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SUBMERGED AQUATIC VEGETATION LONG TERM MONITORING PROGRAM

PROGRESS REPORT 1
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SUBMITTED TO:

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Background

Submerged aquatic vegetation (SAV) has been shown to be important to coastal ecosystems. SAV beds provide nursery habitat for a variety of commercially and recreationally important species. Juvenile bay scallops, (*Argopectin irradians irradians*) have been shown to have enhanced survival from predation in the presence of eelgrass (Pohle, et al. 1991) and therefore could be impacted by declining eelgrass beds. Eelgrass (*Zostera marina*) beds are important in stabilizing sediment and contribute a large portion of the primary production in bays and estuaries (Phillips and McRoy 1980).

Declines in SAV populations have been reported all over the world by various authors (Cambridge and McComb 1984, Cambridge et al. 1986, Den Hartog 1987, Dennison et al.1989, Orth and Moore 1984, Short et al. 1993). Perhaps the most frequently cited cause for these declines is nutrient enrichment and the resultant increase in light attenuation.

Batiuk et al. (1992) determined the habitat requirements for SAV survival in Chesapeake Bay. They concluded that SAV populations in mesohaline waters require a light attenuation coefficient less than 1.5 m^{-1}, with total suspended solids and chlorophyll *a* less than 15 mg/L and 15 µm/L respectively. Dissolved inorganic nitrogen and phosphorus should not exceed 0.15 mg/L and 0.01 mg/L respectively. Eelgrass is most sensitive to deviations from required water quality parameters during the active growth period from spring to early fall. Decreased water quality during this time can have the greatest effect on eelgrass survival.

The minimum light requirements of SAV range from 4% to 29% of light penetrating just below the surface, depending on the species (Duarte 1991, Olesen and Sand-Jensen 1993). This light requirement is much higher than that of algae <3% (Sand Jensen 1988, Lobban and Harrison 1997). Due to their higher light requirement, SAV are more susceptible to water quality changes and therefore are excellent indicators of ecosystem health (Dennison et al. 1993). Declining water quality reduces light penetration into the water column which has adverse effects on SAV growth. Reduced light penetration has been shown to reduce shoot densities and flowering in *Zostera marina* (Backman and Barilotti 1976) as well as decrease the maximum depth limit of SAV (Dennison 1987). Reduction of light penetration coupled with increased nutrients can promote growth of macro algae and epiphytes, thereby shading SAV and further exacerbating its demise.

This report describes the progress to date on the establishment of a long term monitoring program for SAV in the Peconic Estuary.

Methods

Most authors define SAV as submerged vascular, flowering plants found in marine and freshwater environments (Dennison et al. 1993, Batiuk et al. 1992, Stevenson et al. 1993, Orth et al. 1994, ASMFC 1997). For the purposes of this report, we will use this definition.

With the exception of the study performed by Cashin Associates (1996), there have been few investigations regarding SAV in the Peconic Estuary. An extensive literature search was performed to establish methodology similar to other studies and provide a basis for comparison of data resulting from this survey. This survey builds upon the results and recommendations of Cashin Associates (1996) SAV study.

Location of Survey Sites

We chose to focus on eelgrass (*Zostera marina*) for the survey because it is the dominant marine SAV species found in the Peconic Estuary. Widgeon grass (*Ruppia maritima*) is also found in the estuary, but only in a few isolated populations (Cashin Associates 1996). *Ruppia maritima* also has a lower light requirement than *Zostera marina* (Dennison et al. 1993) and therefore would not be as suitable an indicator of changes in water quality and light penetration.

Three beds were chosen in the following locations: Orient Harbor (Town of Southold), Northwest Harbor (Town of East Hampton), and Bullhead Bay (Town of Southampton). Orient and Northwest Harbors were chosen due to their locations in the middle to eastern end of the estuary, and the predominance of good water quality in those areas. Bullhead Bay was chosen because it is believed to be the westernmost existing eelgrass bed in the Peconic Estuary. A minimum of three stations were sampled per site for SAV and sediment analysis.

Samples were taken at Orient Harbor on July 8, 1997, Bullhead Bay on August 14, 1997, and Northwest Harbor on September 23, 1997. The lag time between sampling was due to the time it took to select appropriate sites and to perfect techniques. Future sampling at the 3 sites will occur in 3 consecutive weeks in order to achieve constancy among sites.

SAV Bed Mapping

The maximum depth limit of each eelgrass bed margin was mapped using a Trimble ™ differential GPS with an accuracy of less than a meter. The unit was towed in a kayak by a diver swimming along the edge of the bed. The kayak was kept directly above the diver in order to get the edge of the vegetation as accurate as possible. The DGPS was set to log positions every 5 seconds as the diver moved along the edge. The data was stored in the unit for later downloading

to a computer.
The data can be exported to GIS software such as MapInfo™. Mapping dates and times were selected using mission planning software which predicts the number and orientation of satellites and determines the ability of the unit to achieve sub-meter accuracy.

