1: Continue to use and refine the Peconic Eelgrass Restoration Site Suitability Index Model to identify and prioritize potential restoration locations. Adapt the model on an as needed basis as additional information becomes available (e.g. light logger data) and technologies evolve. *Responsible entity: CCE (lead), New PEP Eelgrass Workgroup* *Timeframe: Ongoing*
		Action Step 5.3.2: Continue to monitor success of restoration efforts. *Responsible entity: CCE, Towns* *Timeframe: Ongoing*
		Action Step 5.3.3: Identify and undertake new restoration efforts based upon results of restoration site monitoring. *Responsible entity: New PEP Eelgrass Workgroup, CCE, Towns* *Timeframe: Ongoing*
<u>Objective 6:</u> **Ensure the existence of water quality conditions necessary for conserving, maintaining, and restoring eelgrass.**		
	<u>Management Action 6.1</u>: Reduce and minimize pollutant generation within the Peconic Estuary watershed.	
		Action Step 6.1.1: Implement regulatory and voluntary measures and initiatives to reduce nutrient pollution and create a balanced nutrient regime. These may include: turf grass (including golf courses) and landscape fertilizer management; onsite wastewater disposal system management (e.g., inspections, mandatory upgrades of substandard systems, and incentives); the use of new nitrogen removing technologies and alternative uses for Sewage Treatment Plant (STP) effluent; Clean Air Act standards to minimize nitrogen loadings from atmospheric deposition; implementation of the Peconic Nitrogen Total Maximum Daily Load (TMDL); implementation of the NYSDEC Municipal Separate Storm Sewer Systems (MS4s) stormwater permit; agricultural stewardship activities; open space preservation; and shellfish restoration initiatives. *Responsible entity: Private land and property owners (including homeowners, golf courses, agricultural operators), SCDHS, Towns, STPs, NYSDEC, USEPA* *Timeframe: Ongoing*

		Action Step 6.1.2: Implement regulatory and voluntary measures and initiatives to reduce toxic pollution. These may include: pesticide and herbicide management; agricultural stewardship activities; and implementation of the NYSDEC Municipal Separate Storm Sewer Systems (MS4s) and Industrial Multi-Sector stormwater permits. *Responsible entity: Private land and property owners (including homeowners, golf courses, agricultural operators), Towns, NYSDEC* *Timeframe: Ongoing*
	Management Action 6.2: Reduce and intercept stormwater and urban runoff.	
		Action Step 6.2.1: Reduce runoff volumes by decreasing impervious surfaces, increasing infiltration areas, and installing detention and infiltration technologies. *Responsible entity: Towns, private property owners, NYSDEC, NYSDOT, SCDPW* *Timeframe: Ongoing*
		Action Step 6.2.2: Incorporate the use of Low Impact Development (LID) practices, including but not limited to conservation landscaping, rain gardens, permeable pavements, and green roofs, into new and existing development. *Responsible entity: SC Planning, Towns, private property owners, PEP* *Timeframe: Ongoing*
	Management Action 6.3: Protect and restore vegetated buffers, wetland, and open space. *Responsible entity: Towns, private property owners, NYSDEC, Suffolk County, TNC* *Timeframe: Ongoing*	
	Management Action 6.4: Explore and investigate, on a case-by-case, as needed basis, the use of inlet maintenance dredging to increase flushing capacity to improve water quality conditions for eelgrass. **Please note that dredging activities may also be harmful to eelgrass beds. See Management Action 1.2.* *Responsible entity: New PEP Eelgrass Workgroup* *Timeframe: Short Term (5 years)*	
Objective 7: **Minimize and mitigate the negative effects from the construction of new and previously placed docks and other shoreline stabilization structures including but not limited to bulkheads, seawalls, groins, and jetties in and around eelgrass beds or in areas where restoration or re-colonization is likely. [Sea level rise is addressed under this objective].**		
	Management Action 7.1: Minimize the effect of docks and other SSS on sensitive eelgrass beds through existing permitting processes or other regulatory measures, including but not limited to a restoration mitigation strategy, promoting dock construction (or reconstruction) that allows for maximum light penetration, a no-net increase policy, and, if possible a net decrease policy. *Responsible entity: NYSDEC, Towns, TNC, public and private waterfront businesses/owners* *Timeframe: Ongoing*	

<u>Objective 8:</u> **Prevent, if possible, and minimize shading and other negative impacts associated with the onset of future harmful algal blooms and Brown and Red Tide episodes.**	
	<u>Management Action 8.1</u>: Support existing and expand Brown Tide monitoring, research, and management initiatives to help identify environmental factors responsible for blooms. Implement initiatives to prevent and alleviate the effects of Brown tide blooms, including but not limited to nutrient management plans (*See Management Objective 6). *Responsible entity: NY Sea Grant, SUNY, SCDHS, PEP* *Timeframe: Ongoing*
	<u>Management Action 8.2:</u> Support existing and expand phytoplankton and other harmful algal species monitoring, research, and management initiatives to help identify environmental factors responsible for blooms. Implement initiatives to prevent and alleviate the effects of phytoplankton and other harmful algal species blooms, including but not limited to nutrient management plans (*See Management Objective 6). *Responsible entity: NY Sea Grant, SUNY, SCDHS, PEP* *Timeframe: Ongoing*

FIGURE 8:
MANAGEMENT OBJECTIVES OF THE EELGRASS MANAGEMENT PLAN AND RELATED PEP COMPREHENSIVE CONSERVATION AND MANAGEMENT PLAN (CCMP) MANAGEMENT ACTIONS
(Denotes Priority CCMP Actions)*

Objective 1:
Enhance protection of existing and future eelgrass beds from physical disturbances.

	*HLR-3.	Assess the Impacts of Dredging Activities on Habitat and Natural Resources and Develop Recommendations and Guidelines for Reducing those Impacts.
	*HLR-3.1	Hold a "Dredging Summit" for the Peconic Estuary System to address specific concerns (*i.e.*, impacts on shorebird nesting, demersal fish eggs, benthic communities, and the potential release of contaminants) and develop dredging guidance on an embayment-specific basis and for identified CNRAs. Integrate dredging guidance into existing regulatory programs.
	*HLR-3.2	Assess navigational dredging in tidal creeks and embayments (utilizing Suffolk County's Generic Environmental Impact Statement) for damages or impacts to eelgrass beds and other habitats and develop permit conditions to minimize impacts that potentially could result in habitat loss and degradation. Determine if navigational dredging locally impairs water quality to the point of precluding restoration of eelgrass.
	HLR-3.3	Determine the need for frequency of maintenance dredging and develop recommendations to reduce runoff and erosion in creeks to reduce the need for maintenance dredging.
	HLR-4	Examine and promote methods of shellfish harvesting that are most compatible with establishment and growth of eelgrass beds and vegetated salt marshes.
	HLR-4.1	Examine methods of harvesting clams, scallops, and other shellfish and determine which are most compatible with eelgrass establishment and growth. Develop recommendations for harvesting methods, frequency, and timing which will recovery of eelgrass throughout the Estuary and enhance shellfish productivity.
	HLR-6	Evaluate the effectiveness of current policies in preserving eelgrass habitat and develop ways to provide increased protection for all extant eelgrass.
	*HLR-6.1	Evaluate the effectiveness of current policies in preserving eelgrass habitat and develop ways to provide increased protection for all extant eelgrass.

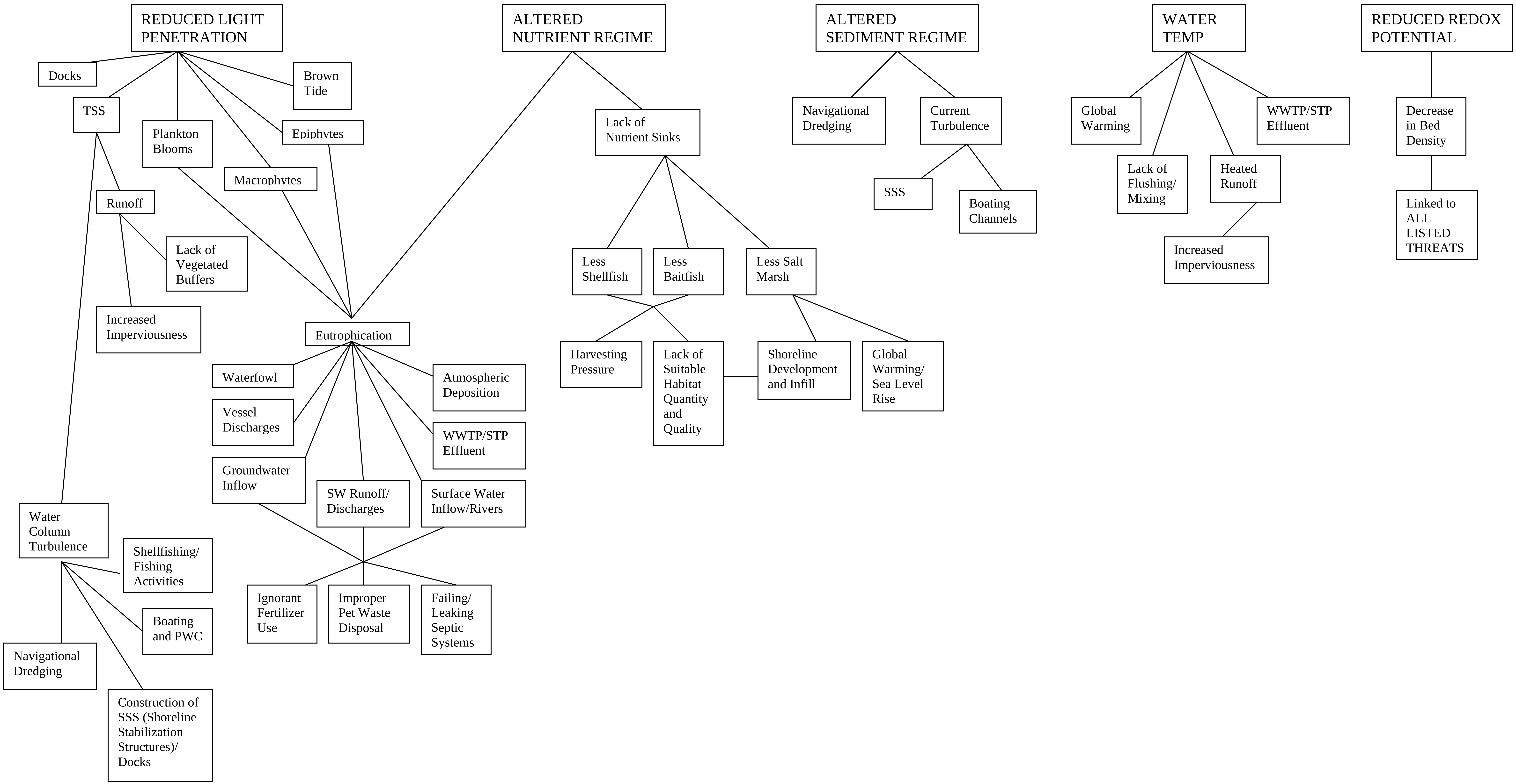
	HLR-6.2	Monitor and protect extant eelgrass beds, and restore degraded eelgrass beds.
	HLR-6.3	Evaluate anchor dragging, propeller scarring, dredging and other known impacts to extant eelgrass beds in the Peconic Estuary and develop recommendations to reduce them.
<u>Objective 2:</u> **Increase stakeholder, user group, and public awareness of eelgrass and the importance of the species in an effort to foster responsible steward-like resource enjoyment.**		
	PEO-6	Develop and implement public education programs for the protection of habitat and living resource in the estuary and the sustainable use of estuary resources.
<u>Objective 3:</u> **Build an established, consistent and comprehensive eelgrass inventory program and sentinel monitoring program.**		
	HLR-6.2	Monitor and protect extant eelgrass beds, and restore degraded eelgrass beds.
	HLR-16.8	Ensure implementation of adequate mapping and monitoring programs to track trends in the extent and quality of eelgrass, and to evaluate progress toward reaching restoration goals.
<u>Objective 4:</u> **Improve our knowledge and understanding of eelgrass through research initiatives to ensure that efforts to protect and restore resources are successful and effective. [Impacts of climate change and sea level rise are to be addressed under this objective].**		
	HLR-6.3	Evaluate anchor dragging, propeller scarring, dredging and other known impacts to extant eelgrass beds in the Peconic Estuary and develop recommendations to reduce them.
	HLR-6.4	Hold a workshop to evaluate the factors that regulate the health and extent of eelgrass beds in the Peconic Estuary and develop management recommendations based on these findings.
	HLR-16	Develop and implement a living resources research, monitoring, and assessment program.
	HLR-16.3	Support research on the interactions between eelgrass and the dominant macroalgae species in the Peconic Estuary to determine impacts of macroalgae on eelgrass distraction and abundance.
<u>Objective 5:</u> **Increase eelgrass bed abundance and density through physical restoration efforts.**		
	HLR-6.2	Monitor and protect extant eelgrass beds, and restore degraded eelgrass beds.

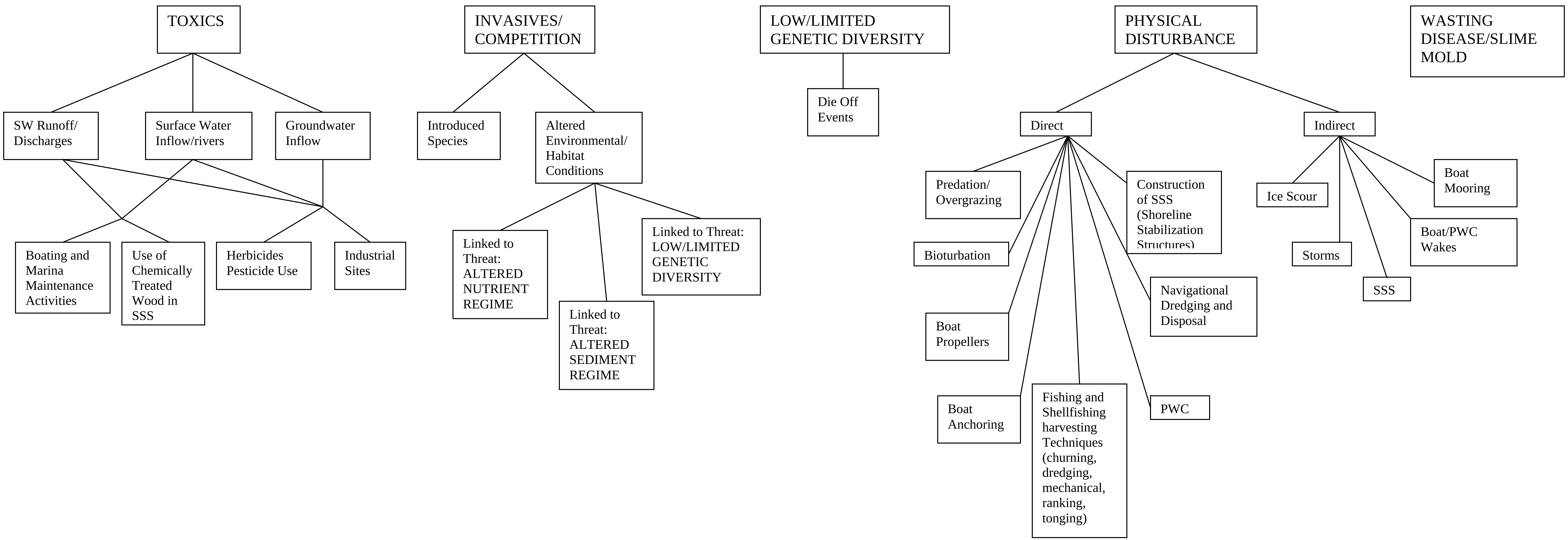
Objective 6: Ensure the existence of water quality conditions necessary for conserving, maintaining, and restoring eelgrass.		
	N-6	Use land use planning to control nitrogen loading associated with new development.
	HLR-6.2	Monitor and protect extant eelgrass beds, and restore degraded eelgrass beds.
	*HLR-8.3	Develop a quantitative goal for eelgrass restoration based on ongoing monitoring and mapping efforts.
	HLR-8.4	Identify and prioritize locations where restoration of eelgrass is most feasible based on water quality and environmental criteria which are being developed for eelgrass in the Peconic Estuary System and elsewhere in its range.
	HLR-9	Monitor and Evaluate the Success of Restoration Efforts.
	HLR-15	Utilize land use planning, BMPs, and other management measures to reduce the negative impacts of human uses and development on the Estuary system.
	P-2	Develop land use regulation that eliminate or minimize new sources of stormwater runoff.
	*P-2.1	Evaluate existing and develop model land use regulations that eliminate or minimize new sources of stormwater runoff.
	P-2.3	Adopt land use regulations that eliminate or minimize new sources of stormwater runoff.
	P-4	Demonstrate and implement technologies to remediate stormwater runoff.
	CLPP-5	Accelerate Land Protection in the Peconic Estuary.
Objective 7: Minimize and mitigate the negative effects from the construction of new and previously placed docks and other shoreline stabilization structures (SSS) including but not limited to bulkheads, seawalls, groins, and jetties in and around eelgrass beds or in areas where restoration or re-colonization is likely. [Sea level rise is addressed under this objective].		
	*HLR-2	Manage Shoreline Stabilization, Docks, Piers, and Flow Restriction Structures to Reduce or Prevent Additional Hardening and Encourage Restoration of Hardened Shorelines to a Natural State.
	*HLR-2.1	Quantify and map all hardened shoreline, docks and piers, and flow-restriction structures in the Peconic Estuary and assess the overall impacts of stabilization structures on natural resources. Develop recommendations to promote alternative shoreline management and incentives for maintaining and restoring natural shorelines.

