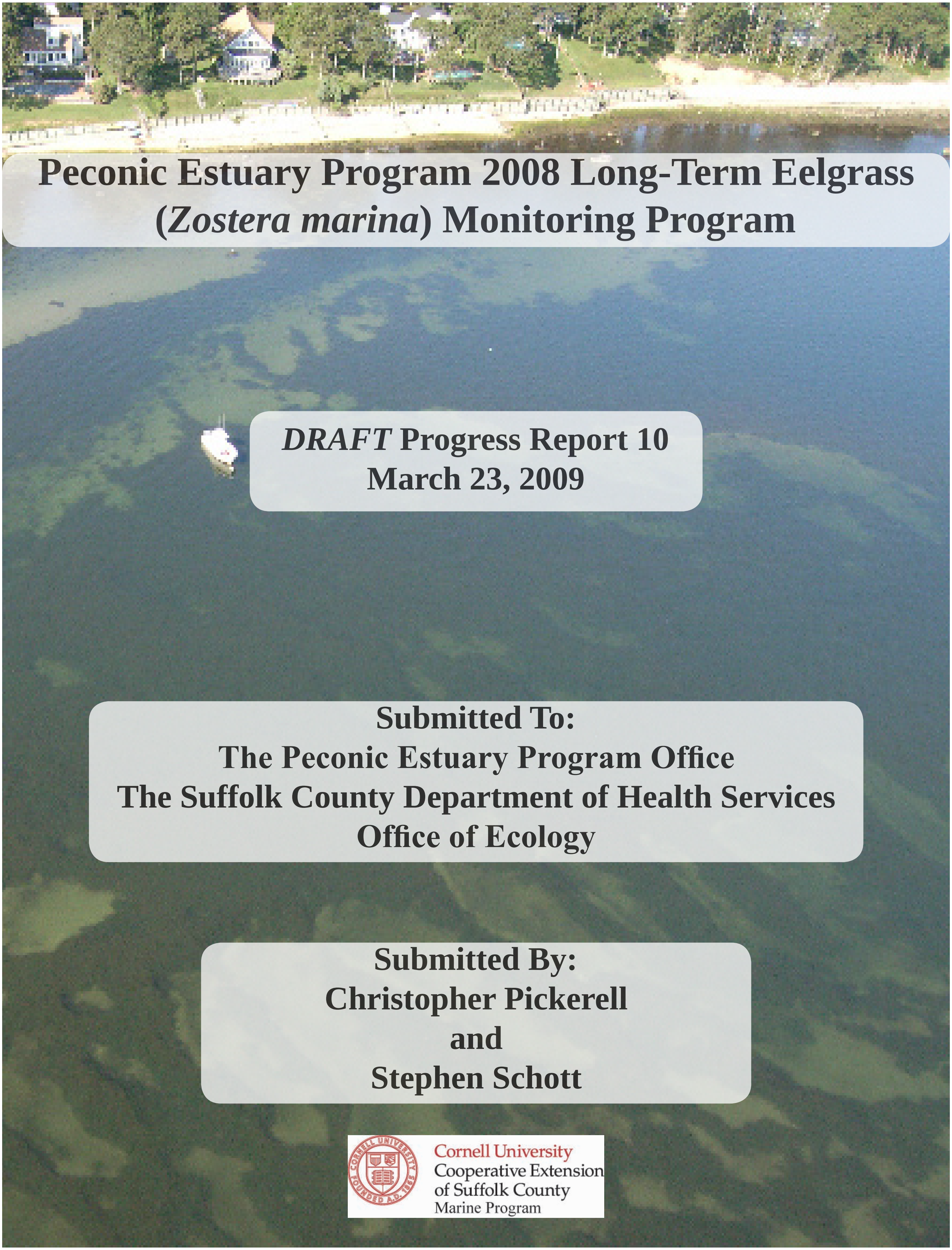

Peconic Estuary Program 2008 Long-Term Eelgrass (*Zostera marina*) Monitoring Program

***DRAFT* Progress Report 10**
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Submitted To:
The Peconic Estuary Program Office
The Suffolk County Department of Health Services
Office of Ecology

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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.

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.

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

Bullhead Bay (BB)	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
Cedar Point (CP)	East Hampton
Orient Point (OP)	Southold

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 m2 (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 m2 (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).

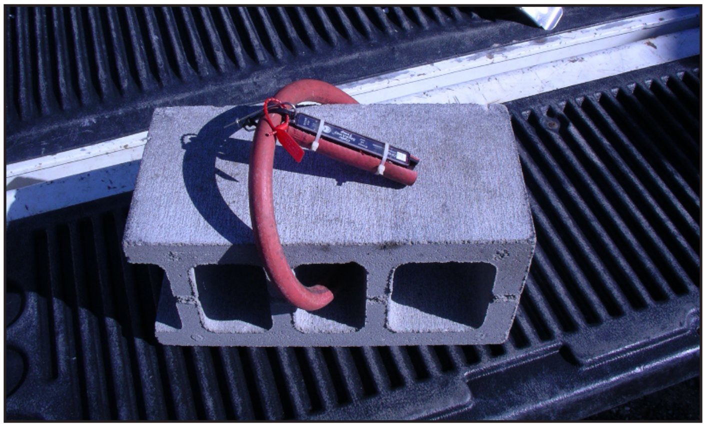


Figure Intro-1. A StowAway® temperature logger attached to a cement block, ready for deployment.

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.

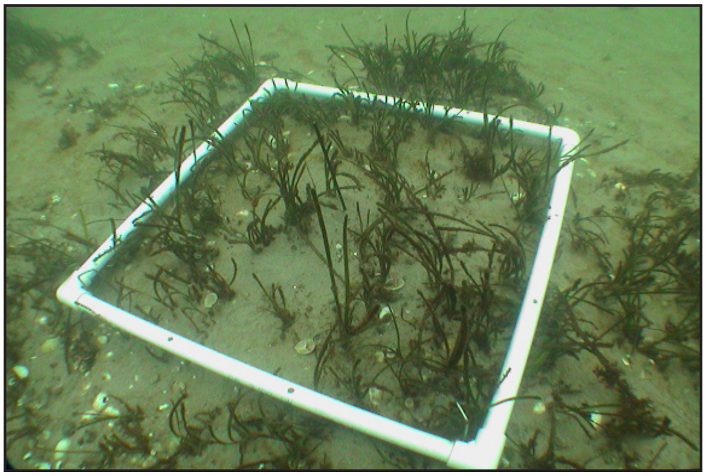


Figure Intro-2. A 0.10 meter^2 PVC quadrat used for eelgrass monitoring.

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 m2 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 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 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.

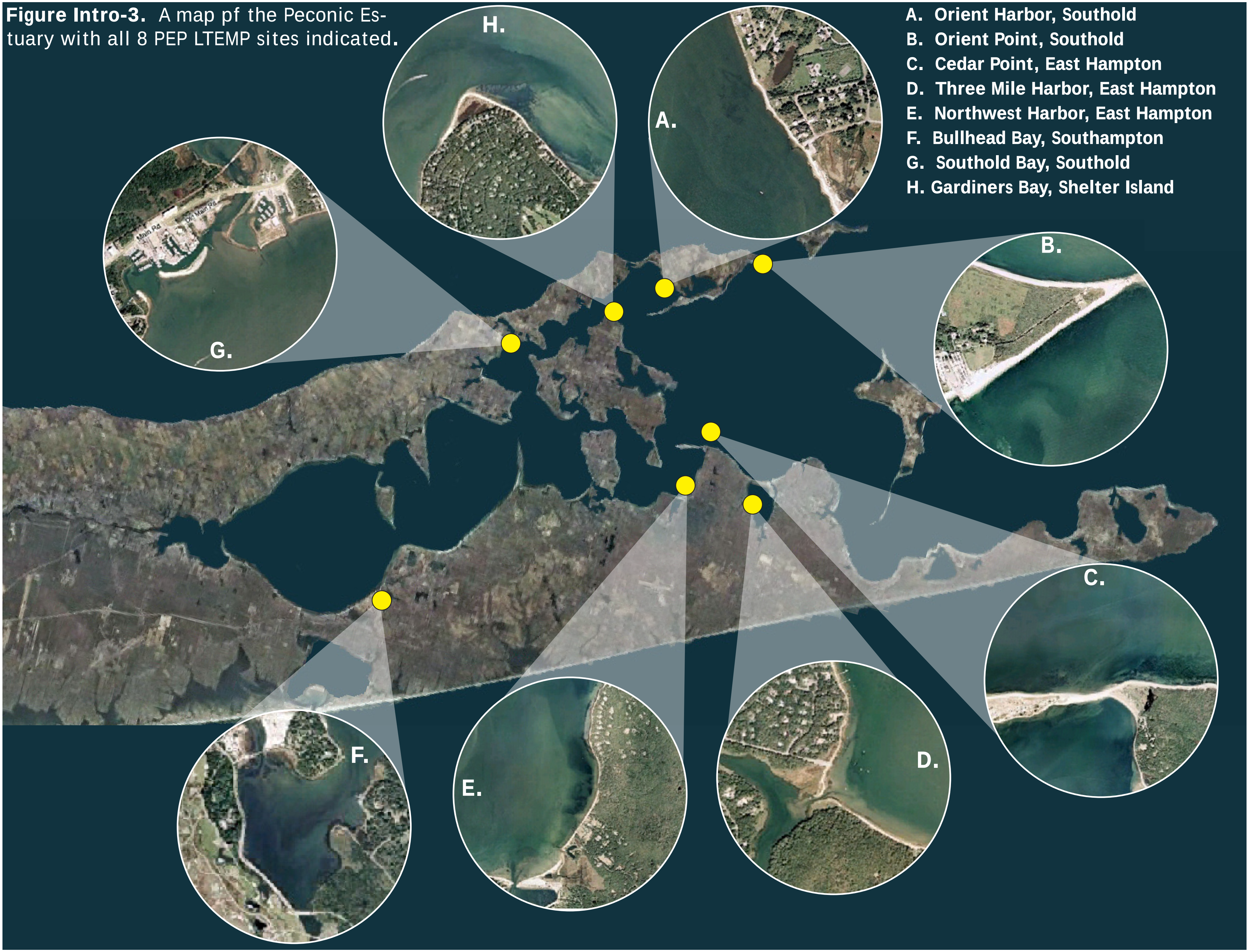


Figure Intro-3. A map pf the Peconic Estuary with all 8 PEP LTEMP sites indicated.

Bullhead Bay is a small sheltered embayment located in the western Peconic Estuary and it is connected to Great Peconic Bay via Sebonnac Creek. The eelgrass meadow at this site is the western most eelgrass population in the Peconic Estuary. This meadow is not only geographically isolated from other extant eelgrass populations, but the environmental conditions under which the eelgrass grows at this site are unique.