Water Quality

The Suffolk County Department of Health Office of Ecology routinely samples water quality for 35 stations in the Peconic Estuary. It was felt that these long term data would be more useful than data taken twice per year during SAV sampling. Data will be obtained for stations near to the sampling sites. The stations which correspond to SAV sites are # 115 - Orient Harbor; # 118 - Northwest Harbor; and # 131 Northwest Creek. Currently, there are no stations in the vicinity of Bullhead Bay.

At the time of SAV sampling, salinity was measured with a hand held refractometer, and temperature with a ANSI/SAMA precision grade thermometer which was calibrated to a NIST reference thermometer.

Light Measurements

Light was logged as photosynthetically active radiation (PAR) which is between 400 and 700 nanometers using a LiCor quantum sensor and data logger. Readings were taken just below the surface, and at depths of 1 meter and 2 meters. The light attenuation coefficient was calculated using the Beer-Lambert equation:

$$I_Z = I_0 e^{-kz}$$

where I_Z is the intensity of light at z, the depth of interest. I_0 is the light intensity just below the surface, and k is the extinction coefficient of water.

Sediment Analysis

Sediment samples for grain size analysis were obtained by pushing a length of 2" PVC pipe at least six inches into the sediment and capping the ends before handing it to personnel on the boat. The excess water was decanted off the top making sure no sediment was lost in the process. The sample was then placed in a numbered ziplock bag labeled with the date, site and station number and kept on ice until return to the lab. The bag number, site and station number were recorded on a data sheet for redundancy. Upon return to the lab, the samples were stored in a refrigerator at 4°C until analysis. Storage did not exceed 14 days.

Samples were analyzed as follows. The entire sample was mixed so that it was homogeneous. Three subsamples were taken and each placed in 100 ml beakers with 50 ml of 1% Calgon solution in distilled water. The samples were then placed on a RotoMix for one hour to disaggregate the particles. Each subsample was then wet sieved through U.S. standard testing sieves (#230 and #10) with distilled water. Sediment retained on the # 10 (2 mm) sieve was classified as gravel, and sediment retained on the # 230 (63 µm) sieve was classified as sand. The sediment retained on the sieves was transferred to preweighed 50 ml beakers and set aside. The rinse water and silt - clay fraction was collected in a 1000 ml graduated cylinder. The suspension in the graduated cylinder was processed using the pipet analysis described by Folk (1974). The cylinder was stirred using a specially made stirring rod, making sure that the entire sample was completely dispersed. Upon removal of the stirring rod, a ASTM timer was started. After 20 seconds, a 20 ml sample was withdrawn with a volumetric pipet at a depth of 20 cm from the top of the liquid. The sample was placed in a preweighed 50 ml beaker. The pipet was then rinsed with distilled water and emptied into the same 50 ml beaker. This comprised the silt and clay fraction of the sediment. After 2 hours 3 minutes, another 20 ml sample was withdrawn from a depth of 10 cm from the top of the liquid. The pipet was emptied and rinsed with distilled water into a preweighed 50 ml beaker. This comprised the clay fraction. All the beakers were placed in a drying oven and evaporated to dryness for at least 48 hours at 60°C. The beakers were then removed from the oven and allowed to cool for a constant time before weighing. The data were recorded and the necessary corrections (Calgon weight) performed.

Further analysis of the sand (> 63 µm) fraction will be performed using a Ro-Tap sediment shaker. A series of screens of desired mesh size are placed in the Ro-Tap and are shaken for 15 minutes. Each size fraction is weighed and the % size distribution determined. Each fraction is examined under a microscope for any remaining aggregates. If there are more than 25% aggregates, the sample must be disaggregated and run through the screens again.

Samples for sediment organic matter analysis were obtained using the same method as samples for sediment grain size. Each sample core was emptied into a stainless steel pan and mixed throughly with a stainless steel spoon. The pan and spoon were rinsed between samples with ambient seawater to avoid contamination. The samples were placed in numbered borosilicate glass jars and kept on ice until return to the lab. The bottle number, site and station number were recorded on a data sheet for redundancy. Upon return to the lab, the samples were frozen to -20°C until analysis. Storage time did not exceed 6 months prior to analysis.