	HLR-2.2	Review existing regulations for shoreline hardening structures at all levels of government, encourage consistent policies and strength regulations where appropriate.
	*HLR-2.3	Establish and enforce a policy of "no net increase" of hardened shoreline in the Peconic Estuary and, if possible, a net decrease in hardened shoreline. Use HLR-1 and HLR-2 as a mechanism to establish this strategy.
	*HLR-2.4	Develop a variety of financial incentives and programs to encourage property owners to remove or modify hardened shoreline structures and replace them with natural vegetation and other vegetated (bioengineered) alternatives to restore the natural shoreline of the estuary.
Objective 8: **Prevent, if possible, and minimize shading and other negative impacts associated with the onset of future harmful algal blooms and Brown and Red Tide episodes.**		
	B-1	Ensure continued Brown Tide monitoring, research, coordination and information sharing.

<u>Appendix A:</u>
Peconic Estuary Eelgrass Threats Assessment
(Developed by Laura Stephenson, NYSDEC 2006)

Peconic Estuary Eelgrass Threats Assessment
L. Stephenson, NYSDEC 2006




TOXICS
INVASIVES/ COMPETITION
LOW/LIMITED GENETIC DIVERSITY
PHYSICAL DISTURBANCE
WASTING DISEASE/SLIME MOLD
SW Runoff/ Discharges
Surface Water Inflow/rivers
Groundwater Inflow
Introduced Species
Altered Environmental/ Habitat Conditions
Die Off Events
Direct
Indirect
Boating and Marina Maintenance Activities
Use of Chemically Treated Wood in SSS
Herbicides Pesticide Use
Industrial Sites
Linked to Threat: ALTERED NUTRIENT REGIME
Linked to Threat: ALTERED SEDIMENT REGIME
Linked to Threat: LOW/LIMITED GENETIC DIVERSITY
Predation/ Overgrazing
Bioturbation
Boat Propellers
Boat Anchoring
Fishing and Shellfishing harvesting Techniques (churning, dredging, mechanical, ranking, tonging)
Construction of SSS (Shoreline Stabilization Structures)
Navigational Dredging and Disposal
PWC
Ice Scour
Storms
SSS
Boat/PWC Wakes
Boat Mooring

<u>Appendix B:</u>
Local Municipal Management Affecting Eelgrass
(Compiled by Kim Petersen, CCE 2007)

TABLE I. LOCAL MANAGEMENT AFFECTING EELGRASS				
Responsible Entity	**Chapter in Code**	**Section/Article**	**Direct/ Indirect Impact**	**Details**
Town of Southold	**219** -Shellfish and other Marine Resources	219-20: Vegetation removal prohibited	**D/I**	• No wetland vegetation of any kind can be removed or soil placed thereon during shellfishing activities
		219-16: Culling shellfish and restoration of underwater lands	**I**	• Bottom must be returned to previous state upon taking of shellfish
	275 (formally 97) - Wetlands and Shoreline	275-2: Definitions	**I**	• Basically same as DEC wetlands regs. , but up to 5ft depth @mlw; 100 ft from wetland boundary
		275-11: Construction and Operation standards	**D**	• Dredging in or close to **seagrass** is prohibited • Whether or not **seagrasses (including eelgrass and widgeon grass**) will be damaged or prevented from growth is considered before permitting dock placement
			I	• Use of lumber treated with CCA, creosote, penta products or homemade wood preservatives prohibited • No new bulkheads in creeks and bays unless low-sill • No new jetties or groins unless results in a total net decrease in the subject area
	Mooring and Anchoring Draft Chapter 34 (new chapter) Dec 11,2006	34-15: Moorings in Designated Mooring Areas created by the Town 34-14 (A,C): Mooring Assignments: General rules for Town waters	**D**	• In designating mooring areas, the Town Board shall ensure town mooring areas avoid **eelgrass** beds. • Boatyard, Marina, Yacht club, and riparian moorings only allowed based on considerations including locations of seagrass meadows.

TABLE II. LOCAL MANAGEMENT AFFECTING EELGRASS cont'd				
Responsible Entity	**Chapter in Code**	**Section/Article**	**Direct/ Indirect Impact**	**Details**
Town of Easthampton	**255**- Zoning	**255-1-20**: Definitions	**I**	• "Lands lying within or beneath tidal waters shall also be deemed to be "tidal wetlands," regardless of the type or amount of vegetation growing thereon or the absence of the same." • All underwater lands are included in wetland definition, no max depth
		255-5-50: Special Permit Uses: Specific standards and safeguards	**I**	• "No permit shall issue for any structure which would unduly interfere with…marine life or habitat or which would destroy other than minimal practicable areas of existing wetland vegetation…
			D	• Dock permit issuance will consider "whether the dock will result in the destruction of beds of **eelgrass** or shellfish."
			I	• Use of wood treated with CCA, ACQ, or creosote will be allowed for coastal structures "unless it can be shown that no reasonable alternative material will serve the purpose"
			I	• No new docks unless floating and seasonally removed; coastal erosion structures only permitted if "imminent, rapid or sudden loss of the property, or a substantial portion thereof, to erosion caused by rain, current, wind, wave or storm tidal action", and structures shall be minimum necessary.
		255-4-20: Natural resources special permit; regulations	**I**	• Like DEC wetland regs, but w/in 150ft of wetland boundary

TABLE II. LOCAL MANAGEMENT AFFECTING EELGRASS cont'd

Responsible Entity	Chapter in Code	Section/Article	Direct/ Indirect Impact	Details
Town of Southampton	Shellfish Permits and Regulation Article II (not in Town Code)	Section 8E. Soft Clams	D	• "Churning over or through submerged **eelgrass** beds is strictly prohibited" Regulated by bay constables
	278 - Shellfish	278-8 ,9: Escallops and Hard Clams	I	• Scallops and crabs may be harvested with a dredge only if same as DEC requirements for scallops • No plant life (or hard clams) may be removed by mechanical means
	330 - Zoning	330-40: Tidal Wetland Regulations	I	• Bulkheading prohibited unless in Waterfront Business District or to protect the natural environment from erosion, silting etc.
	111-Beaches, Parks and Waterways	111-28: Removal of Beach Grass	?	• "No person shall remove, impair, damage or destroy any beach grasses or <u>wetlands vegetation</u> of any kind nor place spoil thereon in any other area of the Town of Southampton without prior written approval by the Director of Natural Resources of the Town of Southampton and the Board of Trustees."
	325-Wetlands	325-3: Definitions	I	• Tidal wetland definition includes "All lands lying in the area inundated by tidal action and/or peak lunar tides", "all estuaries", "littoral zones", though no depth limit specified • Same regulated activities as DEC except **200ft** from wetland boundary
Town of Riverhead	**47**-Bays and Creeks	47-21: Docks, basins and ramps	D	• The potential for destruction of **eelgrass** or shellfish beds is considered by the Conservation Advisory Counsel before issuing a dock permit
			I	• No commercial copper quat (ACQ), pentachlorophenol, or creosote treated wood may be used for shoreline structures. CCA can only be used for pilings.
		Article II- Shellfish	I	• Same as Southampton Town regs

TABLE II. LOCAL MANAGEMENT AFFECTING EELGRASS cont'd				
Responsible Entity	**Chapter in Code**	**Section/Article**	**Direct/ Indirect Impact**	**Details**
Town of Riverhead cont'd	**107**-Tidal and Freshwater Wetlands	107-3,4 –Definitions and Regulations	**I**	• Littoral zone (up to 6ft at mlw) included in tidal wetlands definition. • Same wetland regs. as DEC except **150ft** from wetland boundary.
Town of Shelter Island	**129**-Wetlands	129-3: General guidelines to activities within regulated area.	**I**	• "The depositing or removal of the natural products of wetlands during recreational or commercial fishing, shellfishing or aquaculture is allowed so long as there is no undue disturbance of the wetlands."
			I	• No new bulkheads will be allowed unless property is in imminent peril of destruction from erosion and that other measures are not viable.
		129-8: Definitions	**I**	• Wetlands def. includes "all lands generally covered or intermittently covered with, or which border on, tidal waters, or lands lying beneath tidal water such as…littoral zones", though no depth mentioned. • Same regulated activities as DEC; **100ft** from wetland boundary
	108-Shellfish	108-5: Regulations	**I**	• No churning for soft clams • Same scallop, hard clam regs. as DEC

Appendix C:
New York State Seagrass Task Force Legislation

NEW YORK STATE SENATE
INTRODUCER'S MEMORANDUM IN SUPPORT
submitted in accordance with Senate Rule VI. Sec 1

BILL NUMBER: S8052

SPONSOR: JOHNSON¦¦¦¦¦¦¦¦¦¦¦¦¦

TITLE OF BILL:
An act to establish a seagrass research, monitoring and restoration task force and providing for its powers and duties; and providing for the repeal of such provisions upon expiration thereof

PURPOSE:
To establish a task force that will examine and make recommendations on means of restoring, preserving and properly managing seagrass.

SUMMARY OF PROVISIONS:
Section one establishes a seagrass research, monitoring and restoration task force. The Task force will consist of five voting members and ten non-voting members.

Sections two, three and four provide for the organization of the task force by establishing that the chairperson will be the commissioner of environmental conservation or his or her designee and requires that any vacancies on the task force be filled in the manner provided by the initial appointment.

Sections five, six and seven authorize the task force to hold public hearings and meetings to enable it to accomplish its duties; and requires that every state agency, local agency and public corporation having jurisdiction over areas of native seagrass habitat or over programs relating to the purposes and goals of this act offer full cooperation and assistance to the task force in carrying out the provisions of this act. Defines "native seagrass," as native underwater plants found in Long Island bays and estuaries including, but not limited to, eelgrass and widgeon grass.

JUSTIFICATION:
Long Island seagrass populations were severely decimated by wasting disease in the 1930s and again by a massive brown tide event in the 1980s. Despite the absence of these events in some areas like the Peconic Bays and Long Island Sound over the past 20 years, local seagrasses have not recovered. The intent of this legislation is to set up a task force to develop recommendations for regulations to improve seagrass protection, restoration, research and monitoring.

This task force will establish the necessary framework for reducing the impact of direct and indirect threats and restoring and properly managing seagrass into the future. Direct impacts include physical damage from boat groundings, incompatible fishing practices, docks and bulkheads, and other potentially destructive activities. Indirect impacts include water quality effects from nutrients, sedimentation and toxic contaminants.

Effective regulations for seagrass protection and restoration will depend greatly on the State's ability to understand the severity of these impacts. This task force will identify and assess severity of indirect and direct threats, develop restoration goals, recommend short-term and long-term research and monitoring and propose public outreach and education tools. Seagrass, which is designated as Essential Fish Habitat and a Habitat Area of Particular Concern for many of New York State's recreationally and commercially important marine species, is a vital component to successful and lasting restoration of Long Island finfish, shellfish, crustacean, and waterfowl populations, which has far reaching benefits for improved quality of life and economic growth opportunities for present and future generations on Long Island.

LEGISLATIVE HISTORY:
New bill.

FISCAL IMPLICATIONS:
Minimal.

EFFECTIVE DATE:
This act shall take effect immediately and be deemed repealed January 1, 2009.

LAWS OF NEW YORK, 2006

CHAPTER 404

AN ACT to establish a seagrass research, monitoring and restoration task force and providing for its powers and duties; and providing for the repeal of such provisions upon expiration thereof

Became a law July 26, 2006, with the approval of the Governor.
Passed by a majority vote, three-fifths being present.

The People of the State of New York, represented in Senate and Assembly, do enact as follows:

Section 1. Seagrass research, monitoring and restoration task force. There is hereby established, within the department of environmental conservation a seagrass research, monitoring and restoration task force("task force") which shall consist of five voting members and ten non-voting members who shall be appointed as follows:

(a)the commissioner of environmental conservation or his or her designee;
(b)the commissioner of parks, recreation and historic preservation or his or her designee;
(c)the secretary of state or his or her designee;
(d)one member upon the recommendation of the temporary president of the senate;
(e)one member upon the recommendation of the speaker of the assembly;
(f)ten non-voting members to be selected by the department of environmental conservation representing: recreational anglers, town marine law enforcement, estuary programs, the commercial fishing industry, recreational boaters, the director of New York sea grant, local government officials, the marine resources advisory council, New York businesses and advocates for the environment.

§ 2. Task force members shall receive no compensation for their services but shall be reimbursed for actual and necessary expenses incurred in the performance of their duties.

§ 3. The chairperson of the task force shall be the commissioner of environmental conservation or his or her designee. The task force shall meet no less than four times and at other times at the call of the chairperson.

§ 4. Any vacancies on the task force shall be filled in the manner provided for in the initial appointment.

§ 5. The task force shall be authorized to hold public hearings and meetings to enable it to accomplish its duties.

§ 6. Every state agency, local agency and public corporation having jurisdiction over areas of native seagrass habitat or over programs relating to the purposes and goals of this act shall, to the fullest extent practicable, offer full cooperation and assistance to the task force in carrying out the provisions of this act.

§ 7. As used in this act, "native seagrass" shall mean native underwater plants found in Long Island bays and estuaries including, but not limited to, eelgrass (zostera marina) and widgeon grass(ruppia maritima); "native seagrass meadows" shall mean those habitats in estuarine waters vegetated with one or more species of native seagrass.

§ 8. No later than December 31, 2008, the task force shall transmit to the governor, the temporary president of the senate and the speaker of the assembly a report containing recommendations on how to accomplish the following:

(a) Recommendations on elements of a seagrass management plan including, but not limited to, regulatory and/or statutory alterations required to preserve, restore, protect and map the native seagrass population on Long Island.

(b) Recommendations on means of preserving and restoring seagrass and native seagrass meadows that will bring about a lasting restoration of finfish, shellfish, crustaceans, and waterfowl, that is compatible with an improved quality of life and economic growth for the future of the region. Such proposals shall also include any recommendations for monitoring, additional research, and public education to ensure the success of the effort.

§ 9. This act shall take effect immediately and shall expire and be deemed repealed January 1, 2009.

The Legislature of the STATE OF NEW YORK **ss:**
Pursuant to the authority vested in us by section 70-b of the Public Officers Law, we hereby jointly certify that this slip copy of this session law was printed under our direction and, in accordance with such section, is entitled to be read into evidence.