Figure BB-1. An aerial view of the Gardiners Bay eelgrass meadow with monitoring stations indicated by the superimposed numbers.

Site Characteristics

Bullhead Bay is a relatively sheltered embayment; however, winds from the north to northwest do influence the bay (Figure BB-1). The sediments of the bay range from coarse sand to loose muck. The sandy bottoms are found along the eastern and southern shore (likely influenced by the winter winds out of the north and northwest) as well as the northern areas of the bay where water is funneled under a bridge. The remaining bay bottom is loose mud of various depths. The mud areas have a relatively high organic content, especially for sediments supporting an eelgrass population. Sediment analysis conducted in 1997 at this site found organic content in some areas exceeded 8% organic content (the proposed tolerance limit proposed by Polk et al.,). It seems that this eelgrass population can tolerate these high levels of organics in the sediment. A more comprehensive sampling of Bullhead Bay's sediments will be conducted in 2009 to better characterize grain size and organic content

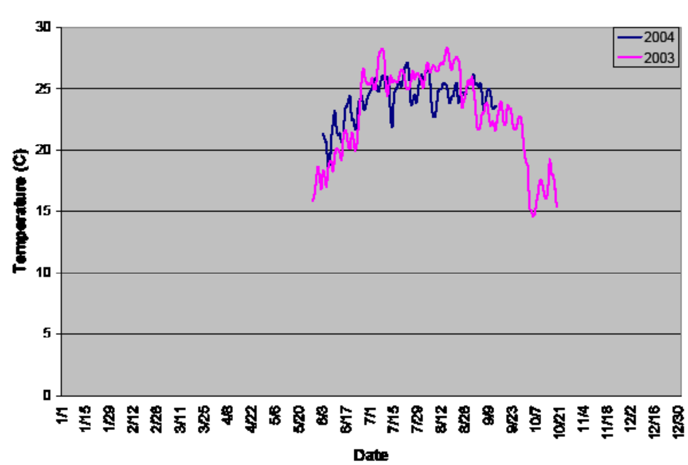


Figure BB-2. Water temperature logger data for Bullhead Bay from 2003 and 2004.

over a greater area in support of potential future research.

Water temperature in Bullhead Bay is an important factor in eelgrass health. As the bay is shallow and sheltered, it tends to warm and cool quickly and it also may reach extremes in seasonal temperatures that other eelgrass populations rarely encounter. Summer temperatures can easily exceed 80F (27C). It is possible that this eelgrass population is living at the edge of its temperature tolerance, but more observations and data collection are needed to develop and accurate temperature profile for the bay. Attempts have been made in the past to deploy temperature loggers in Bullhead Bay, but 3 separate loggers have gone missing. While several temperature loggers, and their data, have been lost in Bullhead Bay over the years, the two datasets illustrated in Figure BB-2, show the temperature data that has been recovered from the bay. These two trend curves are higher than those of other sites, though not significantly so, but this is a reflection of the thermocline that is evident within Bullhead Bay. The Bay's bottom is noticeably cooler than the mid to upper water column. For the 2009 season, there is a plan to deploy a surface/mid-water column temperature logger as well as a benthic logger to analyze the temperature ranges that the eelgrass in Bullhead Bay experience over the length of their shoots.

Water quality at the site has always been in question. There is a major golf course (Shinnecock Hills) along the entire west side of Bullhead Bay (separated by a road but with culverts running underneath the road). It is unknown what levels of nutrient/chemical loading may be sourced to the golf course, but it could be significant. Aside from the golf course, the residential housing along Sebonnac Creek could also be a source of nutrient loading for the bay. Bullhead Bay also supports significant populations of mute swans and Canada geese that not only add nutrients from their droppings, but also impact the bed by their grazing on eelgrass. Even though there are several significant potential sources of nitrogen loading to Bullhead Bay, the eelgrass continues to populate this system. One factor that may reduce the impact of poor water quality in Bullhead Bay may be its overall shallow profile. With the eelgrass growing at depths of 6 feet or less at MLW, light is not attenuated to a point where there it is insufficient for eelgrass photosynthesis. Potential research at this site could look at overland and groundwater inputs of nutrients into the bay to determine the sources and levels of nutrients and determine if there management practices that could reduce these loads.

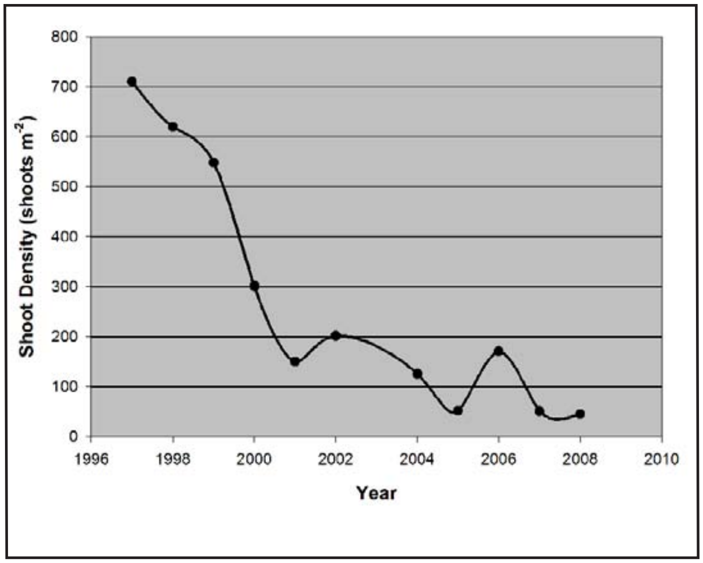


Figure BB-3. Average annual eelgrass shoot density for Bullhead Bay, Southampton, from 1997-2008.

Eelgrass Shoot Density

Bullhead Bay was one of the original three eelgrass monitoring sites for the Peconic Estuary. Beginning in 1997, Bullhead Bay was one of the denser beds in the program with over 700 shoot per meter2. An obvious, and significant loss, was observed between the 1999 and 2000 monitoring seasons (Figure BB-3; Table BB-1), but this decline was likely attributable to changes in sampling size and protocols and the 2000 shoot densities are considered to be a more accurate representation of the eelgrass densities in the Bay. Since 2000, Bullhead Bay has continued to see a decline in eelgrass shoot densities due to several separate events that lead to loss of eelgrass in one or more of the monitoring stations. Between the 2000 and 2004 field seasons, the region experienced two harsh winters resulting in the icing over of most of the western Peconic Estuary and all of the shallow creeks and embayments. Bullhead Bay suffered ice scour-

Table BB-1. Annual mean eelgrass shoot densities and standard error for Bullhead Bay, Southampton.

Year	Mean Density	S.E.
1997	710	+/- 196
1998	620	+/- 112
1999	548	+/- 79
2000	301	+/- 26
2001	150	+/- 18
2002	201	+/- 14
2004	125	+/- 28
2005	52	+/- 11
2006	171	+/- 34
2007	51	+/- 12
2008	46	+/- 9

ing in its two northernmost stations that completely removed all eelgrass in these areas. Even with this decline in eelgrass densities and complete loss of eelgrass in 4 of 6 monitoring station between the 2002 and 2004 field seasons, the eelgrass population has shown signs of recovery by recolonizing areas lost in previous years. The first signs of recovery were in 2006 when eelgrass returned to two stations and the overall eelgrass shoot density showed a threefold increase (Figure BB-3). The shoot density slipped in 2007 back down to 51 shoots per meter2, then a minor decline again in 2008 to 46 shoots per meter2. The 2008 field season did provide some cause for optimism as eelgrass was recorded in 5 of 6 monitoring stations and it was observed, but did not fall within a quadrat, in the sixth station. These stations have been without eelgrass for almost 6 years. The low mean shoot density for the site is still a concern; however, shoot densities are influenced by many factors that may result in stress that lowers shoot density. Site visits at other times of the year, for simple observations, may identify the current low shoot density trend as a seasonal pattern, rather than a chronic condition.

Macroalgae Cover

Macroalgae cover in Bullhead Bay has been unpre-

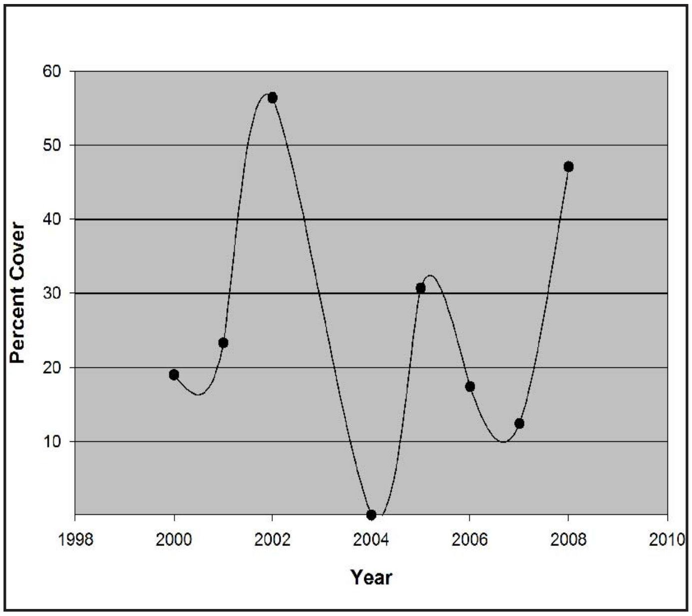


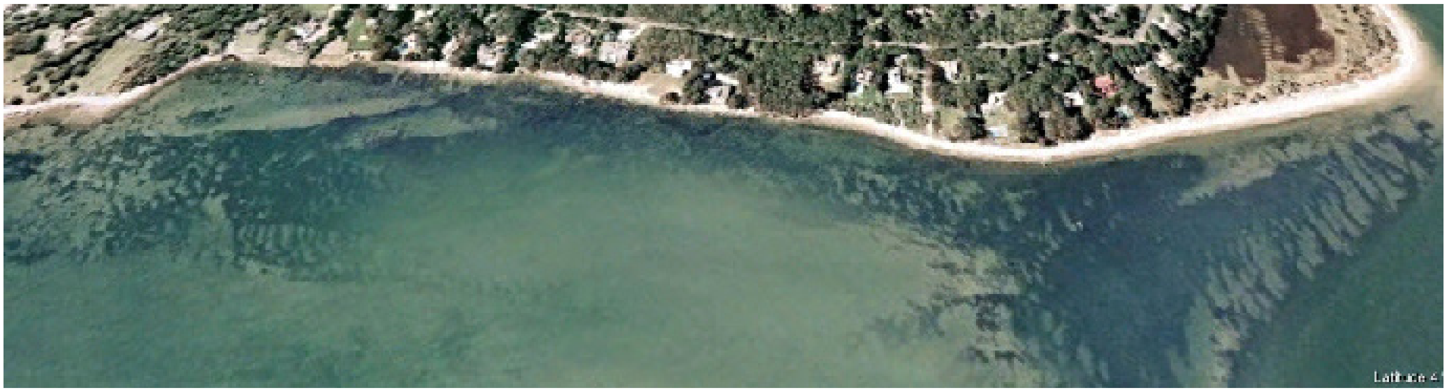
Figure BB-4. The annual mean macroalgae percent cover for Bullhead Bay, Southampton from 2000-2008.

dictable since the parameter was added to the monitoring protocol in 2000. Figure BB-4 shows the up and down trends of the macroalgae cover within the eelgrass meadow in Bullhead. Typically, the macroalgae that reside in Bullhead Bay are unattached filamentous red and green seaweeds that easily entangle with the eelgrass canopy. Due to the fact that the eelgrass provides most of the species of macroalgae with anchorage, the contraction of the bed from 2002 to 2007 resulted in relatively low percent cover of macroalgae over this period and a shift from the once dominant red seaweed Spyridia filamentosa to species that could inhabit the mud bottoms and sand-gravel sediments left bare by the eelgrass loss. During this period, there was an increase in the green alga Codium fragile in the sand-gravel areas of the bay (notably Station 1, 5, and 6) and an increase in the red alga Gracilaria tikvahiae growing over the exposed muddy areas. Macroalgae cover will likely continue to trend with eelgrass shoot densities, however, if the eelgrass maintains, or expands, its coverage in Bullhead Bay, there may be a resulting shift in macroalgae species back toward the filamentous, drift macroalgae that used to dominate this system.