In the lab, the samples were thawed prior to analysis. Each sample was throughly mixed in a stainless steel pan, divided into equal portions and placed in a 100 ml borsilicate glass beaker. The samples were placed in an oven and dried at 60°C until dry. When dry, the samples were ground and thoroughly mixed again. Subsamples were taken and placed in precombusted, preweighed crucibles and weighed. The samples were then combusted at 450°C in a muffle furnace for four hours. A sample of pure calcium carbonate standard was also combusted as a control. After removal from the furnace, the samples were allowed to cool to room temperature and weighed. Loss after combustion represents the amount of organic matter present in the sample.

Vegetative Sampling

SAV samples were obtained using a 0.25 m^2 quadrat. The quadrat was placed on the bottom and anchored with steel staples to prevent movement. The leaves of shoots outside the quadrat were carefully pulled out from the inside of the quadrat and the leaves from shoots inside the quadrat were pulled inside. The root rhizome mat was cut with a sharp knife around the inside edges of the quadrat to a depth of 8 inches. The plants were then removed by hand and placed in plastic mesh baskets and transported to the boat. On the boat, the baskets were emptied and the contents placed in numbered ziplock bags marked with the date, site, and station number. The number and contents of the bags were recorded on a data sheet to ensure redundancy. Ambient sea water was put in the bags to keep the samples moist and the bags were then placed in a cooler for transport to the lab. Upon return to the lab, the samples were refrigerated until analysis. The samples were processed within 48 hours.

Within 24 hours, the samples were washed to remove the sediment from the roots. The wash water was passed through a 2 mm screen to capture any plant fragments and small bivalves. Eelgrass was separated from algae species. The algae were identified to species whenever possible. Wet weights were obtained for all vegetation

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The eelgrass was then examined individually. The shoots were counted and classified as young or mature and presence of flowering shoots was noted. The number of leaves per shoot was counted and examined for the presence of wasting disease and epiphytes. If epiphytes or wasting disease were present, it was noted how many leaves were affected and the leaf area affected. Epiphytic diatoms and bacteria were not considered as part of the survey, only epiphytic macro algae. The epiphytes were removed by carefully scraping the leaves with the edge of a glass slide, then weighed. The eelgrass plants were separated into shoot and root sections and placed on labeled, preweighed sheets of aluminum foil. The epiphytes were identified and placed on a numbered, preweighed aluminum pan. The samples were placed in a drying oven and dried at 60 °C to a constant weight. The samples were weighed upon immediate removal from the oven to avoid weight gain due to water absorption from the air.

Fauna

The presence of faunal species was noted. With the exception of commercially valuable bivalves, quantitative enumeration of faunal species was not performed as it was beyond the scope of this monitoring program.

Results

SAV Mapping

In Orient Harbor, a portion of the edge of the eelgrass bed was mapped. Figure 1. shows the position of this line and the station locations in relation to the shore. The maximum depth edge of the eelgrass bed ranged from 2.1 meters at stations 2 and 3 to 2.5 meters at station 1, and was very well defined at this site. In Bullhead Bay, the entire edge of the eelgrass bed was mapped due to its small size. The depth was variable, ranging from less than one meter to just over a meter. Some portions of the edge were somewhat patchy and undefined. Figure 2. shows the position of the eelgrass bed and the station locations in Bullhead Bay. In Northwest Harbor, the eelgrass bed was extremely patchy and maximum depth edge could not be determined. However the maximum depth where eelgrass was found was 2.8 meters at station 1. Stations 2 and 3 had a depth of 2.0 meters. Figure 3. shows the location of the stations in Northwest Harbor.

Water Quality

Water temperature, salinity and light attenuation at the three sites are shown in Table 1.

Table 1. Temperature, salinity and light attenuation at SAV sampling sites.

Site	Temperature (°C)	Salinity(PSU)	Light Attenuation (m^{-1})
Orient	24	28.3	0.57
Bullhead	24	28.0	0.65
Northwest	18	29.6	0.77

Nutrient and chlorophyll *a* data for Orient Harbor and Northwest Harbor are being obtained from the SCDHS Office of Ecology.

Sediment Characteristics

Sediment percent grain size was determined for each site (Table 2). There was some variation between stations within each site. Orient Harbor and Northwest Harbor were predominantly sand as was station 1 in Bullhead Bay. The remainder of the stations in Bullhead Bay were 40 to 47 % sand and 52 to 59 % silt and clay. The sediment at these stations was highly unstable. The sediment was easily penetrated by the full length of the core (30 cm).

Table 2. Sediment percent grain size (by weight) for SAV sites.