JOSEPH L. BRUNO	SHELDON SILVER
Temporary President of the Senate	**Speaker of the Assembly**

<u>Appendix D:</u>
Priority Recommendations of May 2007 New York Seagrass Experts Meeting

Ranked Order	Group Priority	ID#	Category	Action	Task	Time	Cost (w/out overhead)
1	High	1	Management	Establish a working group for coordination, and info dissemination	Define seagrass habitat, monitoring schemes, scale, indicatiors, leveraging efforts, take lead role in synthesis	Immediate and regular meetings	10% total budget
2	High	2	Management	Synthesis of existing data, merge the datasets, IM coordinator	Follow up on May 2007 mtg, produce a report, getting GIS data layers	By end of 2007	$80K
3	High	5	Monitoring	Monitoring physical conditions of the seagrass beds	Light/Temperature loggers in grass beds, use carefully chosen spatial scale. And more frequent (or continous) light sampling.	Need high resolution in Summer, quarterly thereafter.	$20-30K
4	High	16	Management	Public education / perception	Reduce impacts to seagrasses through changes in resource use and vessel operations - potentially through waste management and regulation. Outreach with signs at boat ramps, etc.	Follow synthesis	$25K - $50K
5	High	3	Monitoring	New mapping of seagrass, with standardization, metadata implementation, timely reporting. Include analysis of historical aerial photos where usable to determine where seagrass existed at different times in the past. Spatial patterns of loss give clues to causes of loss-deep edge losses = light stress.	Best technique to be determined by working group (i.e., aerial photography, hyperspectral satelite data, acoustic surveys on sentiel areas). May be advantageous to do LIS, PE, SSER in same years. Develop a universal metric for defining seagrass habitat	Starting now, do every 2-3 years	$150/sq mile total (photo= 1/3 of cost; interpretation = 2/3). Groudtruthing of remote data necessary.
6	High	6	Monitoring	Monitor seagrass beds themselves; as examples SeagrassNet, Seagrass Watch. Frequency and design to be determined by working group. Options include fixed transects, spatially -distributed random points, fixed points.	Visual assessment for density and cover, do not count individual shoots. To be decided by working group, geared toward question being asked	Ongoing quarterly	10-15 FTE days per quarter
7	High	13	Research	Need to look at multiple stressors together (e.g., light and sulfide, root penetrability of hard substrates)	E.g., manipulate organic matter in common garden experiment? Feed information inot any modeling from the synthesis section	Years 2-3	$100K
8	High	9	Research	Is there a biological disturbance inhibiting persistaence, restoration, recolonization? Bioturbation, crabs, swans, lugworms, whelks, etc.	Use exlusion cages 1 ft deep and above the grass to test with and without planting	Immediate	$85K
9	Phase 1 = high Phase 2 = Low to High	8	Monitoring	Identify sources of light attentuation	Light attenuation parsing to guide whe to focus on. Phase 1 = regression model (color, TSS, Chl a), Gallegos model. Use secchi and WQ data. Phase 2 would be using thise and other factors to do your restoration selection	Part of Synthesis	0 Phase 2 = $130K

10	**Medium to High**	**4**	**Monitoring**	Need bathymetry of SSER first, then PE, then LIS. If light limitation is one of the principal causes of seagrass mortality, bathymetry data will tell you where recovery is possible given incremental improvements in water clarity	10 cm resolution, focusing in the shallow water(e.g., < 3 m in SSER). Weak green laser (3 cm accuracy) RTK (3-D GPS) unit (DOT may have)	**Once**	**Weak green laser (lidar) $1K/sq km. Look to NOAA/ACOE for pro bono**
11	**Medium to High**	**18**	**Research**	Restoration strategy including integration of landscape ecology into planning	Site selection, technique, etc. spatial modeling to predict potential recovery	**Follows synthesis**	**90K**
12	**??? Priority depends on synthesis**	**7**	**Research**	Is GW having a negative effect on seagrass? As a transport pathway for N and pesticides. Includes sewage/septic as affecting N (high nitrate 10uM threshold) - direct toxicity and increased phytoplankton	A) Look at SCDHS data first B) literature search about effects. C) Bioassays of chemicals - are they killing the seagrass or community (grazers)	**TBD**	**0 for A and B; C = $60k**
13	**Low to High**	**17**	**Research**	Nitrogen budget needed for PE (mainly) and SSER to determine what the potential controlling sources may be … integrate with synthesis work	Points to potential management jurisdictions and actions	**Follows synthesis**	**$25K**
14	**Medium**	**15**	**Research**	Epiphytic -grazer interactions - are changes in abundance or absence of grazers influencing current distribution or restoration	Indications of limitation to colonization and bed maintenance. This is examining how these grazers may facilitate survival of seagrass esp in areas where there are potentially high epiphyte loads that would reduce light availability to the plants.	**1-3 years**	**$50K**
15	**Low to High**	**12**	**Research**	Impact of shellfishing (damage) and connection (positive feedback) between seagrass and shellfish	BPBL as a control and set up other test areas, soft vs hard bottom differences; also consider recreational impacts. - i.e. all local gear types with manipulative planting experiments	**Years 2-3**	**$120K**
16	**Medium**	**14**	**Research**	What is the genetic diversity of seagrasses in the various estuarine systems (SSER, PE, LIS)?	Populations genetic analysis - initial screening with appropriate scale of sampling	**Years 2-3**	**$70K**
17	**Low to Medium**	**11**	**Research**	Determine effects of physical disturbance of seagrass bed areas, including dredging, hardening, boating	BPBL could be used as a control for some disturbances, and set up other test areas	**build out of information synthesis**	**$25K - $100K**
18	**Low**	**10**	**Monitoring**	Characterize biota in seagrass beds	How have impacts to the bays influenced the function and secondary production of seagrass beds? This is about how animals USE seagrass beds and conversely, the larger community value of seagrass beds in your area	**Year 3**	**$50K**

Appendix E:

Peconic Estuary Program 2007 Eelgrass Long-Term Monitoring Program Report, October 21, 2008, Cornell Cooperative Extension of Suffolk County

Peconic Estuary Program 2007 Eelgrass (*Zostera marina*) Long-Term Monitoring Program

Progress Report 8
October 21, 2008

Submitted To:

The Peconic Estuary Program Office
The Suffolk County Department of Health Services
Office of Ecology

Submitted By:

Christopher Pickerell
and
Stephen Schott

Cornell University
Cooperative Extension
of Suffolk County
Marine Program

Summary

The Peconic Estuary Program's Long-Term Eelgrass Monitoring Program was continued by Cornell Cooperative Extension's Marine Program in 2007. The six monitoring beds were sampled during the period of 23 August 2007 to 29 August 2007. Divers conducted 60 quadrat counts of eelgrass shoot density and macroalgae percent cover at each monitoring site. Temperature data from data loggers were analyzed to elucidate annual temperature trends. There were no significant changes in the shoot density in 2007, although Northwest Harbor joined Southold Bay and Three Mile Harbor in the complete loss of eelgrass within the monitoring areas. Twenty-nine (29) out of a total of 36 stations (6 stations per each of the 6 sites) no longer supported eelgrass within the 10 m radius of the station coordinates. Macroalgal percent cover showed mixed results, with only Orient Harbor and Three Mile Harbor exhibiting significant increase. The areal extent of Bullhead Bay's meadow showed significant change, where 2 stations that had recovered in 2006 were lost in 2007. Gardiners Bay experienced minimal loss in areal extent. The temperature data continued to be a useful tool in monitoring annual trends and identifying localized periods of high water temperature which is important for eelgrass health and planning of restoration activities in the estuary.

No single causative factors have been directly linked to the losses that have continued at a majority of the monitoring sites. At this time, physical disturbance (both natural and anthropogenic) continues to be the most likely cause of the losses that have been documented. It is likely that no one source is responsible for the damage/losses in the monitoring sites, but rather a combination of stressors are responsible. When an extant eelgrass population is fragmented or reduced in size/density, as several of these beds had become over the last few years, they generally become more susceptible to disturbance and the rate of decline increases.

Eelgrass Introduction

The decline of eelgrass (*Zostera marina* L.) in the Peconic Estuary over the last 70 years has contributed to the degradation of the estuary as a whole. This submerged, marine plant is inextricably linked to the health of the Estuary. Eelgrass provides an important habitat in near-shore waters for shellfish and finfish and is a food source for organisms ranging from bacteria to waterfowl. To better manage this valuable resource, a baseline of data must be collected to identify trends in the health of the eelgrass meadows and plan for future conservation/management and restoration activities in the Peconic Estuary. The more data that is collected on the basic parameters of eelgrass, the better able the Peconic Estuary Program will be to implement policies to protect and nurture the resource.

The basic purpose of a monitoring program is to collect data on a regularly scheduled basis to develop a basic understanding of the ecology of the target species. Since its inception, the Peconic Estuary Program's Submerged Aquatic Vegetation Monitoring Program, contracted to Cornell Cooperative Extension's Marine Program, has focused on collecting data pertaining to the health of the eelgrass beds in the Peconic Estuary. The development of this program reflects the unique ecology and demography of the eelgrass in the Peconic estuary and varies significantly from other monitoring programs like the Chesapeake and other areas on the east coast, which tend to focus more on remote sensing techniques (i.e., aerial photography) for monitoring.

Table 1. The six reference eelgrass beds and the townships in which the beds are located.

Bullhead Bay (BH)	Southampton
Gardiners Bay (GB)	Shelter Island
Northwest Harbor (NWH)	East Hampton
Orient Harbor (OH)	Southold
Southold Bay (SB)	Southold
Three Mile Harbor (TMH)	East Hampton

Methods

The PEP SAV Monitoring Program includes six eelgrass beds located throughout the estuary and represents a range of environmental factors. The name and township location of each of the reference beds are listed in Table 1, with a corresponding aerial perspective of each site found in Appendix 1. Included with each image are the locations of the six sampling stations within the bed and the GPS coordinates for each station.

The monitoring program has evolved its methodologies from its beginnings in 1997; however the basic parameters of eelgrass health, shoot density, has always been the focus of the program, thus allowing for comparisons between successive years. In the beginning, sampling consisted of the destructive collection of three (four in Bullhead Bay) 0.25 m^2 (50cm x 50cm) quadrats of eelgrass including below ground and above ground biomass that was returned to the laboratory for analysis. The sampling in 1998 and 1999 continued to utilize destructive sampling to collect data, however, sample size was increased to a total of twelve quadrats and there was a decrease in the size of the quadrats to 0.0625 m^2 (12.5 x 12.5 cm).

In 2000, the methodology for the monitoring program was amended to increase the statistical significance of the data collected. The adjustments reflected an increase in the number of sampling stations per site (from 3 to 6), the number of replicate samples per station (from 4 to 10) and the size of the quadrats. However, the 2000 methodology included an increase number of destructively sampled quadrats (24 quadrats) for use in biomass estimations. The 2001 protocols maintained the higher number of replicate samples per bed (60 quadrats) but eliminated the destructive sampling aspect of the program. Beginning in 2004, water temperature was collected at several of the monitoring sites using submersible temperature loggers. The specific monitoring protocol for 2004 is outlined below.

Water Temperature Monitoring

In an effort to better describe the relationship between water temperature and the life cycle of eelgrass, temperature loggers were deployed in several eelgrass beds in the Peconics. The following sites were monitored for 2007: Sag Harbor, Northwest Harbor, Cornelius Point (Shelter Island), Red Cedar Bluff (Southampton) and Orient Point (near Cross Island Ferry). The year-long deployment of loggers at Cornelius Point, Northwest Harbor and Sag Harbor allowed for a complete view of the annual water temperature cycle for these areas. The summer deployments at Red Cedar Bluff and Orient Point was meant to focus on the summer temperature trends with the loggers set to record at 2hr intervals instead of the 6hr intervals for the other 3 sites (as was recommended at the Seagrass Experts Meeting, April 2007).

The loggers, Onset Tidbit® and Onset StowAway®, were deployed in January 2007 (Cornelius Point, Northwest Harbor and Sag Harbor; 6-hr interval), June 2007 (Red Cedar Bluff; 2-hr interval) and July 2007 (Orient Point; 2-hr interval) and retrieved October (Red Cedar Bluff and Orient Point) and December 2007 for the 6-hr loggers.

Temperature data was exported from the loggers into spreadsheets. The data was analyzed and graphed using SigmaStat® and SigmaPlot® (SPSS Inc., 1997) software.

Eelgrass Monitoring

The 2007 monitor was initiated on 23 August and completed on 29 August.

Sampling at each site was distributed among six stations that have been referenced using GPS. At each of the six stations, divers conducted a total of 10 random, replicate counts of eelgrass stem density and macroalgal percent cover in 0.10 m^2 quadrats. Divers also made observations on blade lengths and overall health of plants that they observed. The divers stayed within a 10 meter radius of the GPS station point while conducting the survey. Algae within the quadrats were identified by genus and if it was epiphytic or non-epiphytic on the eelgrass. Divers were careful not to disturb the eelgrass, so as not to cause plants to be uprooted or otherwise damaged.

Data was incorporated into a spreadsheet and statistically analyzed using SigmaStat software (SPSS Inc., 1997). The trends, within sites, were analyzed by comparing the 2006 data with the data from the previous years.

Bed Delineation

The deep edge delineations for the 2006

Table 2. Descriptive statistics for eelgrass stem density for 2007.

Location	Sample Size (n)	# Stations w/ No Grass	Mean Stem Density (shoots/m^2)	Standard Error
Bullhead Bay (BH)	60	4	51	±12.1
Gardiner's Bay (GB)	60	2	224	±39.5
Northwest Harbor (NWH)	60	6	0	±0.0
Orient Harbor (OH)	60	5	47	±21.5
Southold Bay (SB)	60	6	0	±0.0
Three Mile Harbor (TMH)	60	6	0	±0.0

season was based on the 2007 Suffolk County Aerial Imagery. The 2007 delineations were incorporated into GIS layers that included the 2002, 2004, 2005 and 2006 delineations and were overlaid on the 2007 true-color aerial imagery for each monitoring site.

Results

Statistical analysis reports are included as a separate set of appendices and include basic descriptive statistics as well as one-way ANOVAs. *P*-values, when not stated, may be found in these appendices. The attached appendices (Appendices 1-4) present graphical data directly referred to in this report.

Water Temperature Monitoring

The graphs for the water temperature data are included in Appendix 1. The data represented in the graphs are the mean daily water temperature (°C) at each site.

For the second straight year, the temperature logger in Bullhead Bay could not be found at the end of the season for offloading of the data. The loss of the logger and TERF frame that anchored it could only be attributed to human interference/removal.

The remaining loggers were recovered and offloaded with the data represented in the graphs (1a-1e) in Appendix 1. The water temperatures generally peaked in the first week of August 2008, with the exception of Cornelius Point, which experienced its summer peak of 24.8°C in mid-July (Appendix 1a). Red Cedar Bluff experienced the highest water temperature of 26.6°C (Appendix 1e), with Northwest Harbor and Sag Harbor a bit lower at 25.8°C and 25.4°C (Appendices 1b and 1d), respectively. Orient Point, as expected, had the lowest peak summer temperature only reaching 23.4°C (Appendix 1c).

Eelgrass Shoot Density and Areal Extent

The basic descriptive statistics for the eelgrass shoot densities for the 2007 season are represented in Table 2. Included in the table are the sample sizes (replicates), number of stations without eelgrass, mean stem density, and standard error of the means. Appendix 2 includes trend analysis graphs of the mean shoot density data for the six monitoring sites from 1997 (1999)-2007.

Bullhead Bay

The 2007 mean shoot density for Bullhead Bay was found to be 50 shoots/m^2 (Table 2), which did not represent a significant decrease in mean shoot density from 2006. The increases in the area of the meadow observed in 2006 either were lost entirely or at least became very patchy as indicated by the loss of eelgrass from the 2 stations (Stations 2 and 6) that had been regained in 2006 (Appendix 3a).

Gardiners Bay

Gardiners Bay saw an increase in shoot density from 2006 to 2007. The 2007 mean shoot density was 224 shoots/m^2 (Table 2), an increase from 178 shoots/m^2 in 2006 (Appendix 2b). However, this increase was not statistically significant.

This site remains highly dynamic in regards to its areal extent. Between 2006 and 2007, there was a loss of the outer most "fingers" eelgrass close to Stations 1 and 2, but the near-shore portion of the bed appears to have filled in and expanded slightly since 2006 (Appendix 3b).

Northwest Harbor

Northwest Harbor showed a total loss of eelgrass from 2006 to 2007. The eelgrass population in 2006 was virtually extinct (shoot density of 8 shoots/m^2) and did not survive through to the 2007 season, when no eelgrass was found at any of the monitoring stations in Northwest Harbor (Table 2).

While no eelgrass was observed at any of the monitoring stations or adjacent areas in 2007, the 2007 aerial imagery suggests that small populations may still exist in the far north of the harbor and around a "hole" inshore of Station 4 (Appendix 3c).

Orient Harbor

The eelgrass remaining around Station 5 in Orient Harbor experienced a minor increase in shoot density in 2007. The mean shoot density for 2007 was 47 shoots/m^2 (Table 2), and was an insignificant gain from the 2006 density 27 shoots/m^2 (Appendix 2d). Station 5 continues to be the only station that supports eelgrass (Appendix 3d).

Southold Bay

Southold Bay has not supported eelgrass at any of the monitoring stations since 2006 (Appendix 2e). Whereas eelgrass was not counted at any of the monitoring stations in 2006, plants were observed still growing at this site. The 2007 season not only failed to record eelgrass in any of the monitoring stations, but no eelgrass was observed anywhere at this site.

The eelgrass appears to have completely collapsed. The 2007 aerial imagery did not show evidence of an extant eelgrass population in Southold Bay (Appendix 3f) and field monitoring did not identify even one individual plant.

Three Mile Harbor

The Three Mile Harbor monitoring site supported no eelgrass in 2007 (Table 2). Eelgrass first disappeared at the site in 2005, but extant eelgrass meadows were found in the vicinity in 2006. Scouting of areas adjacent to the monitoring site found no eelgrass nearby in 2007. Fresh eelgrass shoots were observed floating in the Harbor, indicating that there is an extant population in the area. Scouting in the immediate vicinity of the monitoring site yielded no eelgrass.

<u>Macroalgal Percent Cover</u>

Table 3. Mean macroalgal percent coverage (m^{-2}).

Eelgrass Bed	Percent Macroalgae Cover
Bullhead Bay	12.4
Gardiners Bay	10.0
Northwest Harbor	4.7
Orient Harbor	19.0
Southold Bay	5.6
Three Mile Harbor	28.3

Macroalgal percent cover was quantified for each quadrat within the six beds. Table 3 contains the mean percent coverage of macroalgae for each bed. Graphs for the individual sites are included in Appendix 4.

