Report on 2010 Mayo Creek Salt Marsh Pre-Restoration Monitoring

Prepared for the Town of Wellfleet Conservation Department

Submitted by Tara Nye, Katherine Beauchamp and Jo Ann Muramoto
Association to Preserve Cape Cod
January 20, 2011

Introduction

Mayo Creek discharges into Wellfleet Harbor through a 24-inch concrete culvert that was installed in 1940. The culvert runs under Commercial Street and is in poor condition. The Harbor side of the culvert has a "duckbill" flapper gate that allows drainage from the creek into the Harbor but prevents tidal flow from entering the estuary. The approximate area of the upstream restricted wetland is 19.33 acres of brackish-fresh marsh but the affected floodplain extends upstream of Chequessett Neck Road beyond the 19.33 acres. The Mayo Creek salt marsh system is extensively impaired by tidal restriction, with the vegetation consisting primarily of *Phragmites australis*; subsequently the marsh has minimal accessibility.

The Association to Preserve Cape Cod (APCC) monitored at the Mayo Creek salt marsh during the field season of 2010 to document pre-restoration conditions of the marsh. The monitoring work constitutes Task 4 ("Wetland Monitoring") of a salt marsh restoration feasibility study that is being conducted by the Town of Wellfleet under a grant from the Gulf of Maine Council and the NOAA Habitat Restoration Center. The results will be used by the Town to develop a preferred restoration option(s) and to help plan post-restoration monitoring. APCC monitored vegetation and water quality (i.e., salinity, dissolved oxygen, pH, temperature, conductivity) and took photographic documentation of pre-restoration conditions in the study site (i.e., restricted side) of Mayo Creek. Monitoring was conducted according to APCC's state-approved Quality Assurance Project Plan (QAPP) for monitoring of salt marshes. APCC wetlands biologist Ms. Tara Nye led the monitoring program at Mayo Creek, assisted by experienced staff.

Goals

The overall project goal is to restore approximately 25 to 30 acres of former salt marsh habitat, reduce invasive plant growth, and improve water quality for shellfishing and habitat by restoring tidal flow to a tidally restricted marsh.

The goal of this pre-restoration monitoring program, which was Task 4 in the Town's proposal, will be to document the vegetation species and coverage, including the extent of invasive plant species (Phragmites), and to monitor surface water and pore water salinity in the root zone at designated stations in the study marsh. Documenting the current state of Mayo Creek marsh will provide a pre-restoration baseline which will allow for evaluation of post-restoration changes when tidal flow is restored to the system. This will allow the marsh to be studied over time to document the success of restoration efforts.

Methods

Vegetation Monitoring

APCC proposed to access the marsh at four access points for vegetation monitoring. Subsequently it was determined that one of these access points, at the field behind the trailer park, was not accessible due to impenetrable growth of invasive plants. At each of the remaining three access points, three or more transects were established. Transects were located randomly using a random generator equation in Excel. A total of 13 transects were established. Along each transect, vegetation monitoring stations were located at regular intervals (0 feet, 60 feet, and 120 feet) whenever feasible, or at irregular intervals when site inaccessibility or other constraints prevented regular intervals from being established (Table 1). A total of 26 vegetation monitoring stations were set up. Transects and stations are located as indicated in Table 1.

Table 1. Transect and station location and information.

Mayo Creek Transects and Stations			
Transect	Stations (feet)	Plants	Salinity
Closest to the culvert on Commercial Street			
S1E	0	X	X
S1E	14	X	X
S1E	28	X	X
S1W	0	X	
S1W	11	X	
S2E	0	X	X
S2E	25	X	X
S2W	0	X	
S2W	46	X	
S3E	0	X	
S3W	0	X	X
S3W	60	X	X
S3W	120	X	X
Behind the ball field on Kendrick Avenue			
S4N	0	X	X
S4N	60	X	X
S4N	120	X	X
S5N	0	X	X
S5N	60	X	X
S5N	120	X	X
S6N	0	X	X
S6N	30	X	X
S6N	60	X	X
Off the dirt road at Chequessett Neck Road			
S7E	0	X	X

S8W	0	X	X
S9W	0	X	X
S10W	0	X	X

*Please see Map 1 for station locations.

At each station a 1-meter-square quadrat was placed on the marsh surface and all plants within it were identified and quantified using percent cover. To obtain abundance values, an estimate of the percent of the plot occupied by the target plant was used. To assess percent cover of each species, standard cover classes for estimating abundance were used. This is done by estimating the area of the plot ($1m^2$) that is covered by all of the leaves, branches, and stems of the target species. Standard cover classes are used to reduce variability from one person to another. The nine standard cover classes, as defined in *A Volunteers Handbook for Monitoring New England Salt Marshes* (Carlisle et. al., 2002), are broken down as follows:

Trace to 1%
2 – 4%
5 – 10%
20 – 30%
31 – 45%
46 – 64%
65 – 87%
88 – 100%

For each plot, every plant was identified, and the percent cover was estimated for each species. This was done once per plot during the month of July, 2010.