Orient Harbor	Gravel	Sand	Silt	Clay
Station 1	26.99	67.51	4.17	1.33
Station 2	28.68	64.62	5.58	1.52
Station 3	36.70	56.42	4.81	2.12

Bullhead Bay	Gravel	Sand	Silt	Clay
Station 1	6.68	82.32	8.72	2.64
Station 2	0	44.11	41.63	14.27
Station 3	0	40.27	44.66	15.07
Station 4	0	47.41	36.88	15.71

Northwest Harbor	Gravel	Sand	Silt	Clay
Station 1	0.65	97.76	0.69	0.70
Station 2	0.50	97.03	1.10	1.37
Station 3	0.17	96.03	1.76	2.04

Percent organic matter in the sediment varied from 0.63% at station 1 in Northwest Harbor to 8.95% at station 3 in Bullhead Bay. Table 3 shows the values for percent organic matter for each site.

Table 3. Sediment percent organic matter by weight.

	Orient Harbor	Bullhead Bay	Northwest Harbor
Station 1	1.12	2.07	0.63
Station 2	1.13	8.21	0.76
Station 3	1.28	8.95	0.72
Station 4	----	6.09	----

Vegetation

Orient Harbor - Four species of algae were found growing among the eelgrass: *Codium fragile*, *Ceramium sp.*, *Lomentaria baileyana*, and *Sphaerotrichia divaricata*. Table 4 shows the wet weights of all species.

Table 4. Wet weight of SAV and algae in Orient Harbor per 0.25 m^2.

	C. fragile	*Ceramium sp.*	*L. baileyana**	*S. divaricata*	*Z. marina*
Station 1	< 1g	4.9g	--	--	419.6g
Station 2	< 1g	3.5g	< 1g	2.3	485.6g
Station 3	86.3g	--	--	7.1	418.8g

* epiphytic on *Zostera marina*

Eelgrass densities were 141, 174 and 115 shoots per 0.25 m^2 for stations 1, 2, and 3 respectively. The number of reproductive shoots found at stations 1, 2, and 3 were 2, 6, and 6 respectively. The percentage of young shoots was not determined for this site. There was no evidence of wasting disease on the plants. Epiphytes were found on 3 plants at station 1, 2 plants at station 2, and 2 plants at station 3. With the exception of one plant, only one leaf per plant was affected and the leaf area affected was usually less than 20%. *Lomentaria baileyana* was found to be epiphytic on old eelgrass leaves at station 2. Some of the *Ceramium sp.* found at station 1 was epiphytic on eelgrass. The epiphytes at other stations consisted of encrusting bryozoans. As with the algae, the bryozoans were found on mostly older leaves or the upper (older) portions of mature leaves. The dry weight biomass of algae and eelgrass in Orient Harbor are shown in Table 5 and 6.

Table 5. Dry weight biomass of algae species in Orient Harbor.

	C. fragile	*Ceramium sp.*	*L. baileyana*	*S. divaricata*
Station 1	--	0.8g	--	--
Station 2	--	0.6g	--	0.3g
Station 3	5.3g	--	< 1.0g	0.6g

Table 6. Dry weight biomass of eelgrass shoots and roots.

	Shoots	Roots	Total
Station 1	23.3g	42.5g	65.8g
Station 2	28.7g	43.2g	71.9g
Station 3	22.2g	29.5g	51.7g

Bullhead Bay - Two species of red algae were found at station 1. *Ceramium sp.* was found to be epiphytic on eelgrass leaves and *Agardhiella sp.* was loose on the bottom among the shoots. Stations 2, 3 and 4 had no algal species present. Other algal species noted along the edge of the eelgrass bed were *Enteromorpha sp.* and *Ulva lactuca.*

The eelgrass root system at stations 2, 3, and 4 was close to the surface of the sediment with a fine layer covering the rhizomes. The root system almost seemed suspended across the surface of the sediment. Station 1 had the greatest number of shoots with the third greatest biomass. Station 3 had the greatest biomass with the third greatest density. Upon observation, the plants at station 2 and 3 had longer leaves than station 1. Table 7 shows the wet weight of all species in Bullhead Bay.

Table 7. Wet weight of all species found in Bullhead Bay.

	Ceramium sp.	*Agardhiella sp.*	*Z. marina*
Station 1	0.8g	3.0g	799.3g
Station 2	--	--	1102.1g
Station 3	--	--	1342.0g
Station 4	--	--	564.6g

Eelgrass densities, the number of reproductive shoots and the percentage of young shoots are shown in Table 8. Flowering shoots were more numerous in Bullhead Bay, however most were in various stages of decay and had shed their seeds. Station 1 had the greatest density of shoots, however 79% of which were classified as young individuals budding off of existing shoots and rhizomes.

Table 8. Eelgrass densities and the number of reproductive shoots in Bullhead Bay.

	Density	# of reproductive shoots	% young shoots
Station 1	316	6	79.0%
Station 2	164	25	31.7%
Station 3	144	20	18.8%
Station 4	86	12	22.1%

Dry weight biomass of the algae and eelgrass found in Bullhead Bay are given in Table 9.