Bullhead Bay

The macroalgal percent cover for 2007 showed almost no change from 2006 (Appendix 4a). The macroalgal population continued to be dominated by the red filamentous alga, *Spyridia filamentosa* and the green filamentous alga, *Cladophora*. Unvegetated areas were covered with diatomaceous and cyanobacterial mats.

Gardiners Bay

Gardiners Bay showed a trend of decline in macroalgal percent cover that started in 2006 and continued in 2007 (38.8% to 10%) (Appendix 4b). The 2007 macroalgal cover represented the lowest cover recorded at the site. While the overall abundance of macroalgae at the site was low, the species diversity at this site displayed no significant change from previous years.

Northwest Harbor

Northwest Harbor's macroalgae cover for the 2007 season declined by only 3.2% from 7.9% in 2006 to 4.7% in 2007 (Appendix 4c). As was found in 2006, the macroalgal population at this site was observed to be only two species, *Spyridia filamentosa* and *Agardhiella subulata*.

Orient Harbor

The macroalgal community in Orient Harbor was found to have increased slightly from 2006 to 2007, but not significantly. The 2007 mean percent macroalgal cover was 19% and consisted of *Spyridia filamentosa*, *Codium fragile* and *Agardhiella subulata*. For the second year, a *Cochlodinium* bloom was observed near Station 4. Presence of this species is becoming more common in the Peconic Estuary.

Southold Bay

The percent cover of macroalgae in Southold Bay showed no statistical change from 2006 to 2007 (Appendix 4e). *Codium fragile* dominated the macroalgae community in the eastern area of the site, while macroalgal mats were prevalent in the in western areas near Stations 5 and 6.

Three Mile Harbor

Three Mile Harbor has maintained a relatively stable macroalgal population since 2004 and this trend continued in 2007. The percent cover was up from 2006 by almost 10%, but this was not a significant increase. Species included *Spyridia filamentosa*, *Codium fragile* and *Gracilaria tikvahiae*.

Discussion

<u>Water Temperature</u>

Water temperature continues to follow a predictable pattern in the Peconic Estuary with the warmest waters located in the western Estuary and the cooler areas located to the east. The highest mean daily temperature recorded was at Red Cedar Bluff with the lowest temperature recorded at Orient Point. The 2007 summer water temperatures were cooler than previous years where high water temperatures regularly approached and exceeded 28°C, which may reduce temperature stress on eelgrass populations allowing for some recovery of lost areas. The upper temperature tolerance of eelgrass in the Peconics is assumed to be around 30°C, but an exact limit is not known. Brief periods of high water temperature would likely have little effect on the eelgrass populations, however, extended durations in high water temperatures could have a significant detrimental effect on eelgrass. Eelgrass loss due to high water temperatures, like those experienced in the Chesapeake Bay, warrant the continued monitoring of water temperatures throughout the Estuary.

<u>Long-Term Eelgrass Monitoring</u>

Bullhead Bay

Where Bullhead Bay had demonstrated a significant expansion in 2006, the bed was found to have drawn back toward the center of the Bay in 2007. The gains in Station 2 and 6 in 2006 were lost in 2007, but the loss was not to the same extent as the initial loss recorded in 2002. Bullhead Bay has shown the potential to recover from acute episodes of disturbance in the past, and recovery from the 2007 setback is possible. This bay is benefitted by its sheltered nature which may allow for a higher seedling recruitment and vegetative expansion that is not supported at other sites with higher currents or wave action. Bullhead Bay is also closed for shellfishing, for at least part of the year, and it is not a popular boating area. Both of these factors minimize the anthropogenic impacts on the meadow. Bullhead Bay is also relatively crab-free, specifically spider crabs. Spider crabs have been identified as one of the most significant sources of bioturbation in eelgrass in the Peconic Estuary. Full regeneration of the lost acreage since 2002 is still possible, but may take several years.

Gardiners Bay

Gardiners Bay has shown signs of decline over the last few years, but in 2007, there are signs of possible recovery of the eelgrass population. Although the increase in shoot density was not statistically significant, it does suggest that the bed is healthy and likely regenerating. This is supported by the 2007 aerial imagery in Appendix 3b. The offshore “fingers” of eelgrass have eroded away over time, but the inshore portion of the meadow has filled in and expanded offshore slightly, based on the 2007 photo.

Physical disturbance at the site continues to be the most significant factor influencing the eelgrass population. Shellfishing activities (*i.e.*, clamming) and prop scars from boat traffic appear to have increased in frequency.

Northwest Harbor

The Northwest Harbor eelgrass has been completely lost around the monitoring stations at this site. In 2006, the eelgrass population had declined to an unsustainable level, so the complete loss observed in 2007 was not unexpected. No eelgrass was observed around any of the six monitoring stations, but the 2007 aerial imagery indicated that there may still be small, isolated patches of eelgrass remaining in Northwest Harbor. Due to the lateness of the aerial imagery acquisition (made available in Summer 2008), the suspected eelgrass patches identified in the 2007 imagery have not be ground-truthed. However, a field survey is planned for the Fall 2008.

As recorded in previous years, disturbance by crabs (particularly spider crabs), whelks and clamming activities have contributed to the decline and eventual loss of this bed.

Orient Harbor

The eelgrass at Station 5 continues to be the last population of eelgrass in the monitoring area. The shoot densities have shown a slight increasing trend, especially if the shoot density at station 5 is considered by itself (the dashed line in the graph in Appendix 2d). As the population remaining at Station 5 has been showing an increase in shoot density, there remains the possibility that there could be some recovery of eelgrass in adjacent areas due to seedling recruitment and vegetative expansion. However, the overall reduced nature of this population, in both density and area, reduce the odds of a complete recovery.

Southold Bay

Where eelgrass was still present in areas adjacent to the monitoring stations in 2006, no eelgrass was observed at all at this site in 2007. This leads to the conclusion that the eelgrass population has become extinct in Southold Bay. There is no possibility of recovery of eelgrass in Southold Bay without active restoration, as there is not a nearby eelgrass population to provide propagules for recruitment.

Three Mile Harbor

The eelgrass in Three Mile Harbor outside of Hand's Creek has lost its eelgrass population. Many factors have likely attributed to this loss, but human activity was the most obvious factor influencing the health and extent of the eelgrass population here. The presence of a mooring field, and its expansion in successive years, presented a significant disturbance source for the inshore areas of the former eelgrass bed. Dragging mooring chains and prop dredging were likely factors influencing the decline of the inshore portion of the bed. Outside of the mooring field, eelgrass was subjected to boat traffic from the designated water skiing area, which was expanded into the eelgrass bed. With water depths of 5-7 feet, boats did not directly impact the eelgrass by prop dredging/scarring, but with the mucky sediment at this site being easily resuspended, eelgrass could potentially have faced periods of light limitation that could have contributed to its decline.

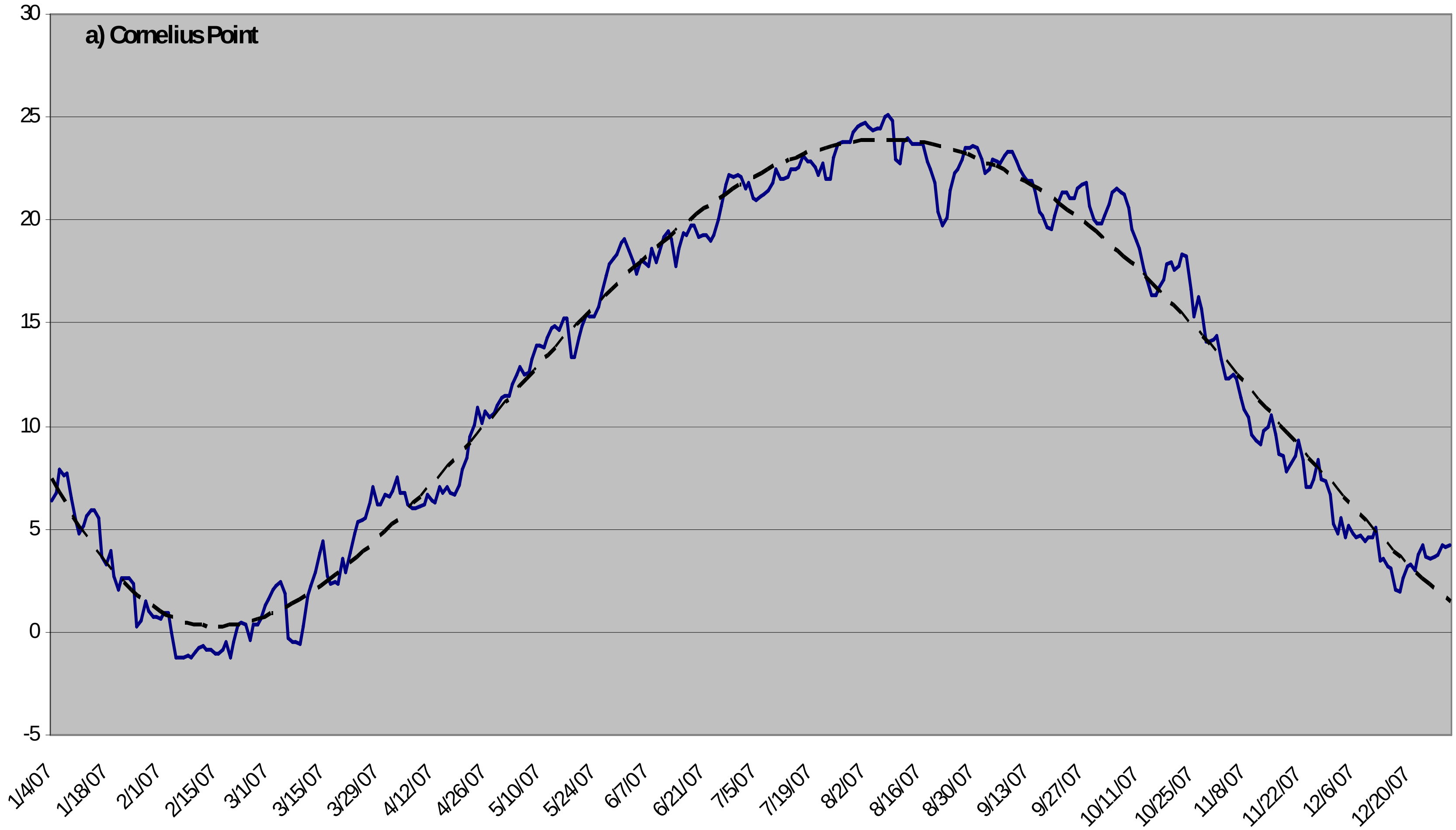
Overview

Since the 2006 monitoring season, there has been complete loss of eelgrass in three out of the six LTEMP sites. Southold Bay and Three Mile Harbor were lost in 2006 and Northwest Harbor was lost in 2007. While the loss of the last of the remaining eelgrass population at Northwest Harbor was a significant event, there was no other significant change in the remaining eelgrass populations in terms of shoot density. Bullhead Bay did experience a loss in areal extent with eelgrass retreating from Stations 2 and 6. Orient Harbor continues to maintain a small population of eelgrass, but has shown no signs of recovery since its decline in 2002-2003.

The primary cause(s) of the declines observed during monitoring have not all been identified, but physical disturbance, both natural and anthropogenic, rank high. Bioturbation by crabs, whelks and moon snails, can have a large impact on an eelgrass bed by uprooting plants and causing fragmentation. Grazing by swans and geese could have an impact on shallow eelgrass beds by both uprooting plants and consumption of eelgrass seeds needed for regeneration of the beds.

Human activities, specifically shellfishing and boating, potentially pose the greatest threat to eelgrass meadows in the Estuary. A single clammer digging in an eelgrass bed not only digs up plants, but also creates openings in the bed that can lead to erosion or serve to fragment the beds. Damage from boats results in disturbance similar to that of clamming, with the initial impact on the eelgrass bed being loss of plants, but prop scars also open up the bed to erosional processes and fragmentation. Physical disturbance should be considered one of the top factors in eelgrass loss in the Peconic Estuary.

Appendix 1. Water temperature (°C) graphs for selected sites within the Peconic Estuary. Datasets are represented as daily mean temperatures for 2007. The dashed lines represent the trend of the individual graph.


a) Cornelius Point
30
25
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15
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5
0
-5
1/4/07
1/18/07
2/1/07
2/15/07
3/1/07
3/15/07
3/29/07
4/12/07
4/26/07
5/10/07
5/24/07
6/7/07
6/21/07
7/5/07
7/19/07
8/2/07
8/16/07
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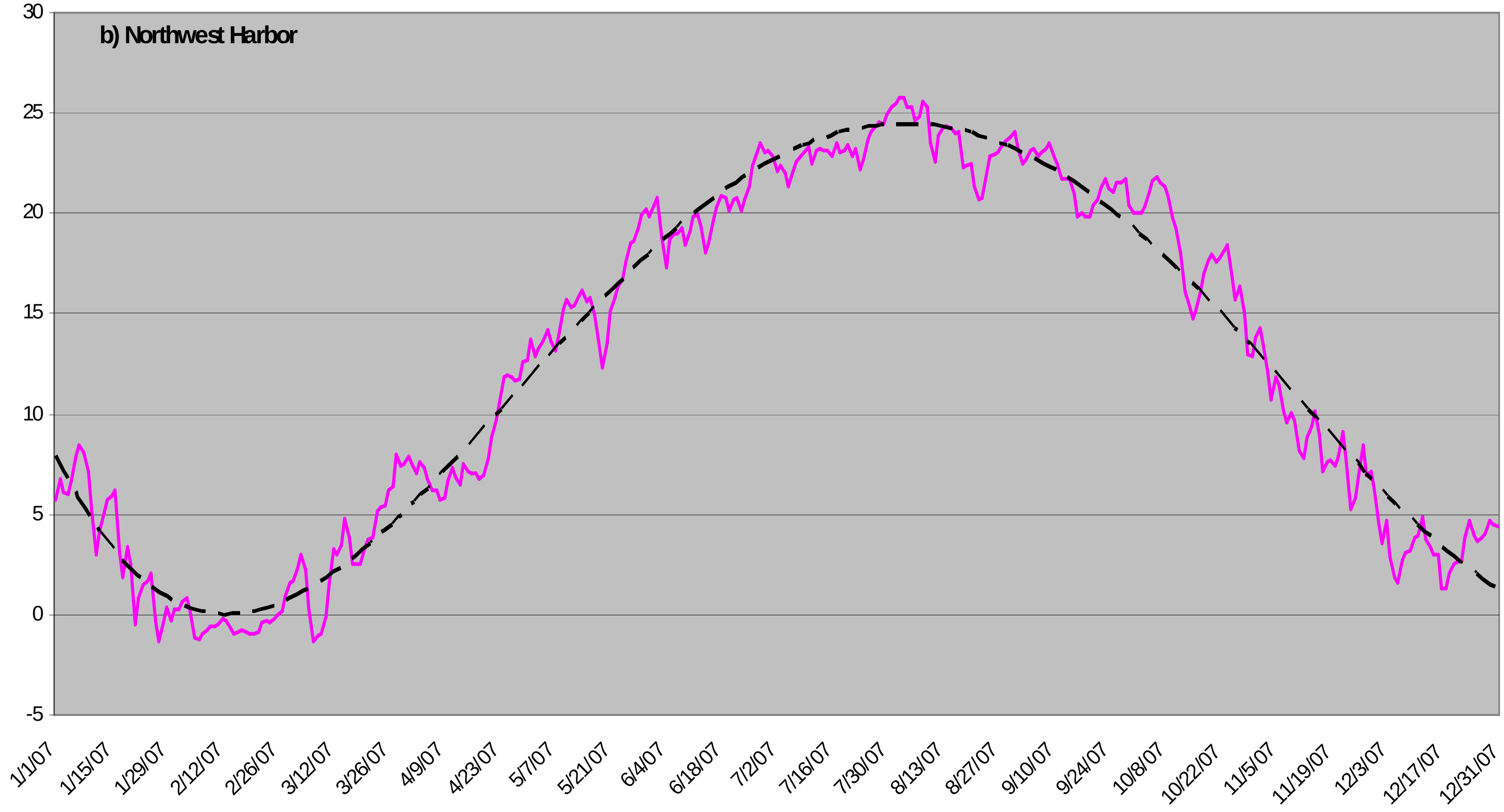
12/6/07
12/20/07