For every station containing *Phragmites australis*, Phragmites abundance was determined using the above-mentioned procedure for estimating standard cover classes, and the height of the three tallest living plants was measured.

<u>Physical Monitoring</u>

Pore and surface water salinity:

Monitoring of pore and surface water salinity was performed twice per month from July through September 2010 at designated salinity stations which coincided with most of the vegetation stations. For pore water measurements, a sipper (stainless steel tubing with a syringe attached to one end) was used to pull pore water up from a depth of 10 centimeters (cm). The water sample was measured for salinity using a hand-held temperature-compensated refractometer. The refractometer was calibrated at the beginning of each session with deionized water.

The protocol for collecting surface water samples calls for obtaining samples from just below the top of the water column, at an approximate depth of 10 cm, and from the bottom of the water column if the water depth is 30 cm or greater. For the most part, the water level in the creek was rarely 30 cm deep. In most cases (upstream from the culvert area), the water depth was less than 10 cm, so only a surface water sample was collected and measured. However, when possible water samples were obtained from the bottom of the creek, measured for salinity and the sampling depth was documented. Salinity measurements taken from the bottom of the creek which were too muddy to be read on a hand-held refractometer were discarded.

To obtain representative salinities from different tidal stages, surface water salinities were measured during various tide stages.

Results and Discussion

Vegetation

Most of the plant species observed in the marsh are freshwater or brackish species (Table 2).

Table 2. List of plants identified at established stations at Mayo Creek, 2010.

Species	**Common Name**
Achillea millefolium	Yarrow
Agropyron pungens	Stiff-leaf Quackgrass
Agrostis stolonifera	Creeping Bent Grass
Aster novi-belgii	New York Aster
Atriplex patula	Marsh Orach
Baccharis halimifolia	Sea Myrtle
Impatiens capensis	Jewelweed
Juncus gerardii	Black Grass
Juniperus virginiana	Eastern Red Cedar
Lobelia cardinalis	Cardinal Flower
Phragmites australis	Common Reed
Pluchea purperascens	Annual Salt Marsh Fleabane
Polygonum punctatum	Water Smartweed
Rosa multiflora	Multiflora Rose
Rubus L.	Blackberry species
Scirpus robustus	Salt Marsh Bulrush
Solidago graminifolia	Grass-leaved Goldenrod
Solidago sempervirens	Seaside Goldenrod
Solidago sp.	Goldenrod species
Spartina alterniflora	Smooth Cordgrass
Spartina patens	Salt Hay Grass
Toxicodendron radicans	Poison Ivy
Typha angustifolia	Narrow-leaved Cattail
Unknown sprout	

Unknown upland plant	

The Mayo Creek marsh upstream of the tidal restriction contains a vegetation community dominated by the invasive Common Reed, or *Phragmites australis* (Figure 1). Phragmites exhibited percent vegetation cover of nearly 55% (Table 3), which is more indicative of a brackish or fresh marsh. A healthy salt marsh typically has a high abundance of halophytes such as *Spartina alterniflora*, *Spartina patens*, and *Distichlis spicata*. Another observation worth noting is the high abundance of bare ground and dead plant material (Figure 1).

Table 3. Most abundant plant species in Mayo Creek marsh, July 2010.

Genus	***Species***	**Total Cover**	**Normalized % Cover (%)**
Achillea	*millefolium*	2	0.1
Agropyron	*pungens*	9	0.4
Agrostis	*stolonifera*	84	3.9
Aster	*novi-belgii*	3	0.1
Atriplex	*patula*	4	0.2
Baccharis	*halimifolia*	83	3.8
Impatiens	*capensis*	120	5.5
Juncus	*gerardii*	45	2.1
Juniperus	*virginiana*	25	1.2
Lobelia	*cardinalis*	7	0.3
Phragmites	***australis***	**1193**	**54.9**
Pluchea	*purpurescens*	4	0.2
Polygonum	*punctatum*	4	0.2
Rosa	*multiflora*	13	0.6
Rubus	*spp.*	1	0.0
Scirpus	*robustus*	126	5.8
Solidago	*graminifolia*	94	4.3
Solidago	*sempervirens*	73	3.4
Solidago	*sp.*	2	0.1
Spartina	*alterniflora*	47	2.2
Spartina	*patens*	81	3.7
Toxicodendron	*radicans*	58	2.7
Typha	*angustifolia*	91	4.2
Unknown	*upland plant #1*	2	0.1
Unknown	*sprout*	2	0.1
Total:		2173	100.0