Table 9. Dry weight biomass of algae and eelgrass per 0.25 m^2 in Bullhead Bay.

			Z. marina		
	Ceramium sp.	*Agardhiella sp.*	Shoots	Roots	Total
Station 1	< 1.0g	< 1.0g	24.4g	60.3g	84.7g
Station 2	----	----	50.8g	62.6g	113.4g
Station 3	----	----	72.1g	55.6g	127.7g
Station 4	----	----	32.5g	30.0g	62.5g

Northwest Harbor - Two species of red algae were found in Northwest Harbor among the eelgrass. *Spyridia filamentosa* with a small amount of *Ceramium sp.* mixed in. The wet weights of eelgrass and algae are given in Table 10.

Table 10. Wet weights of algae and eelgrass in Northwest Harbor per 0.25 m^2.

	Mixed *S. filamentosa* and *Ceramium sp.*	*Z. marina*
Station 1	157.7g	420.9g
Station 2	14.8g	646.6g
Station 3	151.3g	373.5g

Eelgrass densities were 41, 55, and 61 shoots per 0.25 m^2 respectively for stations 1, 2, and 3. There were no reproductive shoots found at any of the stations probably due to the time of year. The percentage of young shoots per station was 26.8, 34.5, and 34.4 respectively. No epiphytes or wasting disease were found. The dry weight biomass of all species is shown in Table 11.

Table 11. Dry weight biomass of algae and eelgrass in Northwest Harbor.

	Mixed *S. filamentosa* and *Ceramium sp.*	*Z. marina* Shoots	Roots	Total
Station 1	18.8g	8.7g	31.2g	39.9g
Station 2	1.9g	8.4g	60.1g	68.5g
Station 3	22.3g	8.5g	35.7g	44.2g

Shellfish

Orient Harbor - One small hard clam (*Mercenaria mercenaria*) and one bay scallop were found at station 1 and three small hard clams were found were found at station 3. All of the bivalves were sub-legal in size and returned to the water.

Bullhead bay - One small sublegal bay scallop was found at station 1.

Northwest Harbor - Two *M. mercenaria* measuring 53.5 mm and 31.5 mm across the hinge were found at stations 2 and 3 respectively. Other chowder size hard clams were observed in the area along with a number of legal sized scallops.

Conclusions

Light attenuation varied somewhat between sites. This variation is probably due to the differences in environmental factors between each site. The increased light attenuation in Northwest Harbor may have been due to a 18 mph wind blowing from the south west at the time of sampling. A wind chop and low tide condition may have added suspended material into the water column and lowered light penetration. Light attenuation may vary depending upon the amount of suspended material and phytoplankton in the water column. The values for the light attenuation coefficient for all sites were less than the maximum allowed for SAV survival as determined by Batiuk et al. (1992). Light readings taken over an extended period of time may be more valuable in determining the average light regime experienced by the plants rather than on any particular day.

As previously stated, there is no water quality sampling station in Bullhead Bay. This data is vital to understanding the dynamics of the eelgrass bed at this site. The entire western edge of the bay is bordered by the National Golf Links, through which a small creek empties into Bullhead Bay's southern corner via a culvert under the road. It is unknown whether there are any nutrients entering the system from the golf course.

Sediment characteristics varied considerably between sites. The high percentage of silt and clay in Bullhead is indicative of the relatively low energy regime that the bay experiences. No strong tidal currents occur within Bullhead Bay. In addition, it is well protected from strong winds on all sides and the short fetch does not allow large waves to occur within the bay. Orient Harbor had a higher percentage of silt and clay than Northwest Harbor. Northwest Harbor experiences some tidal current, and the patchy nature of the eelgrass bed may allow for greater sediment transport. Sediment Organic matter was greatest in Bullhead Bay and least in Northwest Harbor which is also due to the greater sediment transport at the latter site.

Epiphytes were found only on older eelgrass leaves which indicates the plants were growing and shedding leaves regularly. The nutrient levels in both Northwest Harbor and Orient Harbor may be low enough such that the eelgrass is not outcompeted for nutrients and light. The eelgrass may have been able to maintain a high leaf replacement rate and keep ahead of epiphyte growth.