Conclusions

Bullhead Bay has always been a unique eelgrass meadow. It is currently the only eelgrass population identified in the western Peconic Estuary. It is shallow and subject to summer water temperatures over 80˚F for extended periods, in the mid to upper water column. It is possible that the near-bottom thermocline may protect the meristematic region of the plants and allow them to tolerate the higher water temperatures near the surface. It is also possible that this eelgrass population has evolved to tolerate these higher than average water temperatures that would stress other eelgrass populations in the Peconic Estuary. While water quality, specifically nitrogen loading, should negatively impact Bullhead Bay's eelgrass population, the shallow nature of the bay may mitigate some of this stress by allowing the eelgrass to grow at depths where light has not attenuated to the point where it is insufficient for photosynthesis.

As for trends in eelgrass shoot density and areal coverage in the bay, they may be cyclical in nature. Ice scour events are believed to have precipitated the initial decline of the eelgrass meadow between 2002 and 2004. While these ice-related losses are by no means isolated events historically, other current factors (e.g. water quality, grazing pressures, etc.) are likely the cause of the slow recovery of the meadow. In the last two monitoring seasons (2007 and 2008), there has been documented recolonization of areas lost back in he 2002-2004 period. The regrowth of these areas has been attributed to seeds from the extant eelgrass population and their successful recruitment in highly organic mud has provided optimism that, barring any major disturbance events, the 2009 monitoring season should see expanded growth and increased shoot density for Bullhead Bay.



The Gardiners Bay eelgrass monitoring site is located on the east side of Hay Beach Point on Shelter Island. The eelgrass meadow starts near the channel connecting Greenport Harbor to Gardiners Bay in the north and extends southward toward Cornelius Point (Figure GB-1). This site is the most exposed, high-energy eelgrass meadow of the original six monitoring sites. The eelgrass meadow is very patchy and an aerial view of one section of the meadow (Figure GB-2) illustrates the natural appearance of a majority of the meadow.

Figure GB-1. An aerial view of the Gardiners Bay eelgrass meadow with monitoring stations indicated by the superimposed numbers.

Site Characteristics

The Gardiners Bay eelgrass monitoring site is situated in an area of high current and is exposed to significant fetch from the north to the east. This exposure causes the site to be especially influenced by winter storms. The current at this site is also the highest encountered at any of the monitoring sites. The eelgrass meadow is established on relatively shallow sand flats to the south and west of one of the two main channels that connect Gardiners Bay to the western Peconic Estuary. Both the high wave exposure and high currents at this site have removed most of the finer sediments leaving the majority of the site's sediment as coarse sand to gravel (and shell). Organic content of the

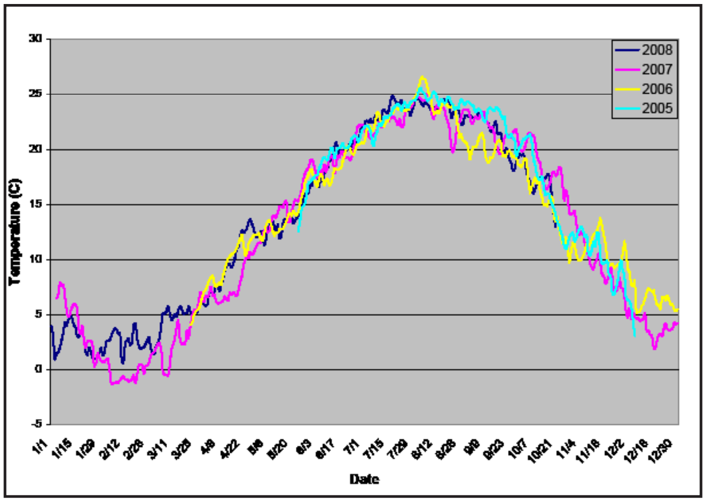


Figure GB-2. Water temperture logger data representing daily averages for Gardiners Bay (Cornelius Point) for 2005 through 2008.

Gardiners Bay site's sediments averaged 0.84% organic material in the sediments with a range of 0.31% to 1.73%. Even this coarse sediment is subject to movement by the hydrodynamic forces acting on this site. Sand waves are readily observable from the air as well as underwater. Mass movement of sediments have been observed to slowly bury eelgrass patches in some areas, while other sections of the meadow experience erosion that leaves eelgrass patches as elevated plateaus. The constant movement of sediments at this site results in a highly patchy eelgrass meadow with a areal coverage that can change significantly over short periods of time.

Water temperature has not been considered to have a significant impact on the Gardiners Bay meadow. The water temperatures monitored at Cornelius Point, just south of the monitoring site have not approached those encountered in Bullhead Bay (Figure GB-2). Summer water temperatures are moderated by the adjacent, cooler Gardiners Bay waters and summer high temperatures (recorded high of 26.5 C) rarely reach the temperature tolerance of eelgrass, at this site. However, the site does encounter moderate daily shifts in temperature that correlates to the changing tides. On outgoing tides, warmer waters from the western Estuary flush out over the Gardiners Bay meadow, raising the temperature slightly, while an incoming tide may result in a decrease in water temperature over the meadow.

Water quality has rarely been a factor in the health of this eelgrass meadow. The flushing that this site experiences is more than adequate maintain nutrient concentrations at ambient levels for the eastern Estuary. Water quality can be an issue at this site. Due to its significant fetch to prevailing winter winds, the turbidity can become high during storms, but suspended solids tend to settle quickly or be flushed shortly afterward. The changing tides may cause a decrease in water clarity. Depending on the time of year and/or the tide, drift macroalgae can be transported on the currents and significantly reduce clarity. The effects of storms and macroalgae drift are examples of acute events that are infrequent at this site. Chronic water quality issues would be very rare at this site and would likely involve an Estuary-wide event.

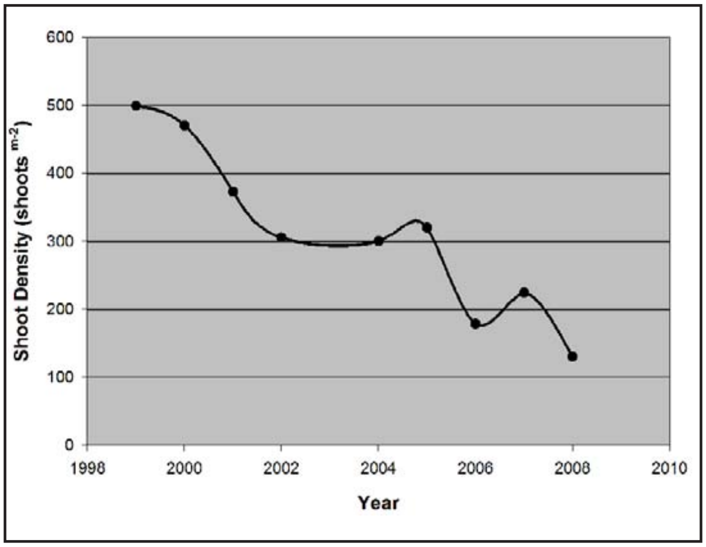


Figure GB-3. Average annual eelgrass shoot density for Gardiners Bay, Shelter Island.

Table GB-1. The average annual eelgrass shoot density for Gardiners Bay from 1999 to 2008, including standard error.

Year	Mean Density	S.E.
1999	499	+/- 37
2000	470	+/- 23
2001	373	+/- 16
2002	306	+/- 25
2004	300	+/- 26
2005	320	+/- 26
2006	178	+/- 31
2007	224	+/- 40
2008	131	+/- 25

Eelgrass Shoot Density

The Gardiners Bay meadow has experienced the same decline in eelgrass shoot density and areal coverage that are evident in all the sites in the monitoring program. Added to the program in 1999, Gardiners Bay was a moderately dense meadow with an average shoot density around 500 shoots per meter2 (Figure GB-4). Gardiners Bay has shown a more moderate rate of decline in shoot density than the other monitoring sites. The period between 2002 and 2004, where most of the other monitoring sites saw a significant decline in eelgrass shoot density, Gardiners Bay remained relatively unchanged. The decline in shoot density from 2005 to 2006 resulted from the complete loss of eelgrass from 2 stations and significant losses in two other stations in this meadow. The two stations that have completely lost eelgrass were stations that were on the outside edge of the meadow. This is the area that storm and current moved sand is constantly eroding in one area and accreting in another. Eelgrass patches are either eroded by the waves and currents, resulting in plants being uprooted, or buried by advancing waves of sand. The meadow has become more patchy since 1999. Some of this fragmentation can be attributed to natural events, but much of the fragmentation that can be observed in the more contiguous meadow near shore, is resultant from anthropogenic activities in this area of the meadow. Along with several moorings that are located within the eelgrass meadow, shellfishing (commercial and recreational) damage the continuity of the meadow and eventually lead to blowouts. Another source of damage to the meadow is the prop scarring caused by boaters that either don't know how to navigate via channel marking buoys or simply ignore the marked channels to take shortcuts. At MLW, much of this meadow is covered by less than 6ft of water. At this depth, prop interaction with the bottom is frequent and the resulting damage can cover meters to tens of meters in length. This particular disturbance is completely preventable if boaters stayed in the designated channel. The addition of another channel marker closer to Greenport, on the south side of the channel could aid boaters in navigating to the next marker, and eliminating accidental "shortcuts" across the eelgrass meadow. The monitoring station that have shown significant loss have likely succumbed to a combination of wind, waves and boats. Bioturbation at this site is considered a minor impact compared to the above stated impacts.