The section of Mayo Creek marsh that has the highest abundance of salt marsh plants is, not surprisingly, closest to the culvert (transects S1, S2 and S3), and specifically on the east side of the marsh. The vegetation on the west side of the creek is dominated by Phragmites. As is the case for all of the other transects (S4 – S10) throughout the Mayo Creek system (south of Chequessett Neck Road). Additionally, there were odd, seemingly randomly located areas of salt marsh dominated by halophytes. One such area was located north of transect S3W, between stations 60 and 120. None of this area fell within a vegetation monitoring plot, but the presence of salt marsh vegetation was noted on the field data sheets.

Although very little *Typha angustifolia* was found in our stations, there was a high abundance of it on the east side of the creek behind the ball field. The last stations on transects S4 and S5 go beyond the Phragmites boundary to where *Typha angustifolia* becomes abundant.

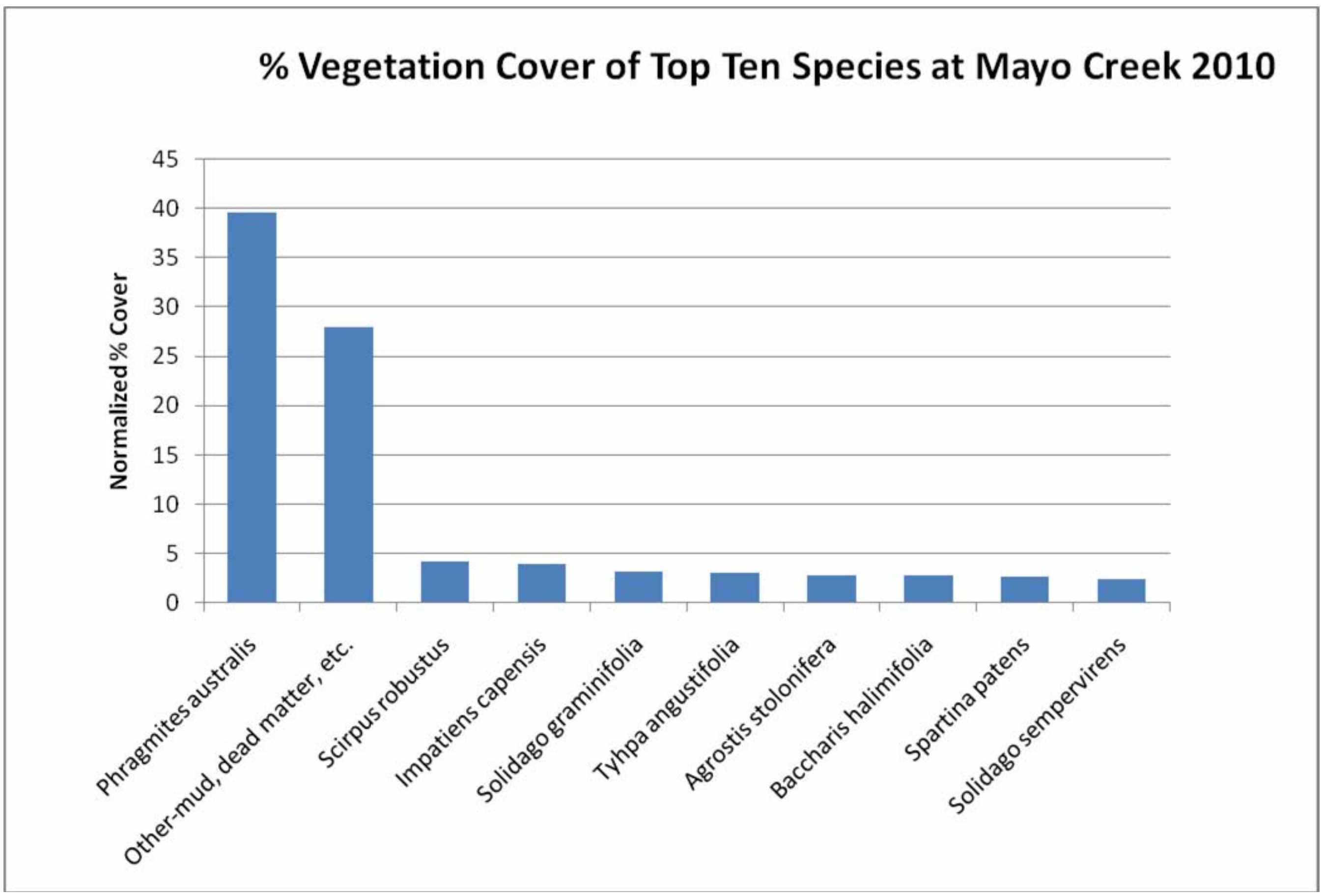


Figure 1. Percent vegetation cover of Mayo Creek plants.