The dry weight biomass of eelgrass in both Orient Harbor and Northwest Harbor was slightly below the average reported by Cashin Associates (1996) of 370 g DW m^2. Bullhead Bay eelgrass biomass is comparable or slightly above the average. Olesen and Sand-Jensen (1994) compared the biomass and density patterns of 29 eelgrass beds in North America and Europe and found average maximum biomass values of 245 g DW m^2 for leaves, 354 g DW m^2 for total plant biomass, and a mean density at maximum biomass of 905 shoots m^2. Orient Harbor and Northwest Harbor had shoot and total plant dry weight biomass that was below average. Stations 2 and 3 in Bullhead Bay had leaf biomass values closer to the average (203.2 and 288.4 g DW m^2), and total DW biomass greater than the average (453.6 and 510.8 g DW m^2). Northwest Harbor had leaf biomass values far below the average (33.6 to 34.8 g DW m^2). Stations 1 and 3 had total biomass values below average (159.6 and 176.8 g DW $m^{2)}$ and station 2 had a total biomass near the average (274 g DW m^2). The reduced shoot densities and dry weight biomass at Northwest Harbor are most likely due to the seasonal senescence of leaves. The root dry weight and total wet weight biomass of eelgrass in Northwest Harbor was comparable to eelgrass in Orient Harbor. Stations 1, 2 and 3 in Bullhead Bay showed greater total wet and dry weight biomass. The silty nature of the sediments in Bullhead Bay may stimulate enhanced growth if eelgrass. A study performed by Kenworthy and Fonseca (1977) indicated that eelgrass growing in silty sediments have increased leaf biomass. Increased nutrients from the golf course may also be stimulating increased growth of eelgrass at this site. The increased shoot biomass may be able to effectively utilize the added nutrients and out compete epiphytes.

There is some speculation that the patchy nature of the eelgrass bed in Northwest Harbor is due to clamming activity. The NYSDEC is known to seed clams in the area. and numerous chowder sized hard clams were observed at the site. Peterson et al. (1987). studied the effects of clam harvesting on eelgrass beds. They harvested clams in eelgrass twice with a 8 to 10 month period between harvests. Their study found that clam raking immediately reduced the biomass of eelgrass in the area raked and the effect increased with harvest intensity. The eelgrass recovered to levels similar to the controls within one year of the second harvest. The study indicates that repeated and frequent harvesting of *M. mercenaria* by raking can have a detrimental effect on eelgrass beds. Kenworthy and Fonseca (1977) found that eelgrass had poor growth in disturbed sediments as compared to plants in undisturbed sediments. The greater amount of algae found in Northwest Harbor may also hinder the growth of young shoots from rhizomes and seeds, preventing recolonization.

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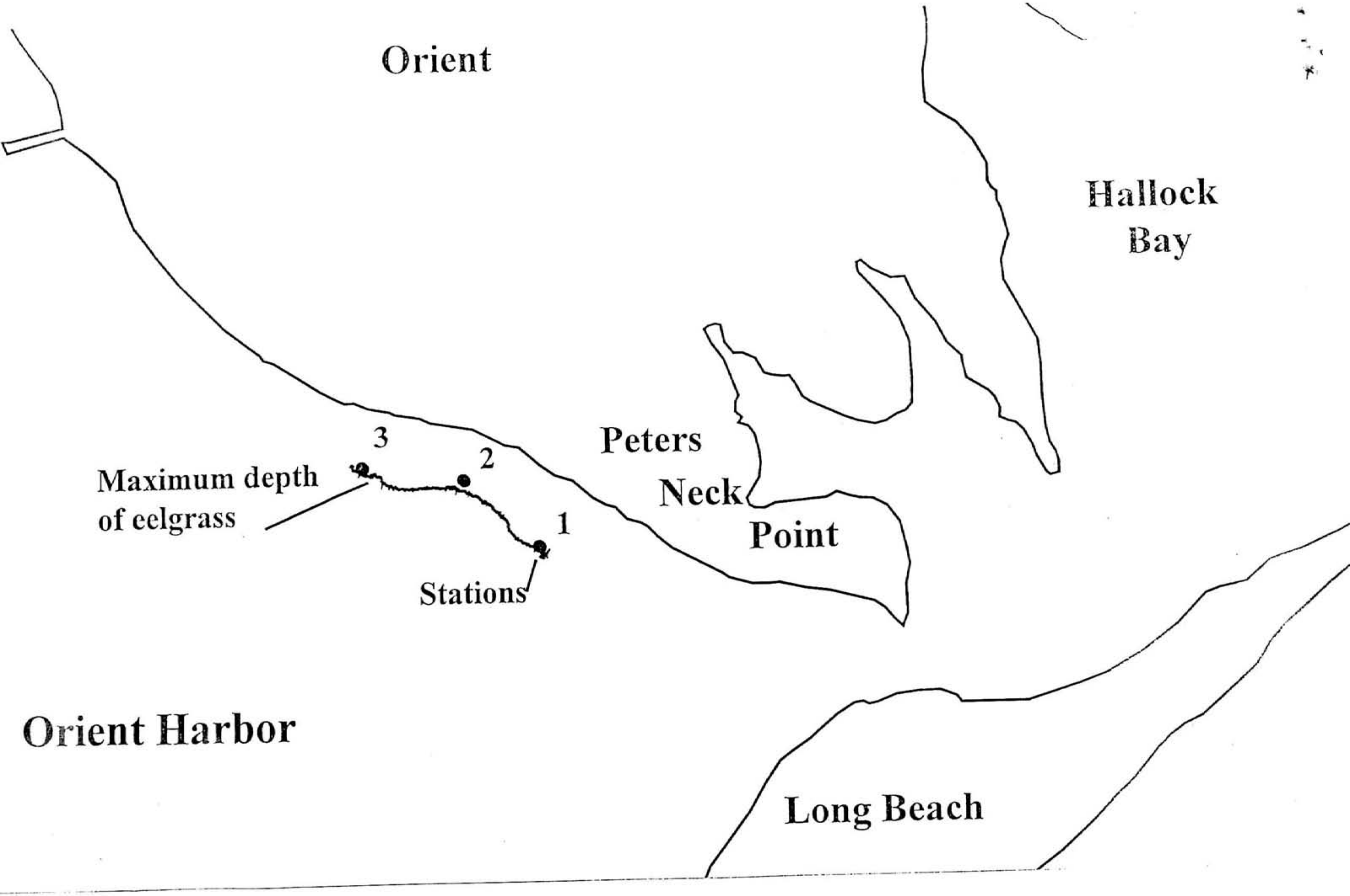
Orient
Hallock
Bay
Peters
Neck
Point
3
2
1
Maximum depth
of eelgrass
Stations
Orient Harbor
Long Beach