b) Northwest Harbor
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25
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5
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-5
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1/29/07
2/12/07
2/26/07
3/12/07
3/26/07
4/9/07
4/23/07
5/7/07
5/21/07
6/4/07
6/18/07
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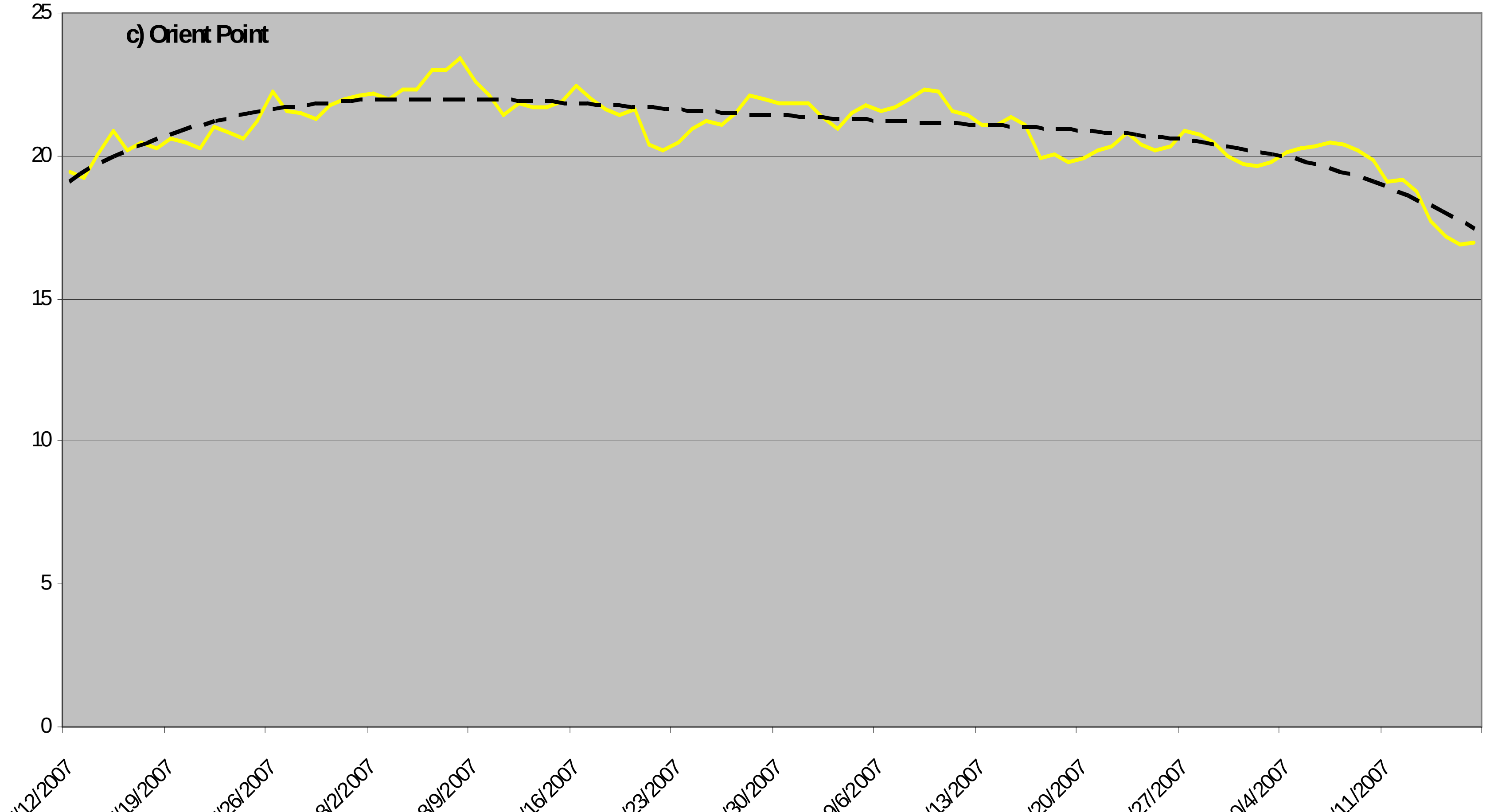
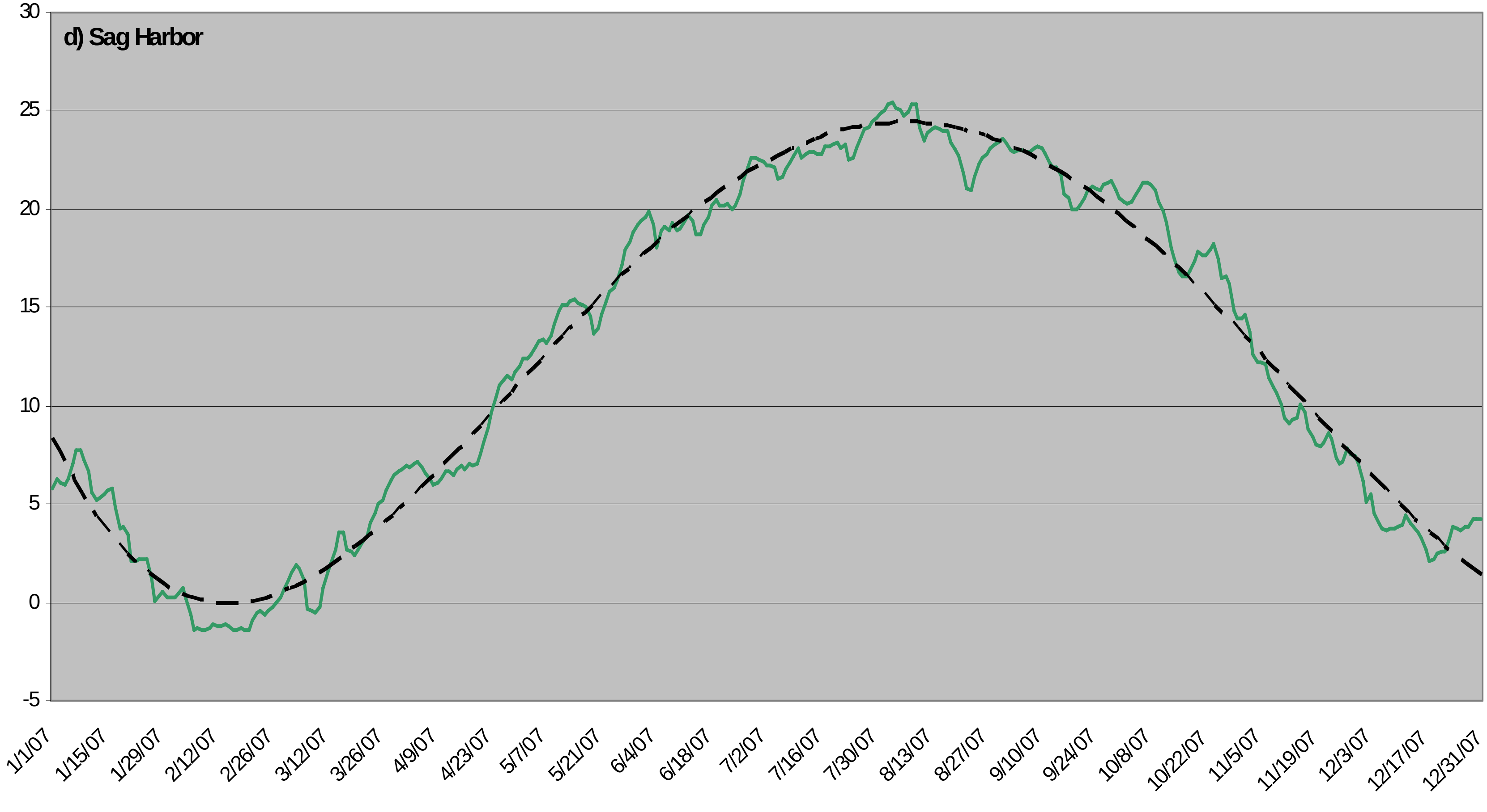
7/30/07
8/13/07
8/27/07
9/10/07
9/24/07
10/8/07
10/22/07
11/5/07
11/19/07
12/3/07
12/17/07
12/31/07



c) Orient Point
25
20
15
10
5
0
7/12/2007
7/19/2007
7/26/2007
8/2/2007
8/9/2007
8/16/2007
8/23/2007
8/30/2007
9/6/2007
9/13/2007
9/20/2007
9/27/2007
10/4/2007
10/11/2007



d) Sag Harbor
30
25
20
15
10
5
0
-5
1/1/07
1/15/07
1/29/07
2/12/07
2/26/07
3/12/07
3/26/07
4/9/07
4/23/07
5/7/07
5/21/07
6/4/07
6/18/07
7/2/07
7/16/07
7/30/07
8/13/07
8/27/07
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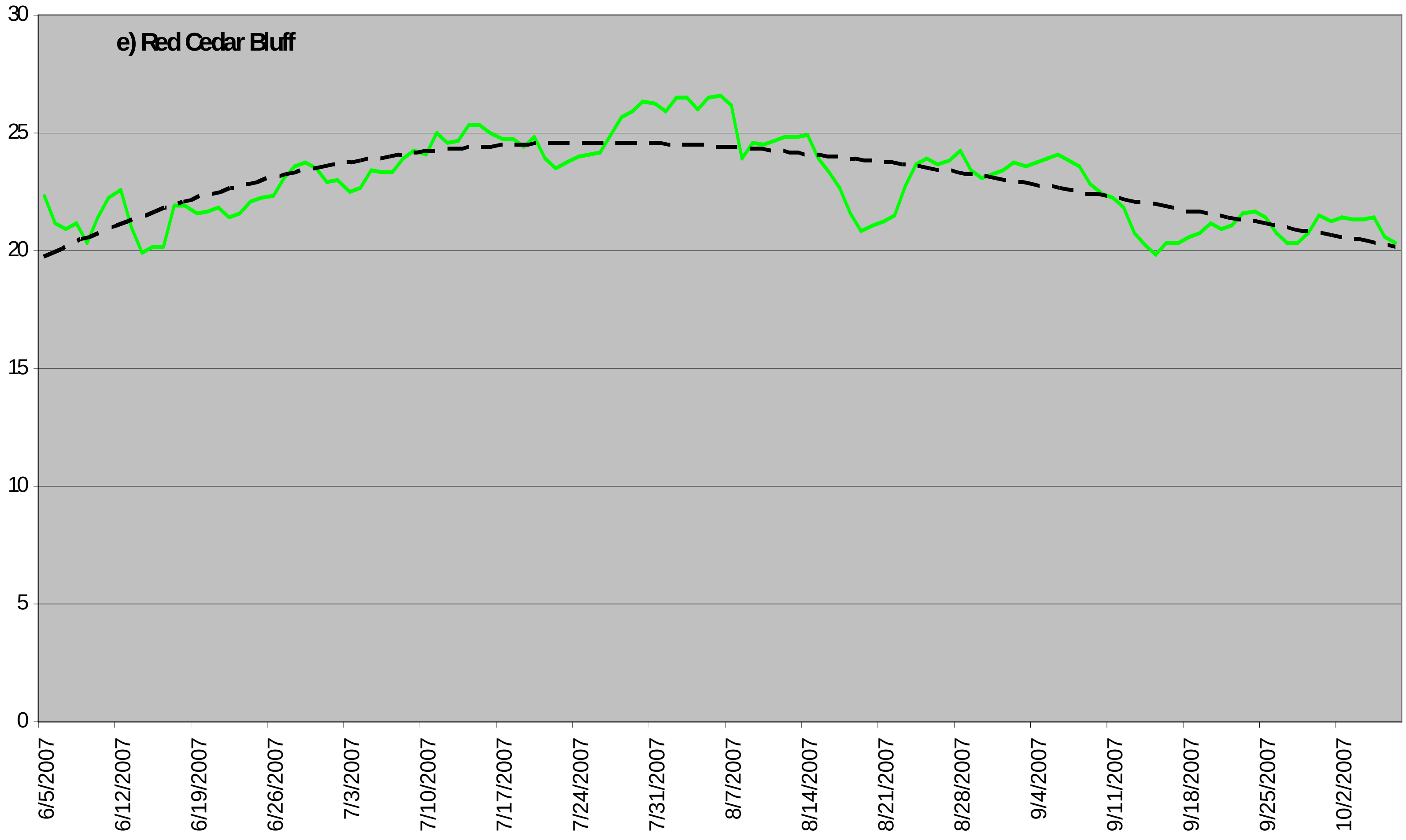
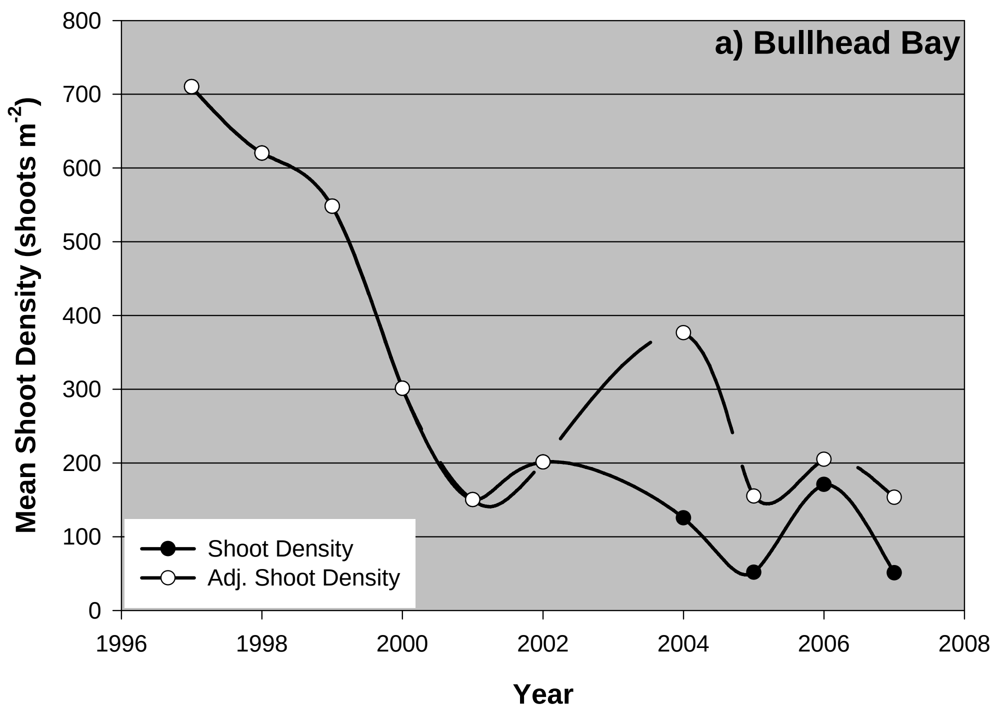
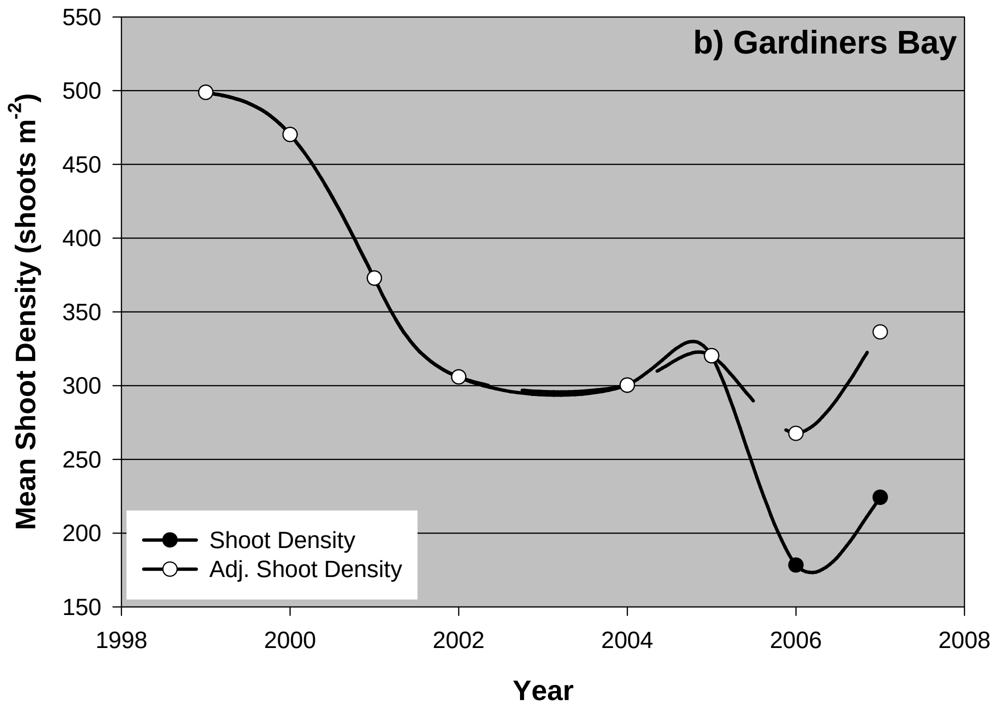
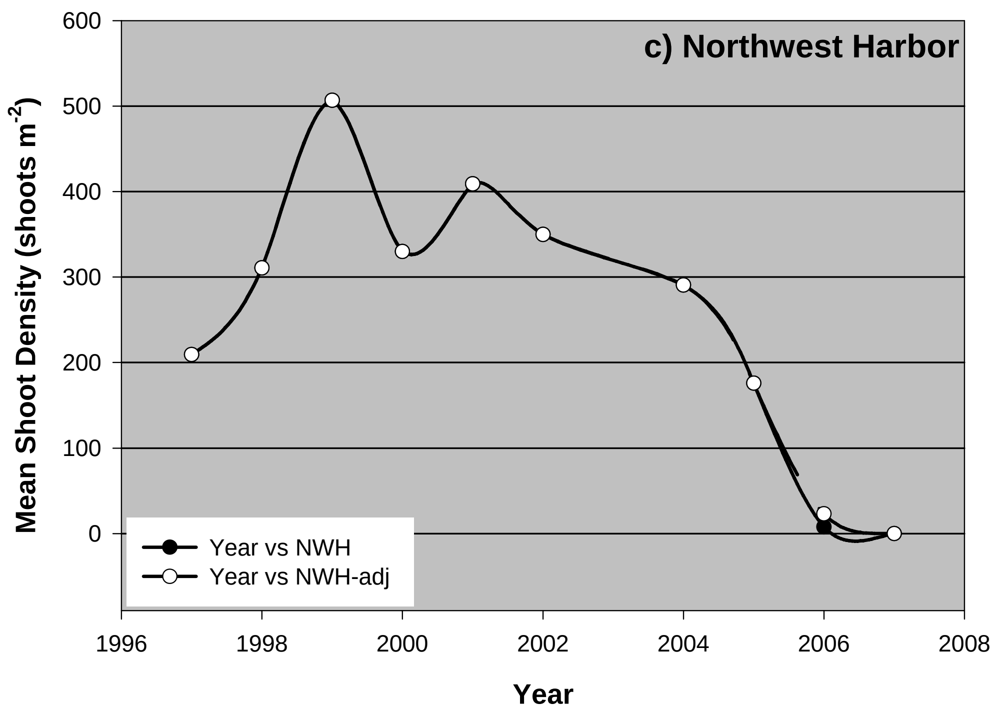
12/3/07
12/17/07
12/31/07