Macroalgae Cover

The location of the Gardiners Bay eelgrass meadow puts it in a prime location to intercept drift macroalgae from Gardiners Bay and the western Estuary, depending on the tide. While the site is not conducive to growth of attached macroalgae, due to the sand,

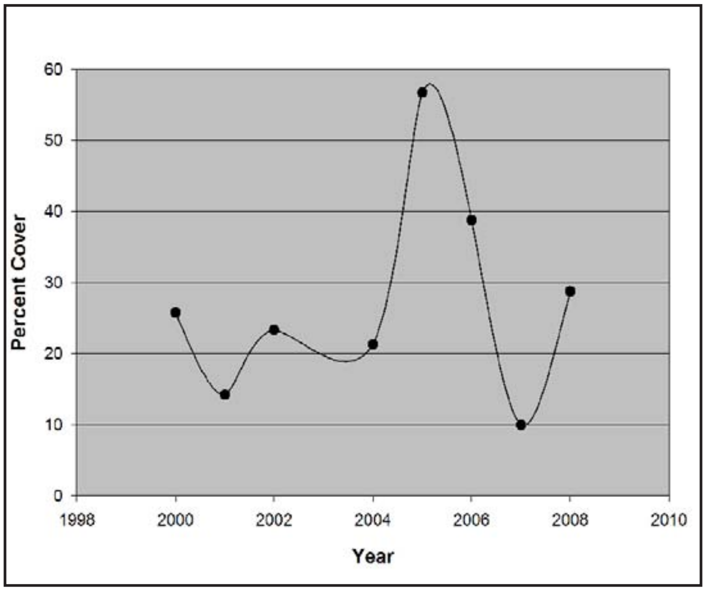


Figure GB-4. Annual mean macroalgae cover for Gardiners Bay from 2000 to 2008.

gravel and shell sediment, the presence of eelgrass allows for the entanglement and continued growth of a wide variety of drift macroalgae. Even though the site experiences high waves and current that would make it difficult for unanchored macroalgae to remain onsite in high density, the Gardiners Bay eelgrass meadow has consistently supported a moderated amount of macroalgae (Figure GB-4). The 2007 macroalgae cover was the lowest recorded at the site, but 2008 found almost a 20% increase from 2007, returning the macroalgae percent cover to a more "normal" level for Gardiners Bay. As with previous years, the species diversity remains relatively high due to the influx of drift macroalgae from the western Estuary and from Gardiners Bay.

Conclusions

The Gardiners Bay eelgrass meadow is the original high-exposure meadow in the eelgrass monitoring program. The meadow is exposed to relatively high currents with each changing of the tides which may result in an increase in light attenuation, deposition of drift macroalgae and movement of sediments (both accretion and erosion), but the eelgrass meadow also benefits from the high rate of flushing to moderate both temperature and nutrient loading at the site. The periodic wave events while potentially damaging in the extreme, also benefit the bed by "stirring things up," and dislodging accumulated drift macroalgae and assisting in sloughing epiphyte-loaded blades. The

Figure GB-5. An aerial photograph (2008) showing the patchiness of one section of the Gardiners Bay eelgrass meadow.

movement of sand by currents and waves is the most significant, natural factor influencing this meadow, yet these are conditions that the eelgrass population has dealt with since its establishments and alone, these factors along would not lead to the extinction of the meadow, barring a catastrophic event.

The Gardiners Bay eelgrass population continued to show a decline in eelgrass shoot density in 2008, after showing signs of improvement in 2007. The outer monitoring stations (Stations 1 and 2; Figure GB-1) continue to show no signs of recovery, while Station 4 showed signs of erosion that was not evident in 2007. The 2009 season will show whether the meadow will be able to recolonize this area, by either rhizome expansion or seedling recruitment. Anthropogenic 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 continue to occur at frequent rates, adding to the natural patchiness of the meadow and causing fragmentation that may worsen over time.

Northwest Harbor is moderately, sheltered harbor located in western East Hampton Town. The Harbor is separated from Gardiners Bay by Cedar Point. While the site has limited fetch in most directions, summer westerlies can create chop and moderate wave action in the Harbor. Figure NWH-1, shows the area of the Harbor that the monitoring program has focused on since the meadows inclusion into the program in 1997.

Figure NWH-1. An aerial view of the Northwest Harbor eelgrass meadow with monitoring stations indicated by the superimposed numbers.

Site Characteristics

As indicated in Figure NWH-1, the monitoring program in Northwest Harbor is relegated to the southern half of the harbor. Within this half of Northwest Harbor, depths range from 3ft (MLW) in the southern areas (Station 1) to 9ft (MLW) at the northernmost stations. The sediment at the site is almost uniform and is dominated by sand. Organic content of the sediment is low, averaging 0.70%. An increase in shell hash, primarily *Crepidula fornicata* shells, has been observed over the years at the deeper station. The shallow stations, in the southern areas, show a general lack of coarse sediment or shell. As mentioned above, Northwest Harbor is relatively sheltered in all directions. The Harbor rarely experiences high wave action and most of the monitoring stations are in water deeper than 6ft (MLW), so there is likely limited impact by waves on these areas of the bed. Current in Northwest Harbor is minimal as well.

The water temperature monitoring in Northwest Harbor has always been taken in the southern area of the Harbor near eelgrass monitoring Station 1 (Figure NWH-1). While this station is a considerable

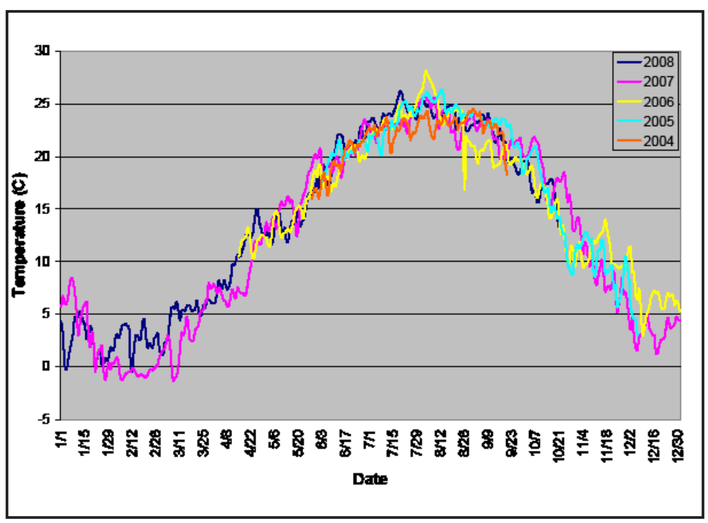


Figure NWH-2. Water temperture logger data representing daily averages for Northwest Harbor from 2004 through 2008.

distance from the northernmost stations, the intention of deploying the temperature logger was to identify the highest temperature that eelgrass could encounter within this meadow. With that intention in mind, the shallow sand flats were most likely where the warmest water would be found. Referring to Figure NWH-2, the daily water temperature data collected at the site since 2004 is presented in the graph. The graphed data is very close between years and indicates that summer high temperatures approach 25C around the second week in August of each year. In 2006 there was a peak in July that almost reached 28˚C, indicating that for at least short period of time, Northwest Harbor may experience temperatures comparable to Bullhead Bay, at least in the shallow sand flats. It should also be noted that the data presented in the graph are daily averages, so it is possible, that that one day in July was not the only time that Northwest Harbor experienced a temperature of 28C or higher.

Water quality in Northwest Harbor is relatively good. There is abundant flushing and development around the Harbor is minimal, resulting in few sources of significant nutrient inputs. Where water quality is not an issue in Northwest Harbor, water clarity can be very low at times. Even with only the moderate winds that the Harbor experiences, a good amount of material can be suspended, reducing visibility to a few feet in worse conditions.

Eelgrass Shoot Density

There continues to be a complete loss of eelgrass within the six monitoring stations for Northwest Harbor. No evidence of an extant eelgrass population was observed during the 2008 field survey in the southern half of the Harbor. The possibility of eelgrass patches surviving in the lower Harbor still exists and their locations will likely be identified by the scheduled eelgrass aerial survey in the Spring/Summer of 2009. On an unrelated trip to the northern shore of Northwest Harbor to Cedar Point, a few small patches of eelgrass were observed in the shallows. Historical aerial photographs have indicated that eelgrass potentially covered a large portion of the upper Harbor bottom as recently as 2004, but no comprehensive ground-truthing was ever conducted to determine the validity of the photo-interpretation. As for the sudden decline and loss of eelgrass in the southern half of Northwest Harbor, a clear cause is still unknown. There have been indications of relatively small-scale disturbances in previous monitoring reports including, clamming, whelk and spider crab damage, and poor water clarity, but it is unlikely that even these factors combined could be responsible for the rapid decline and elimination of eelgrass over such a large area.

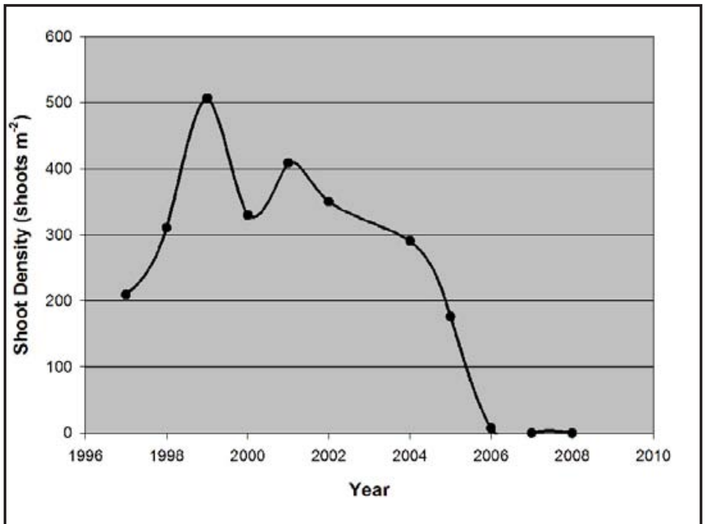


Figure NWH-3. Average annual eelgrass shoot density for Northwest Harbor, East Hampton.

Table NWH-1. The average annual eelgrass shoot density for Northwest Harbor from 1997 to 2008, including standard error.