Fig 1

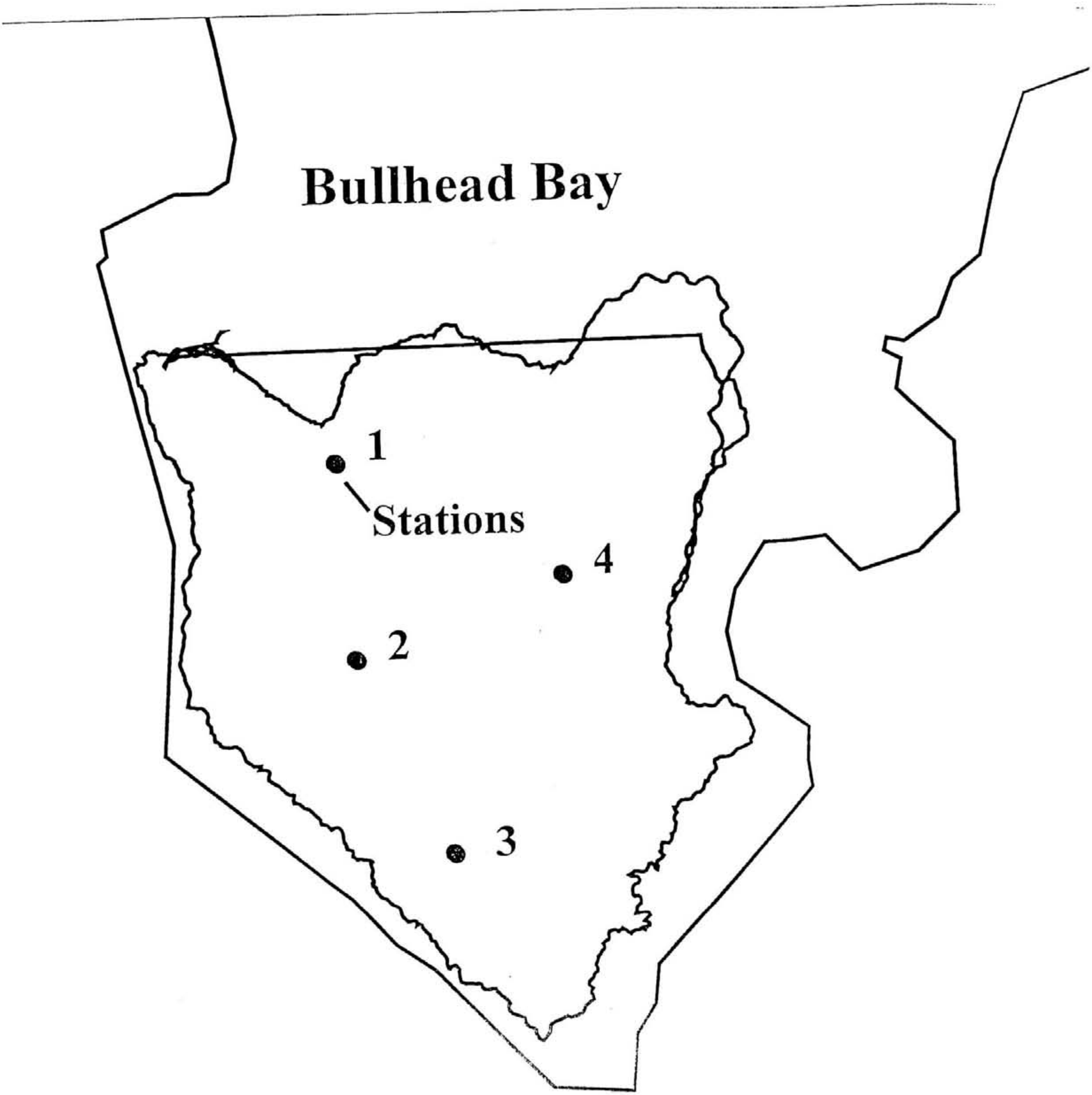