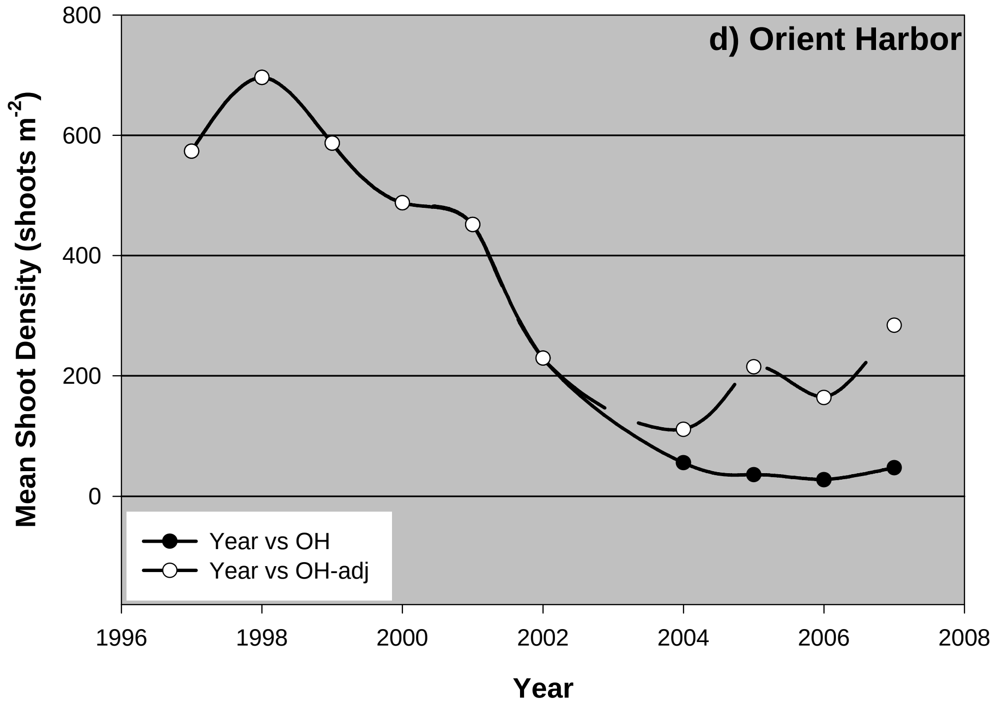

e) Red Cedar Bluff
30
25
20
15
10
5
0
6/5/2007
6/12/2007
6/19/2007
6/26/2007
7/3/2007
7/10/2007
7/17/2007
7/24/2007
7/31/2007
8/7/2007
8/14/2007
8/21/2007
8/28/2007
9/4/2007
9/11/2007
9/18/2007
9/25/2007
10/2/2007

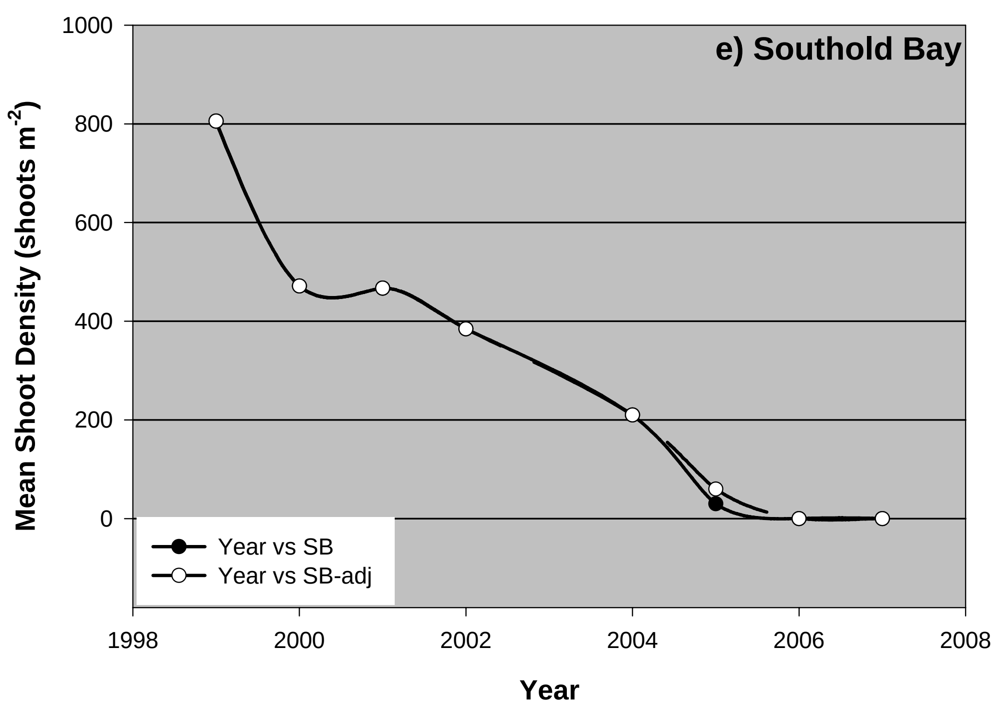
Appendix 2. Graphs of the mean eelgrass shoot densities for the six long-term monitoring sites. (Shoot density is expressed as shoots $^{-2}$). The dashed line represents the mean eelgrass shoot density for each of the beds with unvegetated stations removed.

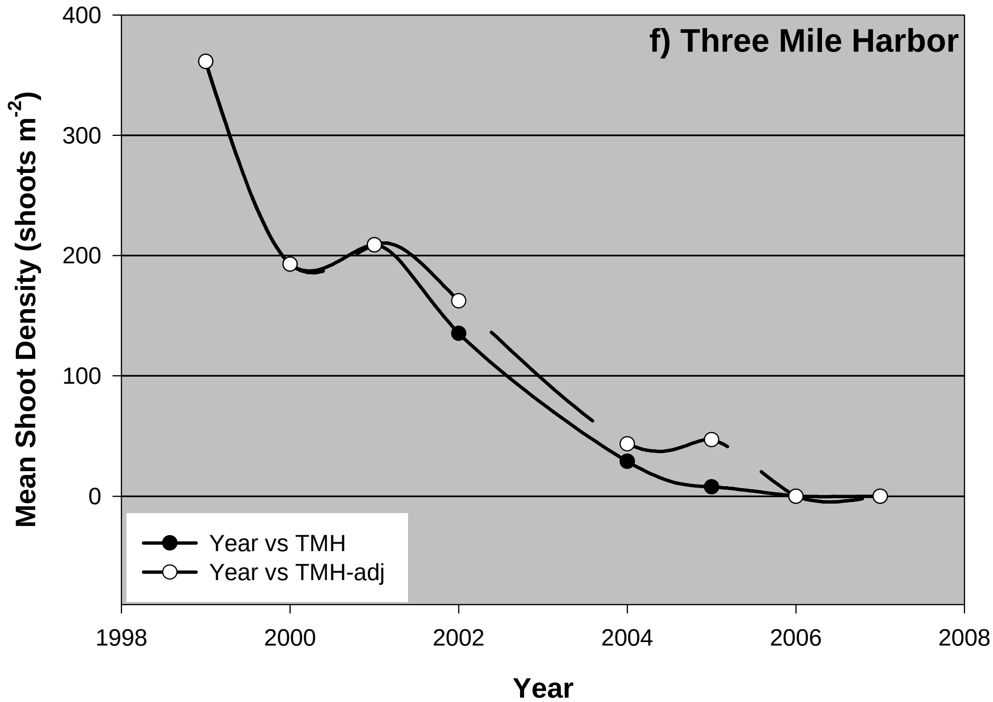



b) Gardiners Bay
Mean Shoot Density (shoots m-2)
550
500
450
400
350
300
250
200
150
1998
2000
2002
2004
2006
2008
Year
Shoot Density
Adj. Shoot Density


c) Northwest Harbor
Mean Shoot Density (shoots m-2)
600
500
400
300
200
100
0
1996
1998
2000
2002
2004
2006
2008
Year
Year vs NWH
Year vs NWH-adj


d) Orient Harbor
Mean Shoot Density (shoots m-2)
800
600
400
200
0
1996
1998
2000
2002
2004
2006
2008
Year
Year vs OH
Year vs OH-adj

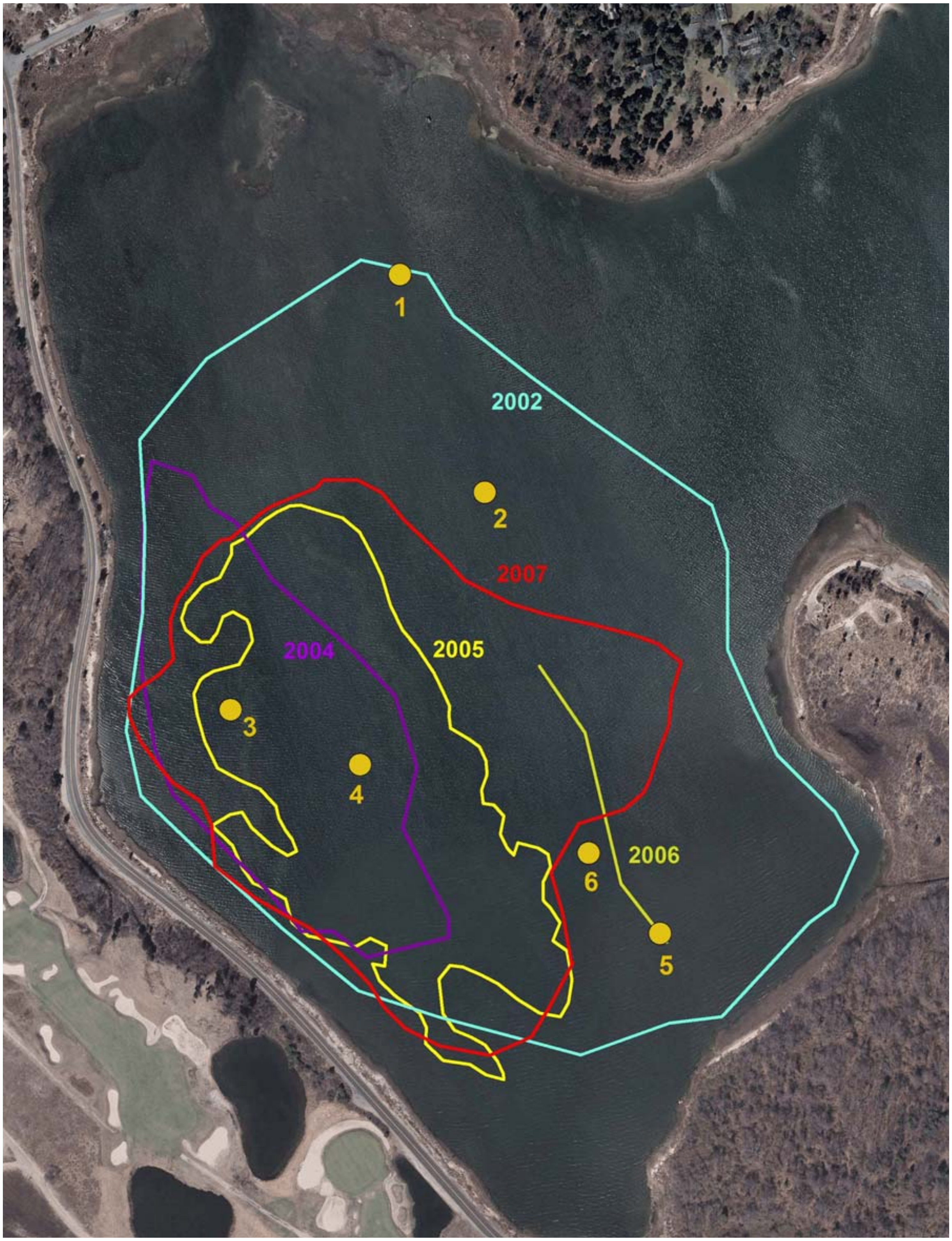

e) Southold Bay
Mean Shoot Density (shoots m-2)
1000
800
600
400
200
0
1998
2000
2002
2004
2006
2008
Year
Year vs SB
Year vs SB-adj



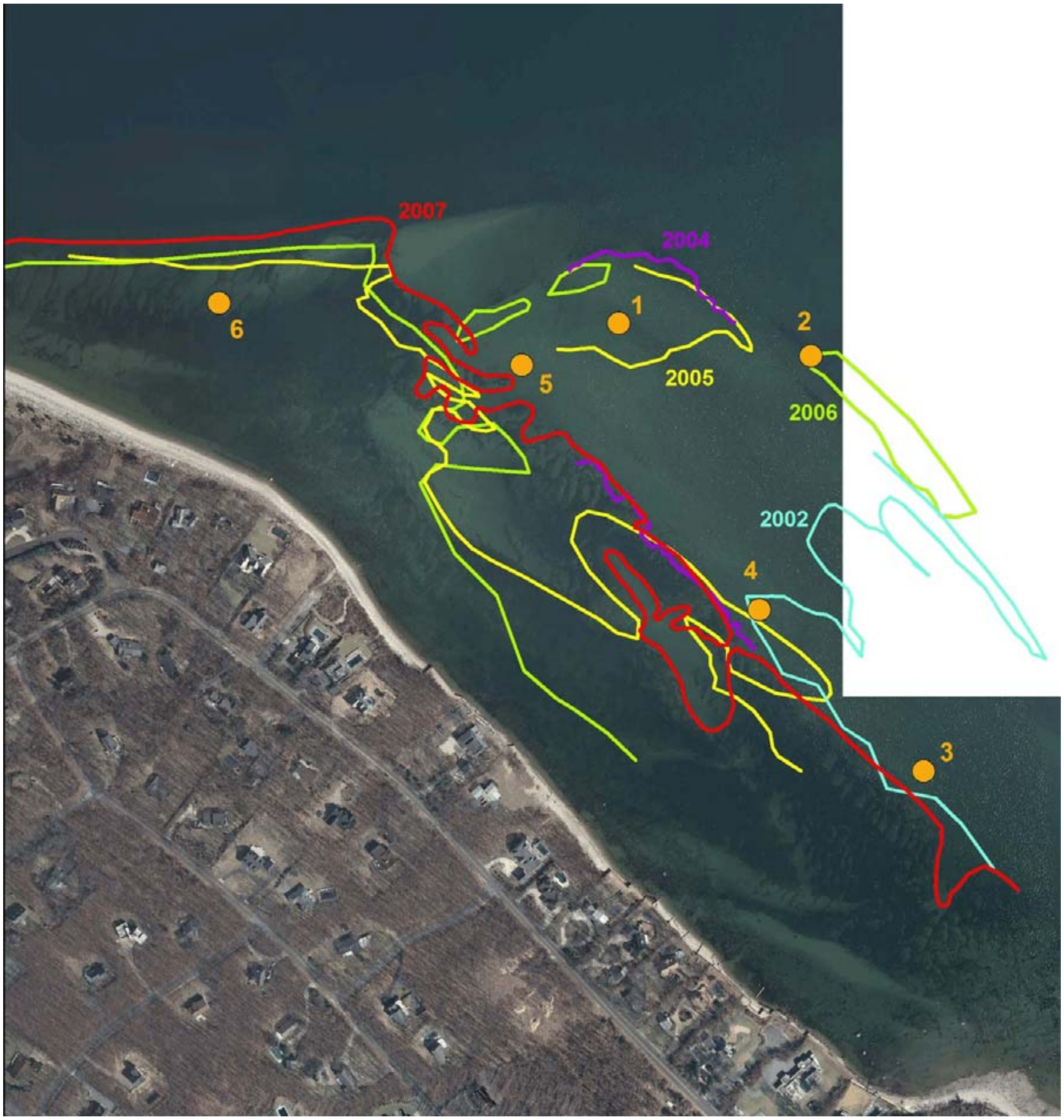
f) Three Mile Harbor
Mean Shoot Density (shoots m-2)
400
300
200
100
0
Year vs TMH
Year vs TMH-adj
1998
2000
2002
2004
2006
2008
Year

Appendix 3. Aerial photographs, with deep edge delineations, of the six monitoring sites for 2004. Monitoring stations are indicated by numbers (1-6) for each site.