Year	Mean Density	S.E.
1997	209	+/- 24
1998	310	+/- 21
1999	507	+/- 57
2000	330	+/- 21
2001	409	+/- 20
2002	350	+/- 19
2004	291	+/- 18
2005	176	+/- 16
2006	8	+/- 3
2007	0	+/- 0
2008	0	+/- 0

Macroalgae Cover

The macroalgae cover in Northwest Harbor increased slightly in from 2007 to 5.4% in 2008. This represents less than a 1% change in macroalgae cover, and, based on observations and knowledge of this monitoring site, macroalgae cover will not exceed 10% in the near future. It have been mentioned in previous monitoring reports that the macroalgae at the site was dominated by the filamentous red alga Spyridia filamentosa, almost to the point of there being a monoculture of this alga growing entangled in the eelgrass. Since the loss of the eelgrass within the monitoring stations, there has been an overall decline in macroalgae at the site, but conversely, there has been a slight increase in the number of species observed. In 2007 there were 4 total macroalgae species observed, but in 2008 there were twice that amount. While this increase in species numbers is insignificant, it could be a reflection of the change in some parts of the Harbor where Crepidula is becoming more abundant where eelgrass was the dominant benthic organism just a few years ago.

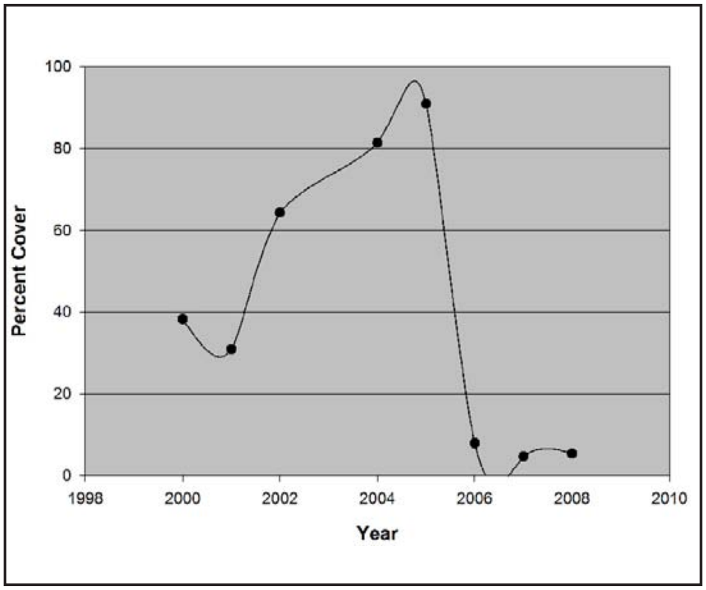


Figure NWH-4. Annual mean macroalgae cover for Northwest Harbor from 2000 to 2008.

Conclusions

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. The lack of eelgrass within monitoring stations in 2008 confirms that eelgrass is completely gone from these areas with no immediate expectations of recolonization. The 2007 Suffolk County aerial imagery indicated that there may still be small, isolated patches of eelgrass remaining in Northwest Harbor and the 2009 aerial imagery may be able to confirm and identify any other extant eelgrass populations within Northwest Harbor. However, restrictions in the minimal size of eelgrass patches identified during the photo-interpretation phase of the 2009 eelgrass aerial survey may let small patches of eelgrass go without documentation and ground-truthing. A separate effort may be undertaken by CCE to identify small patches for ground-truthing during the 2010 monitoring season, small eelgrass patches are ignored due to size constraints in the larger survey. 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, but there may be other factors that contributed to the widespread loss in the meadow.

Orient Harbor was one of the largest remaining eelgrass meadows when it was chosen for inclusion in the PEP LTEMP in 1997. The meadow, at the time, stretched from the Orient Yacht Club pier to the mouth of Hallock Bay. The meadow covered from 3ft (MLW) to 10ft (MLW) (observations based on 2000 monitoring season) where it abruptly ended. While patchy in some areas of the meadow, overall the meadow was continuous eelgrass. The meadow, situated on the eastern shore of Orient Harbor (Figure OH-1) is protected from most of the prevailing winter winds, but northwest, west, and southwest winds have a large fetch across Orient Harbor and moderate wave events are not uncommon. Currents over the eelgrass meadow are relatively low.

Figure OH-1. An aerial view of the Orient Harbor eelgrass meadow with monitoring stations indicated by the superimposed numbers.

Site Characteristics

The Orient Harbor eelgrass meadow while sheltered from the most of the prevailing winter winds, the meadow does experience moderate wave action from winds out of any of the western directions that blow for a significant duration. The sediment in Orient Harbor is predominantly sand (average of 62.9%), but it also contains a significant gravel fraction of 30.8%. The average organic content is higher than Gardiners Bay and Northwest Harbor, but it is still at a level that is within eelgrass's tolerance at 1.18%. Typically, the coarser sediments are found closer to shore in the shallower waters with the sand and organic content increasing in the offshore portions of the meadow. New sediment samples are planned for the 2009 survey.

While water temperature has not been monitored in Orient Harbor by deployed temperature loggers, water temperature data from Suffolk County Department of Health Services has shown that water temperatures in Orient Harbor are similar to those at the Gardiners Bay site, but Orient Harbor tends to be a slightly warmer in the summer months. Starting in 2009, a temperature logger will be deployed in Orient Harbor to support potential eelgrass work as well as ongoing scallop restoration efforts within Orient Harbor.

Water quality has generally been favorable for eelgrass in Orient Harbor. Since 1997, there has been an increase in the development along Orient Harbor including new homes and hardened shorelines. While there has been no indication in past analysis of water quality data for this site that this development has had any direct impacts, the building on several, large new homes with septic systems in close proximity to the Harbor, holds a potential impact to the eelgrass meadow. A problem identified at the Seagrass Experts Meeting in 2007 identified that groundwater inputs of nutrients (i.e. nitrogen) and herbicides could have direct impact on eelgrass in some areas of the Estuary. A preliminary study by Suffolk County in 2000-2001 indicated that Orient Harbor had some significant areas of groundwater upwelling. Given the amount of farming that has historically occurred in Orient, it is possible that upwelling water in Orient Harbor may contain contaminants harmful to eelgrass. There are future plans to pursue this issue throughout the Peconic Estuary, with Orient Harbor as a potential site for analysis.

Eelgrass Shoot Density

While historically, the Orient Harbor eelgrass meadow has been one of the most stable meadows in the Peconic Estuary (based on historical aerial photographs), the last decade has seen a decline in the shoot density and overall area covered by eelgrass in the Harbor. Figure OH-2 shows the downward trend in eelgrass shoot density since the meadow was included in the Long-term Eelgrass Monitoring Program in 1997. As with other meadows in the Peconic Estuary, Orient Harbor suffered a widespread die-off in its meadow between 2002 and 2004. The cause of this loss is not known, but several factors are suspected. By 2005, only one station of the original six still supported eelgrass. This station (Station 5) included many large, dense patches of eelgrass, however, it was located in relatively shallow waters making it susceptible to storm damage and recreational shellfishing. By 2008, there was no longer any eelgrass within the monitoring stations in Orient Harbor.

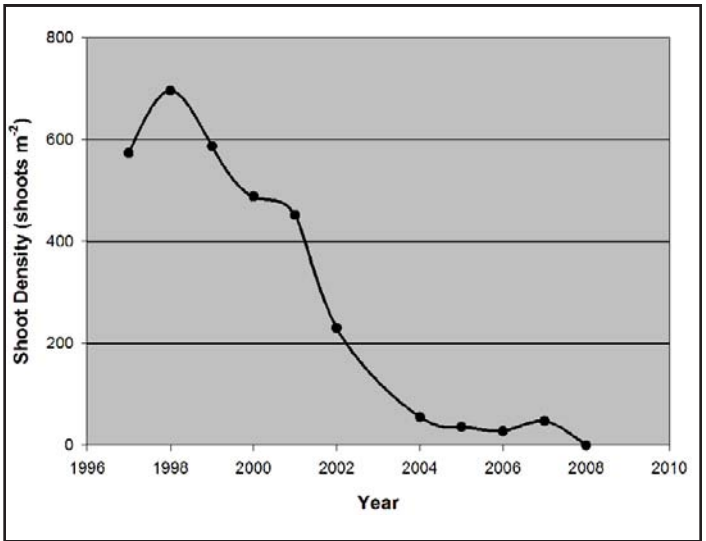


Figure OH-2. Average annual eelgrass shoot density for Orient Harbor, Southold.

Table OH-1. The average annual eelgrass shoot density for Orient Harbor from 1997 to 2008, including standard error.

Year	Mean Density	S.E.
1997	573	+/- 68
1998	696	+/- 82
1999	587	+/- 50
2000	488	+/- 26
2001	452	+/- 16
2002	230	+/- 13
2004	56	+/- 15
2005	36	+/- 12
2006	27	+/- 12
2007	47	+/- 22
2008	0	+/- 0

Aerial photographs from 2007 and 2008 suggest that there may be surviving eelgrass patches closer to the mouth of Hallock Bay, and the 2009 Eelgrass Aerial Survey may locate other extant patches within Orient Harbor.

Macroalgae Cover

With the loss of eelgrass over the monitoring area, there has been an increase in the percent cover of large, anchored seaweeds at the site. This is likely due to the slow change in sediments from dominantly sandy to a higher percentage of gravel and shell. Of interest is the increase in the nonindigenous green seaweed *Codium fragile* at this site. While *Codium* is not the primary species in Orient Harbor, it is becoming common as there is a sediment shift and suitable substrate for anchorage becomes available. The red seaweeds *Spyridia filamentosa* and *Agardhiella subulata* are the most prevalent species in the Harbor. *Ulva* species (e.g. *U. lactuca*, *U. intestinalis*, etc.) are also relatively common. The seaweed population dynamics should be monitored in the future, especially that of *Codium*, as there is the potential of *Codium* beds preventing the recolonization of areas that previously supported eelgrass. It is also worth mentioning that 2008 was the third season that the diatom *Cochlodinium polykrikoides* has been observed forming small blooms within Orient Harbor. The blooms have been encountered near Stations 4 and 5 each year.

Conclusions

Even with no eelgrasss remain in and around the monitoring stations in Orient Harbor, there remains

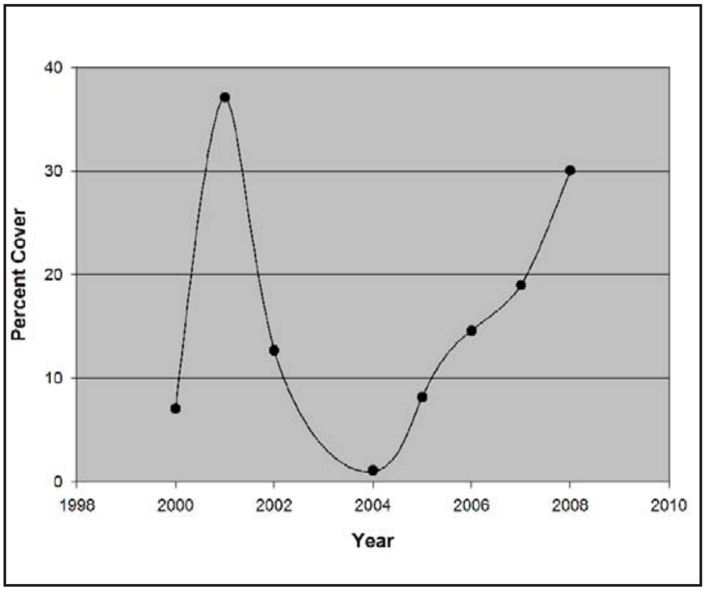


Figure OH-3. Annual mean macroalgae cover for Orient Harbor from 2000 to 2008.

the possibility that there could be some recovery of eelgrass in adjacent areas due to seedling recruitment and vegetative expansion from extant patches/populations that have not been identified. This area of Orient Harbor receives a significant amount of eelgrass wrack from the Gardiners Bay meadow at Hay Beach Point and the possibility of drifting flower shoots depositing seeds and leading to natural recruitment and patch development does exist, though it is more likely that reovery of this meadow will require substantial restoration efforts.