Fig 2

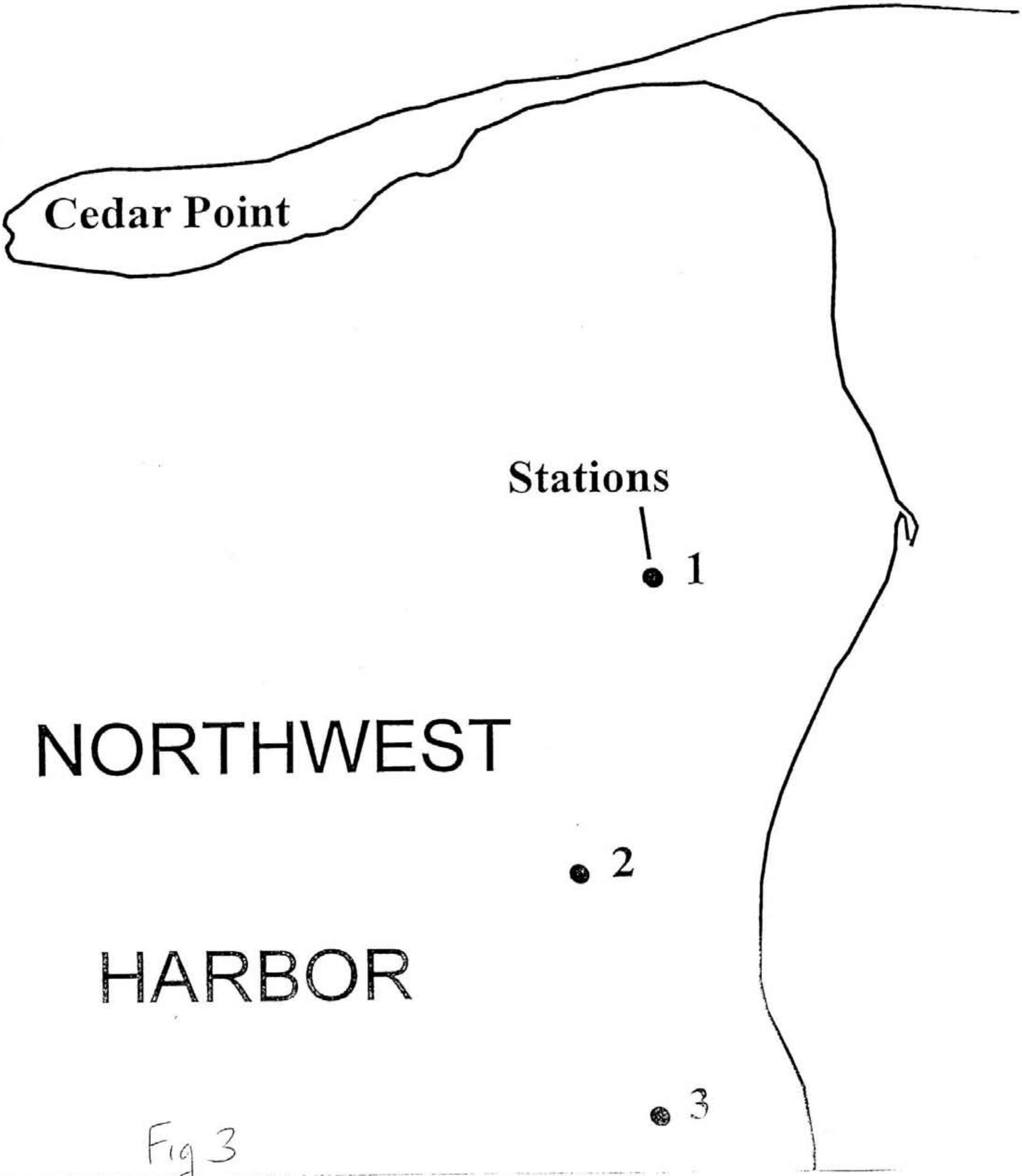

Fig 3