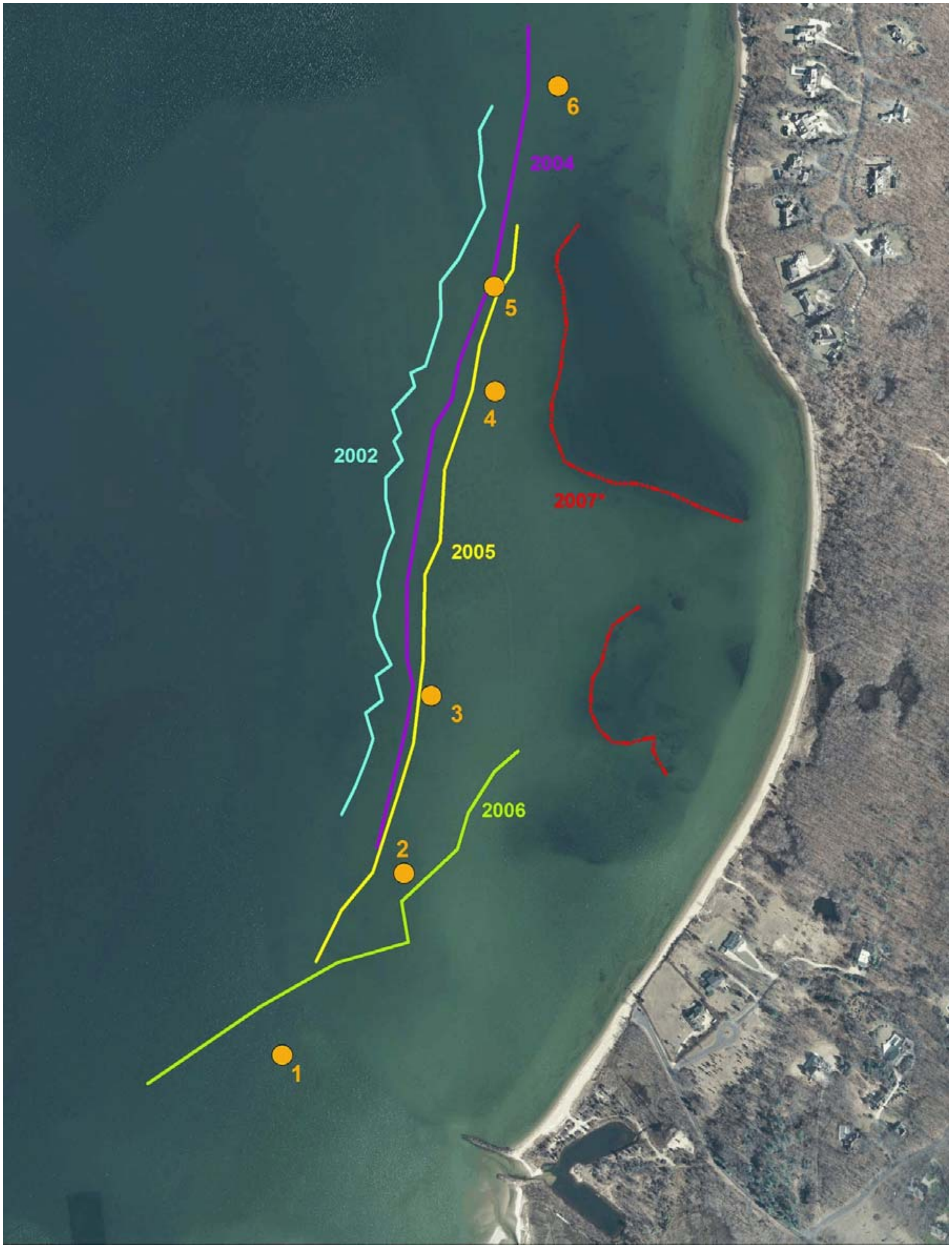
a) **Bullhead Bay**



b) **Gardiner's Bay**

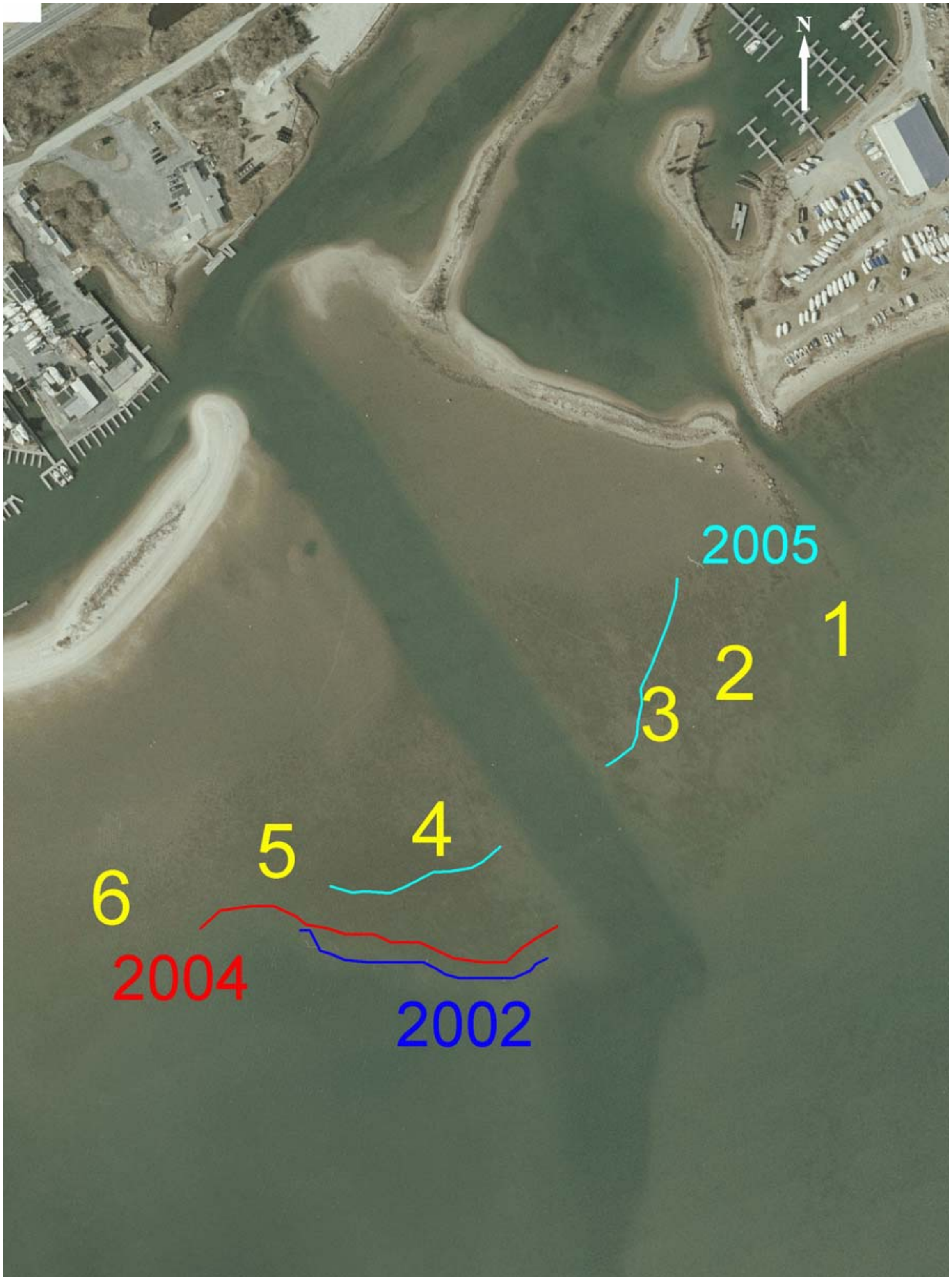


c) **Northwest Harbor**

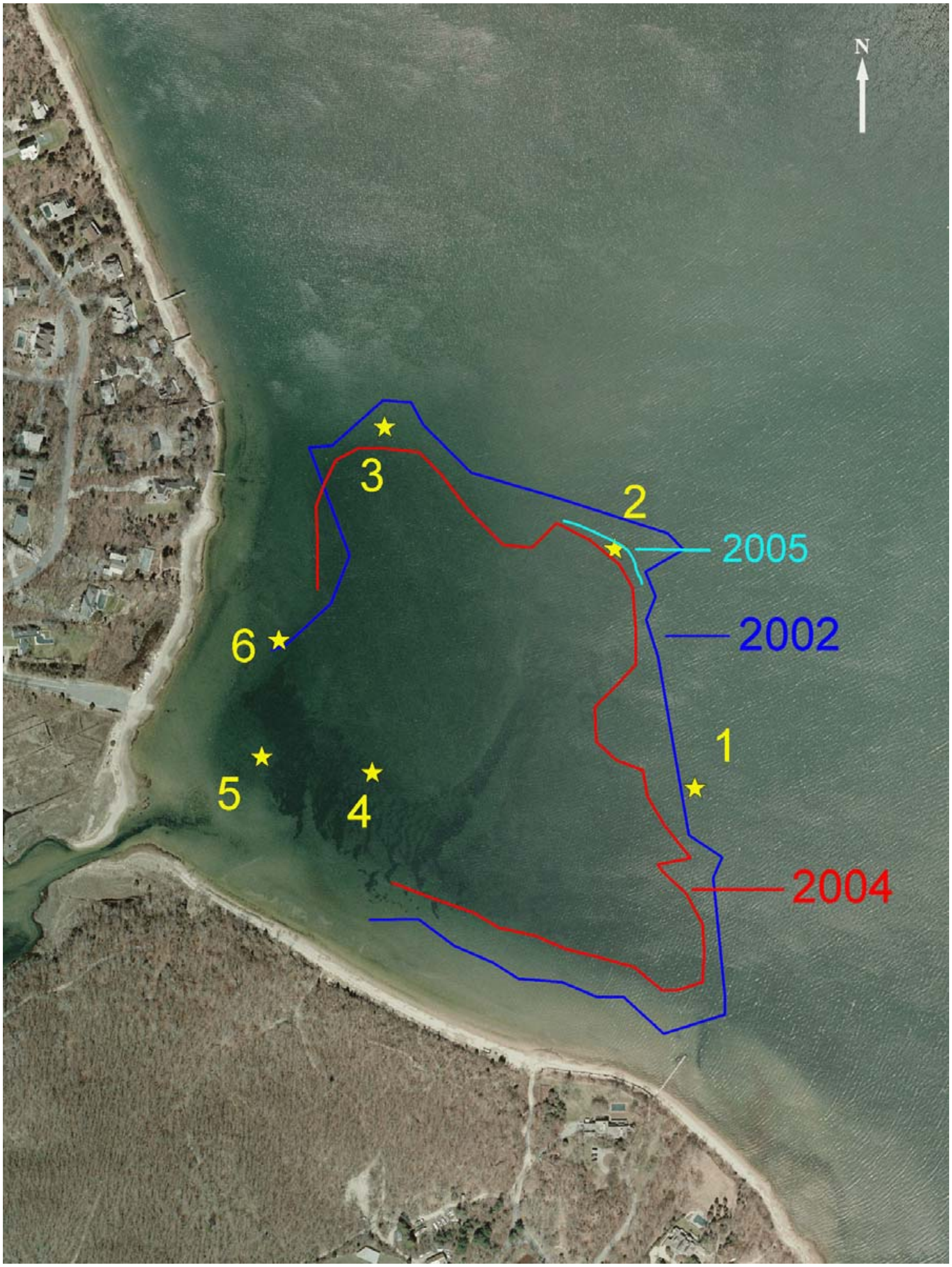


d) **Orient Harbor**

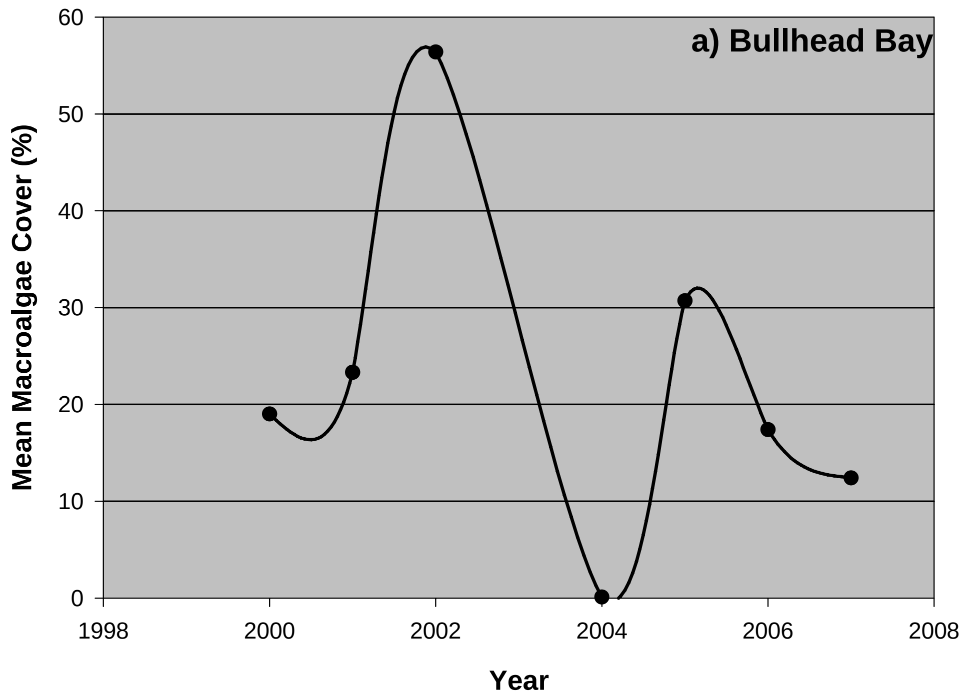
e) **Southold Bay** (note that there are no deep edges for 2006 or 2007 due to complete loss of eelgrass).

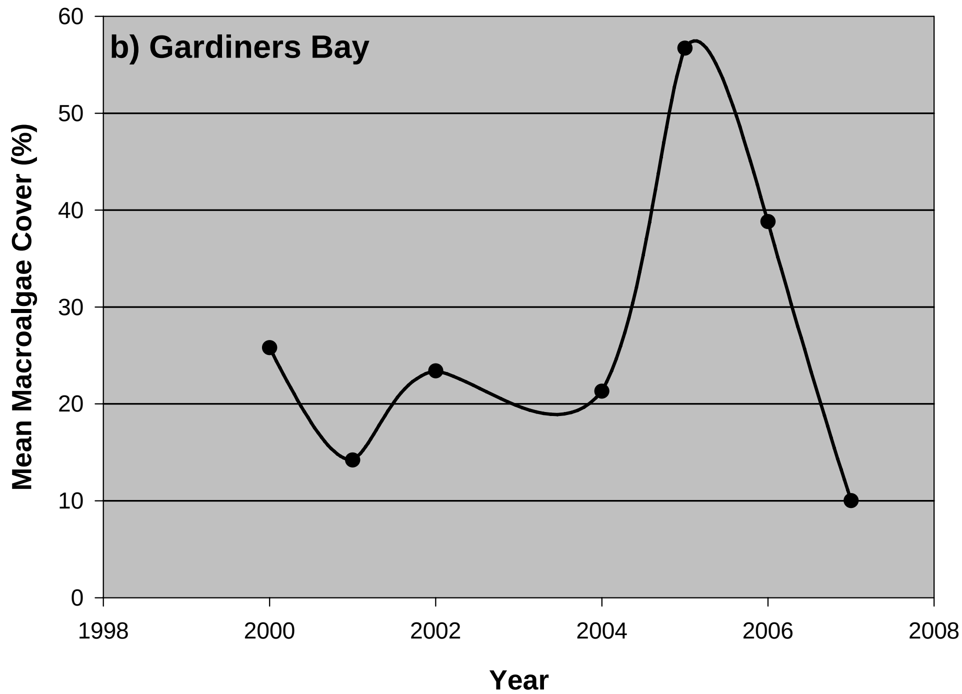


f) **Three Mile Harbor** (note that there are no 2006 or 2007 delineations due to complete loss of eelgrass within monitoring area).