Southold Bay was the western most eelgrass meadow on the north shore of the Peconic Estuary when it was added to the monitoring program in 1999. The meadow was situated at the mouth of Mill Creek, Southold, which connected Hashamomack Pond to Southold Bay (Figure SB-1). This meadow is located in a high boat traffic area and has three boating channels that divide meadow. The site is relatively shallow, especially on the eastern side of the meadow, except for the boat channels.

Figure SB-1. An aerial view of the Southold Bay monitoring site with monitoring stations indicated by the superimposed numbers.

Site Characteristics

The Southold Bay eelgrass bed is sheltered from most prevailing winds, so wave exposure is generally low to moderate. However, some storm event in the past, when positioned correctly, have exposed this meadow to high wave action that lead to substantial erosion of the barrier beach and mass movement of sediment within the meadow. The sediment composition of this site is predominantly sand (~80%) with a minimal amount of organic content included in the mix (0.81%). On the eastern side near the channel to Goldsmith's Boatyard and Mill Creek Marina, are boulders, submerged and emergent, that are dense close to shore but decrease in frequency moving offshore. Across the main channel to Mill Creek toward the area of Budds Pond, the sediment becomes less firm, indicating an increase in the finer silt/clay fraction and organic content.

Water temperatures within the Southold Bay meadow contributed to the chronic stress that the eelgrass population faced during the summer months. The meadow inhabited shallow waters, which allowed for rapid warming, especially on calm, summer days and lead to stress in the shallow areas of the meadow. Add to this, the warm water flushing into the meadow from Hashamomack Pond, and the temperature stress on eelgrass at this site could add substantially to the stress the meadow already experienced from the turbidity, nutrient loading and constant boat traffic.

Water quality at Southold Bay has always been an issue. While the site receives adequate flushing from the tidal currents moving between the western Estuary and Gardiners Bay, the eelgrass meadow is also positioned to receive waters from Hashamomack Pond, which is a war, nutrient-loaded water body. The waters from Hashamomack are also turbid and lead to periodic low light events in the eelgrass meadow throughout the year.

Eelgrass Shoot Density

Southold Bay has not supported eelgrass within any other monitoring stations since 2006 and it is believed the entire site since 2007 (Figure SB-2). With the complete extinction of all eelgrass from this area, there is no possibility of recovery of eel-

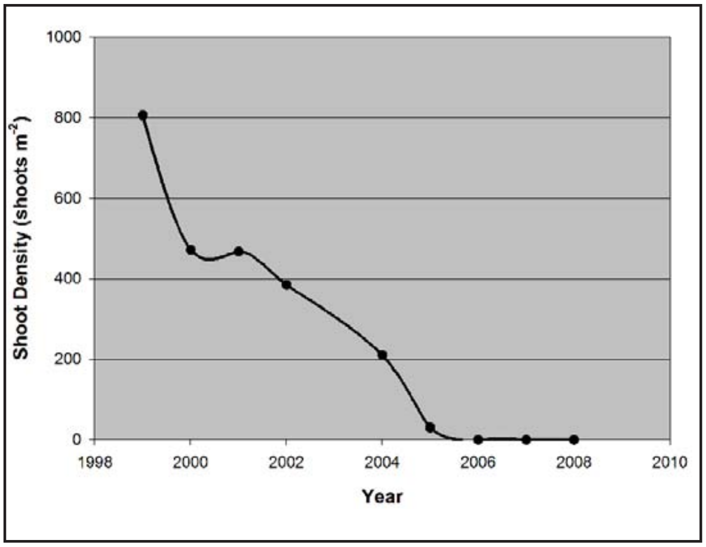


Figure SB-2. Average annual eelgrass shoot density for Southold Bay, Southold.

grass in Southold Bay without active restoration, as there is not a nearby eelgrass population to provide propagules for recruitment. When Southold Bay was included into the monitoring program in 1999, it was described as an eelgrass meadow in decline. While the final conclusion of the meadow may not have been in doubt at that time, it is surprising how quickly the meadow succumbed to this fate. Past PEP LTEMP reports have indicated dredging may have had an indirect impact on half of this meadow, when a winter storm washed the fresh dregde materials off of the barrier beach fronting the western half of the meadow resulting in a significant portion of the meadow to be buried. This couple with other diturbances

Table SB-1. The average annual eelgrass shoot density for Southold Bay from 1997 to 2008, including standard error.

Year	Mean Density	S.E.
1999	805	+/- 69
2000	471	+/- 31
2001	467	+/- 32
2002	384	+/- 16
2004	210	+/- 23
2005	30	+/- 8
2006	0	+/- 0
2007	0	+/- 0
2008	0	+/- 0

in this meadow have helped to increase its rate of loss to the point of extinction that is its current condition.

Macroalgae Cover

The macroalgae community at this site has always been dominated by drift macroalgae. Due to the fine sandy sediment and the relatively rare, except in the eastern boulder field, substrate suitable for anchorage, large macroalgae have not been common here. With the loss of eelgrass between 2005 and 2006, the macroalgae cover dropped from an average percent cover in the 30s to less than 10% in one season (Figure SB-3). The macroalgae cover continues to remain low with the 2008 season observing only a 3.1% mean macroalgae cover for the site. The boulder field to the east still maintains high macroalgae coverage, but this is a limited area and the seaweeds common on

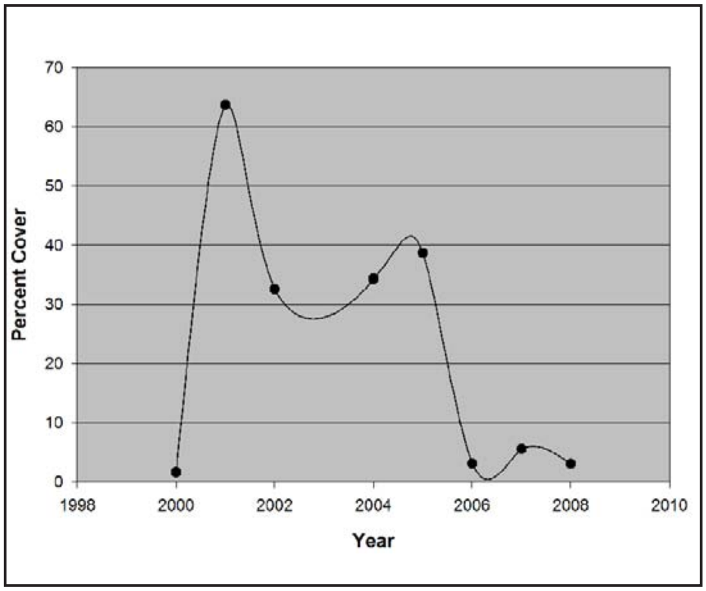


Figure SB-3. Annual mean macroalgae cover for Southold Bay from 2000 to 2008.

the boulders, *Codium*, *Fucus*, and *Sargassum*, can not anchor on the finer sediments prevalent over the rest of the site.

Conclusions

Without substantial changes to water quality and human impact to this site, the potential for an eelgrass meadow to be established and thrive at this site is very low. The meadow was already degraded in 1999 and quickly declined to extinction in under a decade. Even with improvement of water quality and clarity at this site, the anthropogenic disturbances alone would be enough to discourage restoration activities.

Three Mile Harbor the eastern most meadow in the eelgrass monitoring program. Situated inside a large, protected harbor the eelgrass once thrived throughout this system. The monitoring site for the PEP is located on the western side of the Harbor near the mouth of Hands Creek (Figure TMH-1). The area includes an East Hampton Town mooring field as well as a designated water ski area just offshore of this area.

Figure TMH-1. An aerial view of the Three Mile Harbor monitoring site with monitoring stations indicated by the superimposed numbers.

Site Characteristics

The monitoring site in Three Mile Harbor has minimal fetch in all directions and is considered a low wave exposed site. The sediments over much of the monitoring area would support this sheltered classification as they tend to be higher in silt/clay and organic material than the some of the other more energetic sites. The sediments within the eelgrass meadow were composed of 86% sand and 13% silt/clay. The organic content averaged to 1.78% (with a maximum of 2.3%). Generally, the inshore stations have the lower silt/clay and organic content and the outer station, especially Station 2, have the finer sediments with higher organic content.

Water temperature at this site has never been directly monitored by deployed instruments, however anecdotal evidence suggests that this meadow rarely experienced temperatures higher than 25C. Temperature has never been considered a significant stressor for this eelgrass meadow.

Three Mile Harbor's water quality is relatively good. Considering the boating population, as well as the residential population surrounding the Harbor, the potential for eutrophic conditions is very high. The boating population is supplied with a pumpout boat and the various marinas also have these capabilities and the seems to have that source of nutrient loading under control. There have been no other indications that water quality, in regards to nutrient loading, is a problem in Three Mile Harbor near the eelgrass monitoring site. Water clarity issues have been encountered in the meadow, stemming from the proximity of the water ski area, which had been expanded to include the eastern portion of the meadow (Stations 1 and 2; Figure TMH-1). Ski boats running this area at low tide readily fluidize and suspend the finer sediments which, in turn, reduce the light penetration at the site. As it may take hours for fine particles to settle back out of the water column, it is possible that eelgrass at this site suffer lower light availability for a considerable length of time after the initial point of disturbance.

Eelgrass Shoot Density

The Three Mile Harbor monitoring site continued to

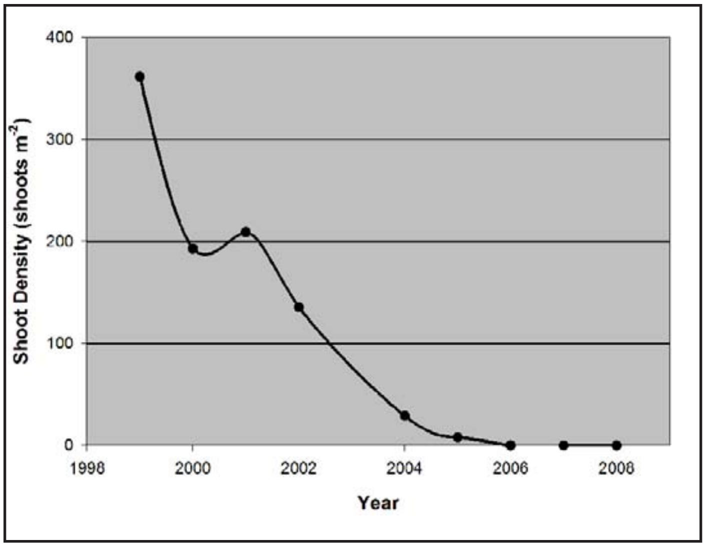


Figure TMH-2. Average annual eelgrass shoot density for Three Mile Harbor, East Hampton.

show no presence of eelgrass since its initial loss in 2005 (Figure TMH-3). While extant eelgrass patches were found in the vicinity in 2006, the 2007 and 2008 field surveys found no eelgrass in any areas adjacent to the monitoring site. However, fresh eelgrass shoots were observed floating in the Harbor, indicating that there is an extant population in the area. A survey unrelated to the monitoring program was conducted in Hands Creek in November 2008, and a large, extant eelgrass meadow was discovered. Shoot densities in this population averaged approximately 91 shoots per meter^2.

Macroalgae Cover

Three Mile Harbor has maintained a relatively stable macroalgal population since 2004 until 2008, where there was a insignificant, but notable increase in percent cover from 19.7% in 2007, to 28.2% in 2008 (Figure TMH-3). The macroalgae community continued to be dominated by *Spyridia filamentosa*, *Codium fragile* and *Gracilaria tikvahiae*. The *Codium* is generally confined to the inshore areas near the mooring field, while *Spyridia* and *Gracilaria* can grow over the softer sediments offshore.

Table TMH-1. The average annual eelgrass shoot density for Three Mile Harbor from 1997 to 2008, including standard error.

Year	Mean Density	S.E.
1999	361	+/- 49
2000	193	+/- 17
2001	209	+/- 13
2002	135	+/- 10
2004	29	+/- 6
2005	8	+/- 3
2006	0	+/- 0
2007	0	+/- 0
2008	0	+/- 0

Conclusions

The Three Mile Harbor monitoring meadow has gone extinct. While this is unfortunate news, an opportunity presents itself to determine what may have caused the loss. The establishment and expansion of both the mooring field and the water ski area are thought to have been the main stressors on the meadow at this site. Where the inshore portion of the meadow was subjected to dragging anchor chains, shading, and prop dredging, the outer portions of the meadow were experiencing episodes of low light conditions and uprooting of plants due to sediment fluidization caused by prop-wash. If these activities could be directed away from a small area, then, with propagules from Hands Creek (the nearest extant meadow), a small test restoration plot may be able to provide some insight regarding the contribution of the mooring field and water skiing on the decline in this eelgrass meadow. If this test is successful in the absence of the two stressors, then there would be a potential for restoring eelgrass to this site as long as management actions are taken to protect the site from moorings and water-skiing.

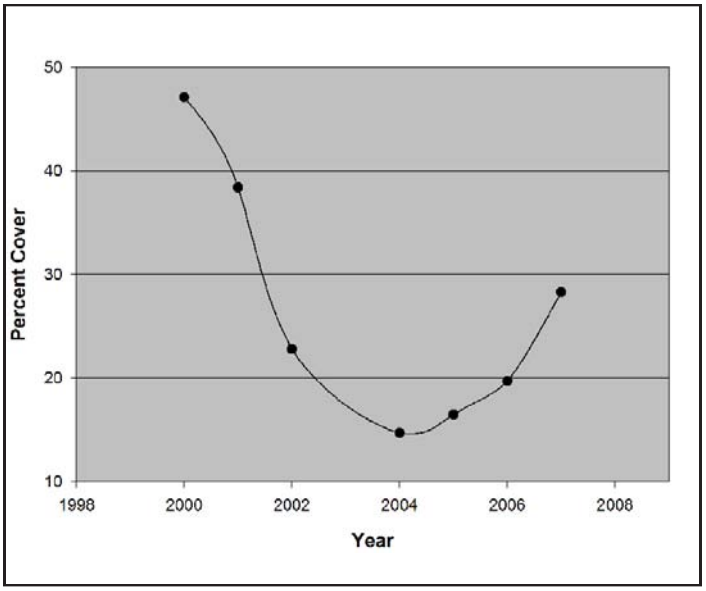


Figure TMH-3. Annual mean macroalgae cover for Three Mile Harbor from 2000 to 2008.

Cedar Point includes a narrow peninsula that separates Gardiners Bay from Northwest Harbor in East Hampton Town. The north shore of Cedar Point (Gardiners Bay side) supports a large, but patchy eelgrass meadow. The site is highly exposed to winds out of the north and there is a moderate current at the site. An overview of the site and the monitoring stations can be found in Figure CP-1, below.

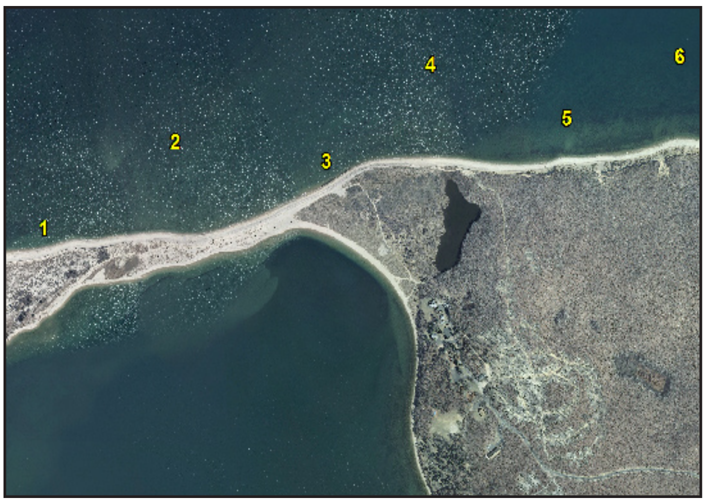


Figure CP-1. An aerial view of the Cedar Point monitoring site with monitoring stations indicated by the superimposed numbers.

Site Characteristics

Cedar Point is open to all northern fetches across Gardiners Bay. High wave exposure during winter storms would be common and the sediments and eelgrass patch dynamics support this fact. Although the sediment analysis for this site have not been completed at the time of this draft, they will be included in an updated draft when available. Observation made during the eelgrass monitoring survey and, earlier in the season while collecting flower shoots for restoration projects, the overall coarse nature of the site became evident. The first impression one gets is of diving on a rocky shore along the eastern Long Island Sound. There are plentiful boulders, rock and gravel. Sand would likely be the dominant substrate, but gravel will likely be the secondary sediment in some sections of the meadow.

Water temperature and quality should be similar Gardiners Bay. The water should be relatively low in nutrients (specifically, nitrogen) and the summer high water temperatures should follow those of Orient Point. A temperature monitoring program is planned for 2009 and the Cedar Point meadow will be one of the sites that will host a temperature logger, so more detailed information regarding the temperature regime at this site will be available in the 2009 Monitoring report.

Eelgrass Shoot Density

With 2008 being the first year of data collection for this meadow, there is not enough data to determine, or even speculate, trends. Whereas CCE has spent a significant amount of bottom time at the Orient Point meadow and can make some observation regarding the possible directions the eelgrass population may take at that site, the Cedar Point meadow has just become an important meadow in terms of eelgrass restoration as well as for the eelgrass monitoring program. The 2008 monitoring survey found that the average eelgrass shoot density for Cedar Point was 285 shoot per meter^2. The maximum shoot density counted at the site was 770 shoots per meter^2. In many ways, the Cedar Point eelgrass meadow resembles the Orient Point meadow, prior to the October 2006 storm that caused large-scale loss. Both sites are patchy with evident blowouts caused by wave action and bioturbation (i.e., crab digging along meadow edges). The two populations show similar range in shoot density and the meadow phenology is similar, with seeds coming to maturity at approximately the same time. Figure CP-2 shows a typical underwater view of an eelgrass patch at Cedar Point.

Macroalgae Cover

Cedar Point is a coarse substrate site. The site includes a significant amount of larger materials, in the form of boulders, that would not be reflected in the sediment analysis. All of this large substrate is ideal for the attachment of large amounts of macroalgae. Cedar Point supports one of the largest *Sargassum filipendula* beds in the Peconic Estuary and this brown seaweed is often encountered growing interspersed with eelgrass patches at this site. Other species to note include the brown seaweed *Scytosiphon lomentaria* (a.k.a.- sausage-weed), which can grow up over 4ft tall from late Spring to early summer throughout this meadow. The macroalgae cover recorded for the eelgrass monitoring survey was found to average around 37%, which is considered low to moderate compared to other eelgrass meadows in the Peconic Estuary.

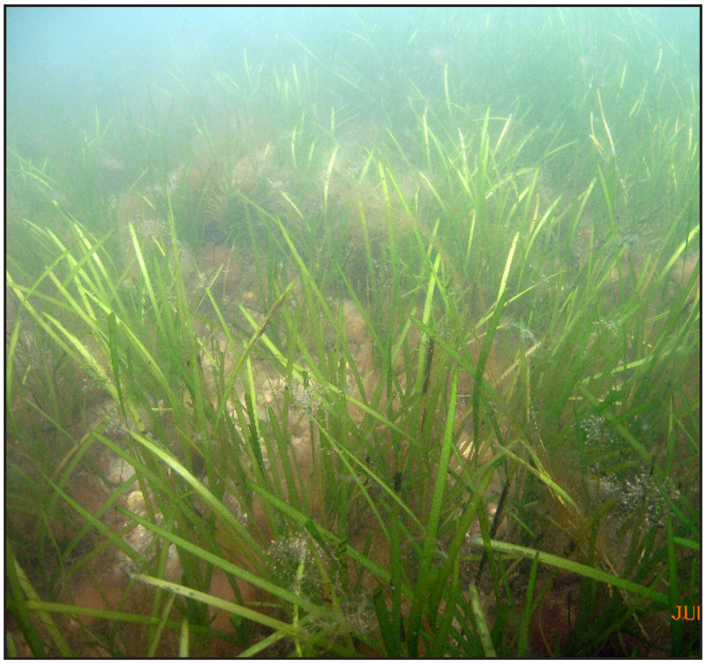
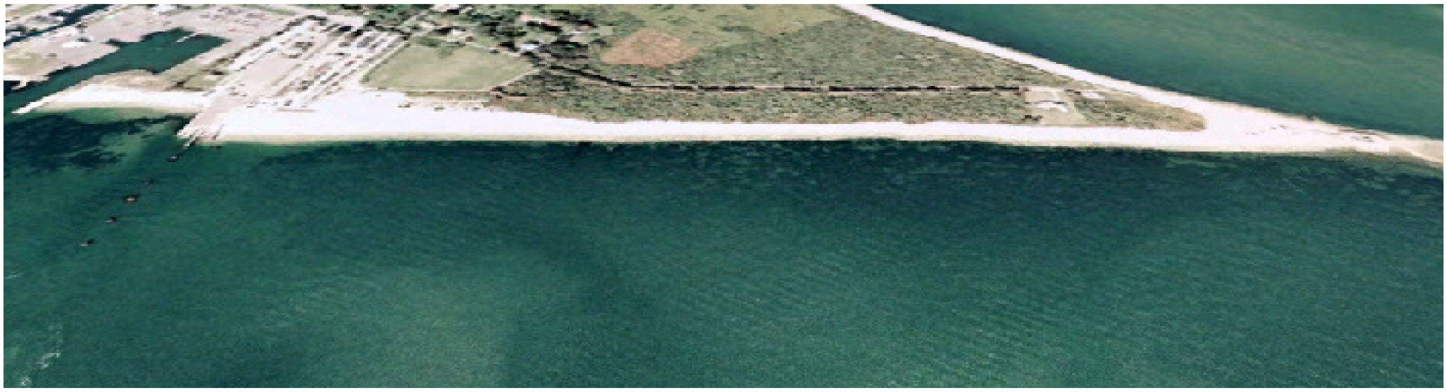


Figure CP-2. An underwater view of an eelgrass patch at Cedar Point, East Hampton.