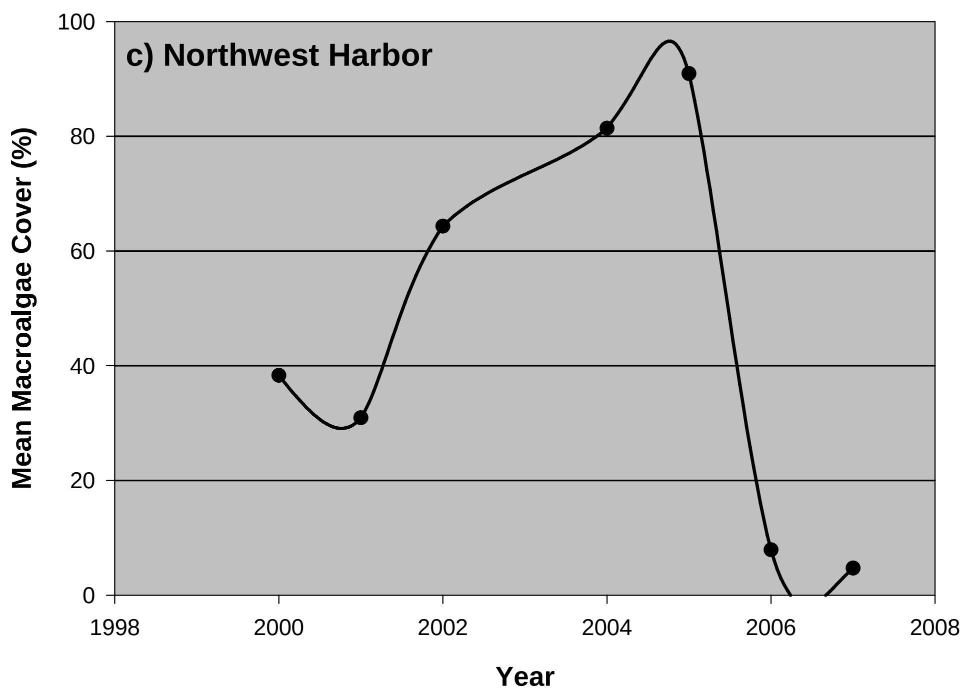


Appendix 4. Graphs representing the mean percent macroalgal cover at the six sites from 2000 to 2007.

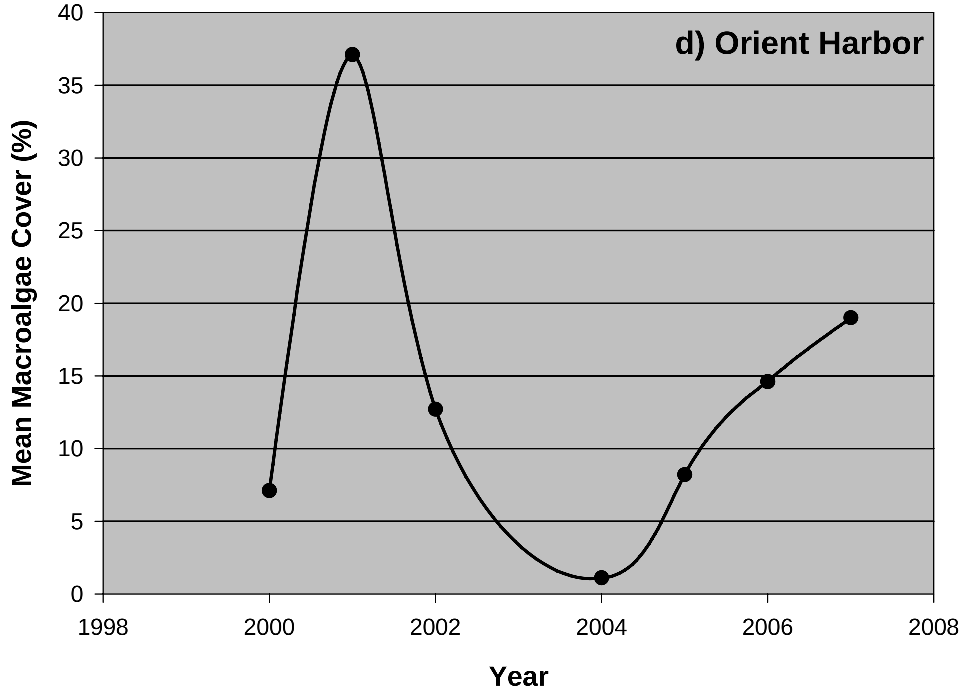


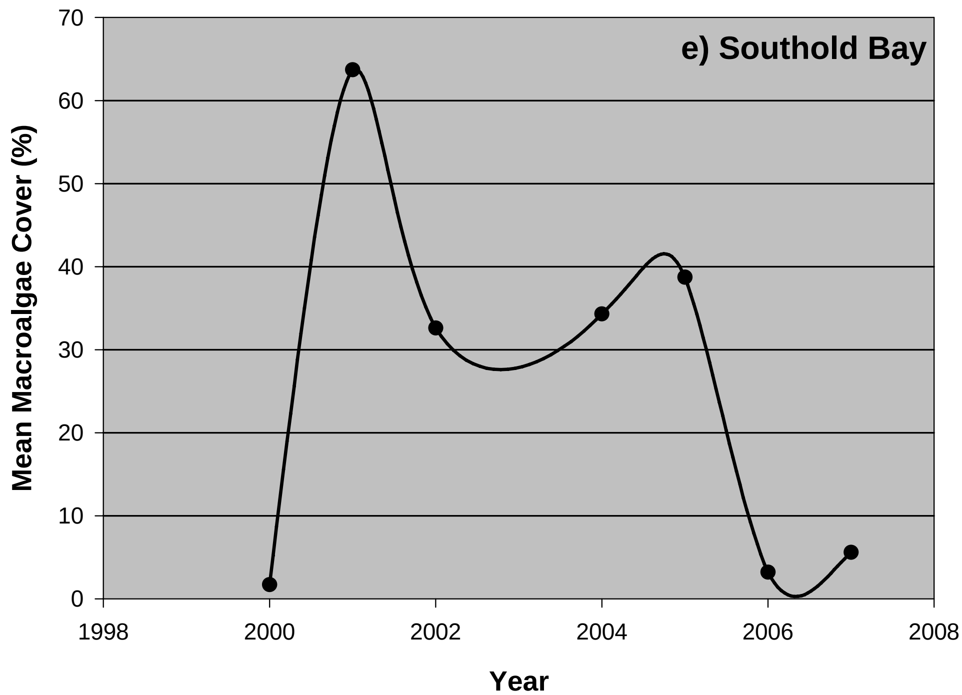


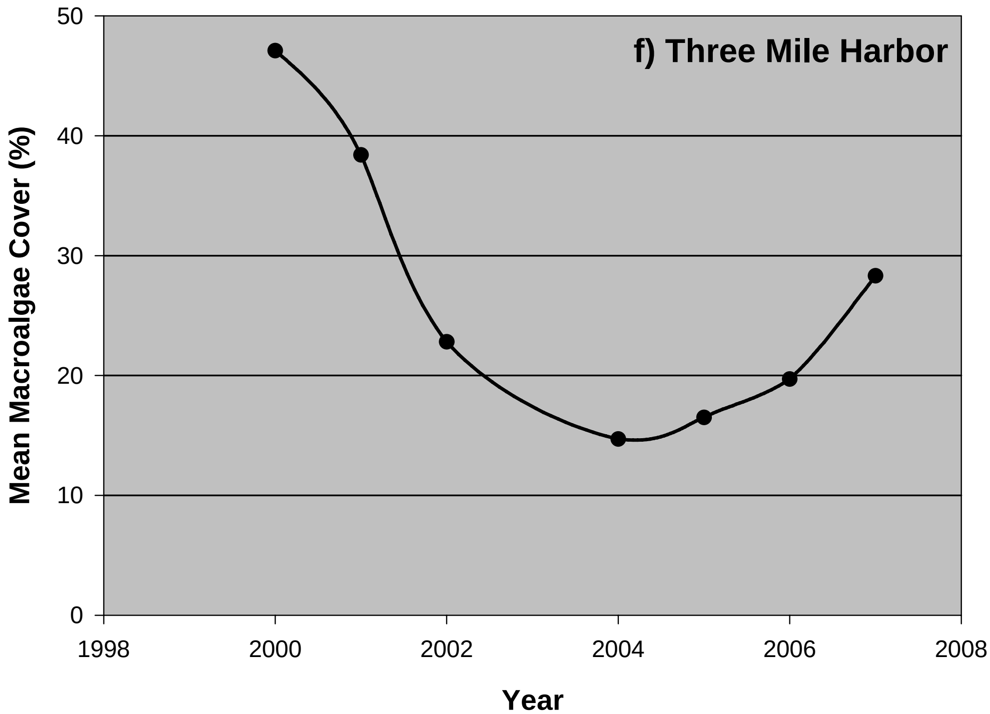
b) Gardiners Bay
Mean Macroalgae Cover (%)
60
50
40
30
20
10
0
1998
2000
2002
2004
2006
2008
Year



c) Northwest Harbor
Mean Macroalgae Cover (%)
100
80
60
40
20
0
1998
2000
2002
2004
2006
2008
Year


d) Orient Harbor
Mean Macroalgae Cover (%)
40
35
30
25
20
15
10
5
0
1998
2000
2002
2004
2006
2008
Year


e) Southold Bay
Mean Macroalgae Cover (%)
70
60
50
40
30
20
10
0
1998
2000
2002
2004
2006
2008
Year


f) Three Mile Harbor
Mean Macroalgae Cover (%)
50
40
30
20
10
0
1998
2000
2002
2004
2006
2008
Year

Appendix F:
Research Conducted in the Peconic Estuary Regarding Eelgrass
(Compiled by Kim Petersen, CCE 2007)

Research Conducted in the Peconic Estuary Regarding Eelgrass

Timeframe	Location within Peconic Bay	Citation	Brief Description
1934-1935	n/a	Cottam, C. 1935. The Present Situation Regarding Eelgrass (Zostera marina). USDA Biological Survey. Leaflet BS-3.	This paper addresses the condition throughout the Atlantic including Europe post "wasting disease", mentioning that "Peconic bay conditions are still bad, although reports offer some encouragement." Contains valuable information on the history and extent of disappearance, effects of disappearance, and potential causes ("fungous disease... similar to *Labyrinthula*"). Note: Disease still present in Shinnecock and Mecox Bays, but have shown progressive betterment compared to the rest of LI bays.
1936-1937	n/a	Lynch, J. J., and C. Cottam. 1937. Status of eelgrass (Zostera marina) on the North Atlantic Coast. USDA Biological Survey. Leaflet BS-94.	Follow up of previous paper (above). Indicates no sign of eelgrass in Peconic bays yet, with reports of only a few struggling plants in the past 6 years. Note: "Shinnecock Bay has one of the best growths on the N. Atlantic coast". Details locations and morphology of eelgrass in these bays.
1974		Thayer, G.W. and H.H. Stuart. 1974. The bay scallop makes its bed of eelgrass. Marine Fisheries Review 36 (7): 27-30.	Describes eelgrass and other seagrasses as being the preferred habitat for settling scallops.
July 78' and July '79	Northwest Creek	Churchill, A.C., 1983. Field studies on seed germination and seedling development in Zostera marina. *Aquatic Botany* 16: 21-29.	The main findings were that a high percentage of seeds germinate, but a distinct seasonality exists in the time of germination. 50% of seedlings survived into autumn/winter but the remainder were lost during spring. Predation a possible factor. Stages of seedling development were classified.
Sept '81-Jan '83	Northwest Creek	Bodner, P.J.Jr., 1985. A field study on seed production and sediment seed reserves in a Long Island population of *Zostera marina*. Masters Thesis, Adelphi University.	This study compared the potential seed yield of a *Zostera* meadow to the actual number of seeds recovered in the meadow sediments. Potential seed yield was high (2,125 seeds/m2), but the maximum

			number of seeds recovered was never more than 5%.
Summer 1984	Northwest Creek (also Smith Point)	Churchill, A.C., Nieves, A., Brenowitz, A.H. 1985. Flotation and Dispersal of eelgrass seeds by gas bubbles. *Aquatic Botany* 4: 83-93.	Though most observations were made in Moriches, some measurements of dispersal distance and float time were recorded at NW Creek. Findings included approximately 5-13% of seeds were dispersed by flotation; dispersal distance ranged from 1-200+m and float time ranged from 0.5-40+ minutes.
Summers of 1985 and 1986	Reeves Bay and New Suffolk (others in GSB)	Cosper, E. M., W.C. Dennison, E.J.Carpenter, V. Monica Bricelj, J.G. Mitchell, S.H. Kuenstner, D. Colflesh, and M. Dewey. 1987. Recurrent and persistent brown tide blooms perturb coastal marine ecosystem. Estuaries 10(4):284-290.	This study not only identified a previously undescribed microalga species making up the monospecific bloom which occurred throughout Long Island embayments during the summer months of 1985-86, but it documented the effect on local eelgrass and scallop populations. An estimated ~55% (65 km) of areas capable of supporting eelgrass growth pre-bloom became incapable of sustaining the seagrass.
1988	All L.I. Estuaries	Dennison, W.C**.**, G.J. Marshall, and C. Wigand. 1989. Effect of "brown tide" shading on eelgrass (*Zostera marina* L.) distributions. *Coastal Estuarine Studies* **35**: 675-692.	Pre-bloom aerials from 1967 (NYS DEC) were compared to several aerial surveys conducted in 1988 for this study. No eelgrass was found in western Peconic Bays in 1988 surveys. Eelgrass in the Shelter Island area was significantly affected by brown tide, but eelgrass east of S.I. was not affected.
Aug 30-Sept 21, 1989	Lake Montauk (field experiments)	Pohle, D.G., V. M. Bricelj, S. Garcia-Esquivel. 1991. The eelgrass canopy: an above-bottom refuge from benthic predators for juvenile bay scallops *Argopecten irradians*. Marine Ecology Progress Series 74; 47-59.	Both field and lab experiments revealed highly significant enhancement of scallop survival in the upper canopy (20-35cm above bottom) relative to shoot base. A highly inverse relationship between scallop size and attachment performance for 6-20mm scallops was found, and the "critical window" of vulnerability to predation for post settled scallops was discussed.

1990-1993	Lake Montauk, Napeague Harbor, Northwest Harbor, Hallock Bay	Strieb, M.D, V.M. Bricelj, and S.I. Bauer. 1995. Population biology of the mud crab, *Dyspanopeus sayi*, an important predator of juvenile bay scallops in Long Island (USA) eelgrass beds. Journal of Shellfish Research 14(2); 347-357.	Though this study was conducted mainly for implications regarding scallop predation, mud crab densities within 4 eelgrass meadows in the Peconics were found. Hallock Bay eelgrass was characterized which included canopy height, shoot density, %silt/clay, and crab densities within muddy vs. sandy substrates were compared. In Napeague Harbor, mud crabs were rare if not absent in unvegetated habitat.
1990	Northwest Harbor, Napeague Harbor, Hallock Bay	Garcia-Esquivel, Z. and V. M. Bricelj. 1993. Otogenic changes in microhabitat distribution of juvenile bay scallops, *Argopecten irradians irradians* (L.), in eelgrass beds, and their potential significance to early recruitment. The Biological Bulletin **185:** 42-55.	Though this study was conducted for implications regarding scallop recruitment and settlement, valuable density and shoot height information as well as macroalgae presence was noted.
August 1997	East Hampton	Protocols for harvesting and transplanting eelgrass in the Peconic Estuary. Prepared by EEA, East Hampton Town Natural Resources Dept. and Cornell Cooperative Extension. August 1997.	Describes step by step protocols for harvesting and transplanting eelgrass using plugs and staples. Photos of each step are included.
Spring and Summer 2001	Northwest Harbor, Orient Harbor, Flanders Bay	Paulsen, R., C. Smith, and D. O'Rourke. 2002. A preliminary analysis of the relationship between submarine groundwater discharge (SGD) and submerged aquatic vegetation in the Peconic Estuary. U.S. Environmental Protection Agency, Washington, D.C.	Though SGD zones were located and seepage measurements were conducted at all three locations, only the two transects in Northwest harbor were selected for water, soil, and sediment analysis. Major differences in grain size distribution between vegetated and non-vegetated transects was noted; the sediment pore water and groundwater was found to have low concentrations of nitrogen and phosphate, therefore the main source of these nutrients might have been the sediment and plant detritus.