Conclusions

Cedar Point is a cool water eelgrass meadow that experiences moderate to high wave action and moderate currents. These conditions seem to favor eelgrass growth as the plants are not stressed by summer high temperatures or stagnant nutrient rich waters. Human use of this area is minimal due to the hard sediment and the presence of boulders which are a hazard to navigation. East of Station 6 (Fig. CP-1), there is a pound net that likely impacted the eelgrass meadow when it was installed, but other than that, anthropogenic impacts on this site are negligible.



Orient Point is the eastern tip of the north fork of Long Island. To the south of the point is Gardiners Bay and the eelgrass meadow that was added to the Peconic Estuary Program Long-term Eelgrass Monitoring Program for 2008. The meadow was a large, relatively dense meadow until October of 2006, when, after a week of strong winds out of the east, the meadow suffered extensive losses from the mid-bed to the deep edge. The nearshore area of the meadow saw minimal loss, but the result was that three-quarters of a large, healthy eelgrass meadow was devastated in a short period of time. Since that time, CCE has established a sentinel site at Orient Point to monitor the recovery of the meadow along three permanent transects (Fig. OP-4). It was also decided around this same time to add two new meadows to the PEP LTEMP to balance the loss of eelgrass at four of the six monitoring meadows and Orient Point was chosen for the opportunity to monitor a meadow in recovery.

Figure OP-1. An aerial view of the Orient Point monitoring site with monitoring stations indicated by the superimposed numbers.

Site Characteristics

The Orient Point meadow has large fetches in almost all directions. Except for winds out of the west and northwest, the site will feel the influence of almost any wind at the site. Waves, such as those experienced during the storm event in October 2006, can be large and result in mass movement of sediments at this site. Orient Point is considered to be a high wave exposure and moderate current site. The meadow shows obvious indications that the wave and current forces influence the meadow. Erosional "blowouts" are common throughout the shallow portions of the meadow. Where these blowouts occur, the eelgrass meadow abruptly end at a drop off of several inches to one foot. The edge of the meadow is often left hanging over the edge. Figure OP-2 shows a characteristic blowout found in the Orient Point meadow.

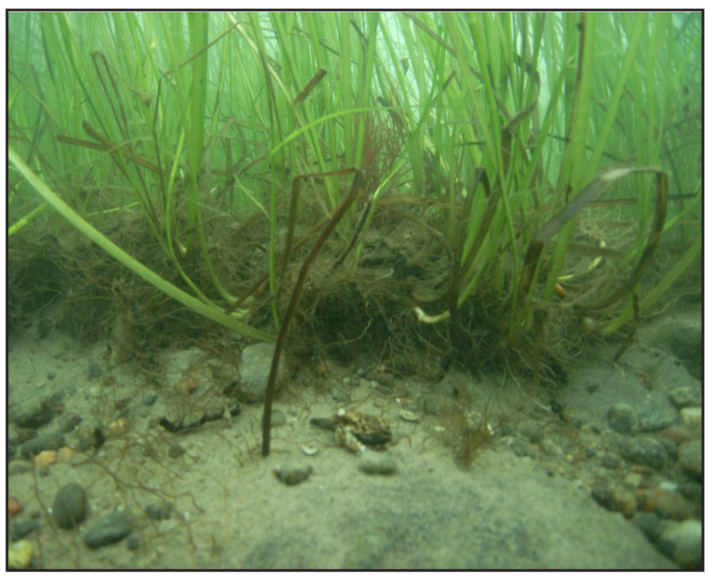


Figure OP-2. A side view of a "blowout" where a openning has been eroded in the meadow. The eelgrass is left to grow out over the edge where it is eventually dislodged. Also notice the coarse sediments left behind after the erosion.

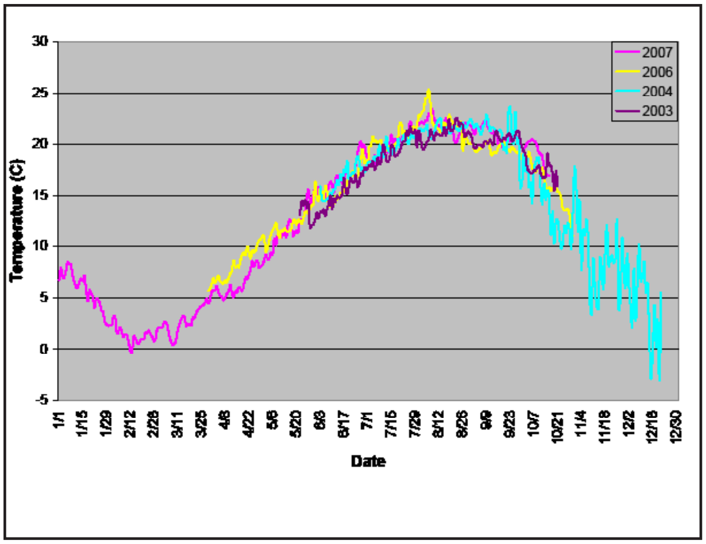


Figure OP-3. Water temperature logger data representing daily averages for Orient Point from 2003 through 2007.

The sediments at this site were analyzed initially in 1997, when the site was considered for the monitoring program. The 1997 analysis found that the sediment was predominantly sand (68.5%) with a significant amount of gravel (26.7%). Organic content of the sediment was found to be relatively low at an average of 0.86%. A current sediment analysis is underway, but the results were not available at this time of this draft. The sediment analysis will be added to the report when it is completed and an updated draft will be released at that time.

Water temperature data has been collected at Orient Point since 2003 in support of CCE's eelgrass restoration activities in the Peconic Estuary and Long Island Sound. The water temperature data is presented in Figure OP-3 for the years 2003, 2004, 2006 and 2007. The logger has not been recovered from 2008 do to logistical issues, but when it can be recovered in the Spring of 2009, its data will be incorporated into the updated draft with the sediment data. Based on the data represented in Figure OP-3, Orient Point is, on average the coolest of the eelgrass monitoring stations in the Peconic Estuary. In most years, the summer daily average water temperatures remain below 25C, except for the one July day in 2006, where the temperature peaked above 25C. The overall cool summer water temperature is one of the factors that allows eelgrass to thrive at this site.

Eelgrass Shoot Density

Being that this is the first year of Orient Point's inclusion in the eelgrass monitoring program, there is little data to formulate and trends at this point. As was mentioned above, Orient Point was once a thriving eelgrass meadow that covered a large area and maintained a relatively high average shoot density. After the storm event in October 2006, the meadow was reduced by an estimated 75% its original acreage. The 2008 monitoring season found that the average shoot density for the meadow was only 47 shoots per meter^2. Since there is no recorded shoot density data over the whole meadow from the period prior to October 2006, it is difficult to determine how far the meadow has declined. However, based on data collected from the permanent transects established at the site by CCE to monitor recovery of the meadow, shoot densities in the Orient Point meadow may have been as high as 850 shoots per meter^2. Average shoot densities would have been between 400-500 shoot per meter^2.

Macroalgae Cover

Macroalgae cover at Orient Point is lower than it had been prior to the October 2006 storms, based on observations. The 2008 survey found the macroalgae cover to be approximately 16.8%, but this is likely at least half the cover of macroalgae that once existed at this site. This decline in macroalgae at the site is in part due to the scouring that the site had taken during the 2006 storms and also the subsequent burial of the coarser sediments by sand and silt that were deposited over the whole meadow. With less suitable substrate to anchor to, there has been an overall decrease in

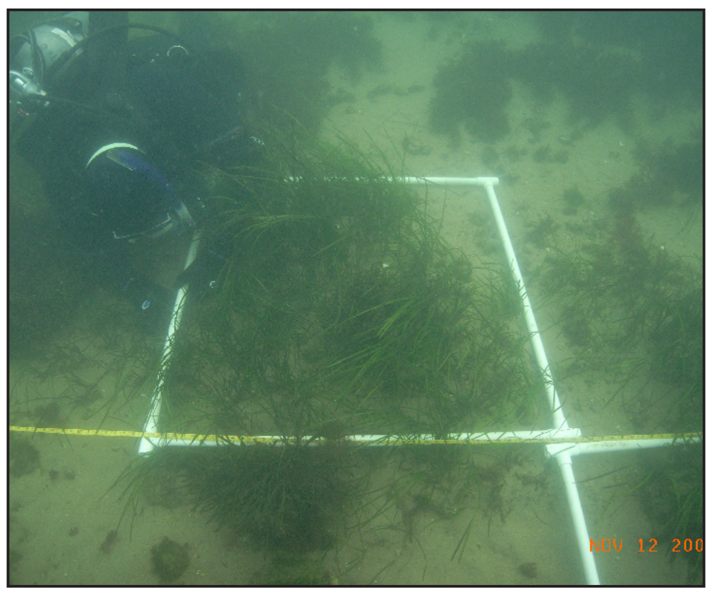


Figure OP-4. A CCE diver counts eelgrass shoots in a 1-meter^2 quadrat along one of three permanent transects established in Orient Point to monitor the meadows recovery from a 2006 storm.

macroalgae at this site.

Conclusions

With just one year of data collected, it is difficult to make any predictions as to the trends this meadow will take in the future. Based on the data that CCE has collected from the permanent transects, there is definite recovery of eelgrass occurring in the shallow and mid-depths of the meadow. Future monitoring visits will hopefully continue to find evidence of recovery at this site.