Of particular interest was the abundance and height of the invasive and opportunistic *Phragmites australis* (Figure 2 and Table 4). Phragmites stem heights were measured and then averaged by location. For example, all of the Phragmites stems measured near the culvert (transects S1, S2 and S3) were averaged together to represent Phragmites abundance and height in the vegetation community closest to the tidal restriction, similarly, the heights of Phragmites measured along the transects behind the ball field (transects S4, S5 and S6) were averaged together, and the transects off the dirt road running into Chequessett Neck Road (S7, S8, S9 and S10) were averaged together. As seen in Figure 2, there is a trend of increased Phragmites height at stations located farther upstream, away from the restriction.

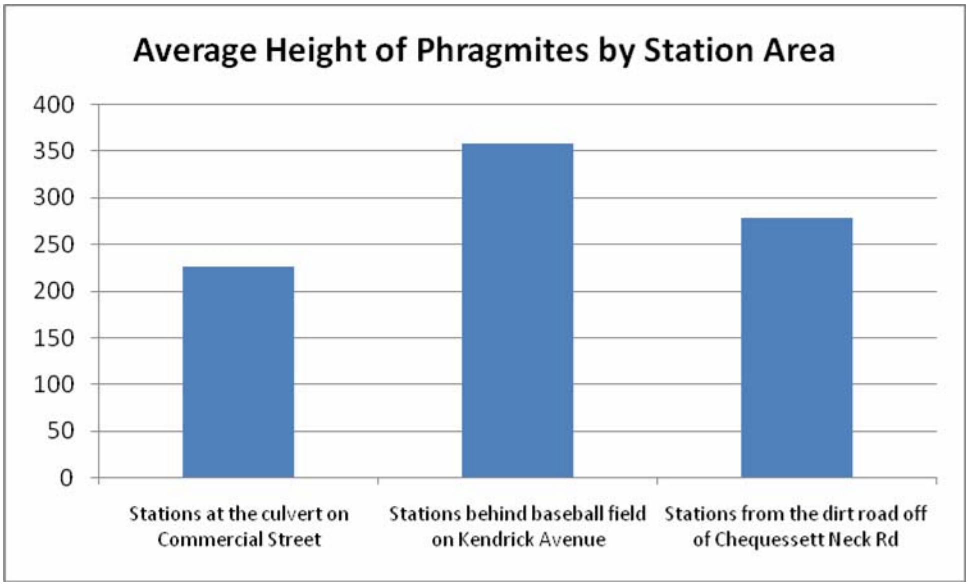


Figure 2. Average height of *Phragmites australis* in Mayo Creek.

Table 4. Average height of *Phragmites australis* per station.

Plot ID	Average Height (cm)
S1W-0	298
S1W-11	147
S2W-0	294
S2W-46	174
S3W-0	277
S3W-60	163
S3W-120	230
S4N-0	301
S4N-60	340
S4N-120	280
S5N-0	299
S5N-60	454
S6N-0	405
S6N-30	399
S6N-60	337
S7N-0	210
S8S-0	237
S9S-0	304
S10S-0	360

Ground-truthing of aerial photogrammetry of Phragmites: Using the Phragmites percent cover data obtained from monitoring stations, APCC attempted to ground-truth the aerial photogrammetry of Phragmites cover. Updated aerial photography from 2009 was obtained from Mass GIS and overlaid with GPS points representing the APCC vegetation monitoring stations. Callout boxes were used to display the percent cover of Phragmites in each station. Three maps were created, one for each of the three areas of the marsh that were monitored (Phragmites Ground-truthing Maps 2, 3, and 4). In areas of high Phragmites cover (i.e., 76% coverage or higher), aerial photographs in most cases show a distinct color change from light beige to dark brown, implying that areas of dense Phragmites can be deduced in aerial photographs. In areas with lower Phragmites cover (i.e.,55% or lower), the color is significantly lighter. When Phragmites per cent coverage is much lower, it is more difficult to detect any color change in aerial photographs. We conclude that aerial photographs may be useful for helping to identify major stands of Phragmites if aerial photographs are obtained during the time of year when vegetation is senescent or dead (i.e., when Phragmites flowering stalks are dark brown).

Physical

Surface Water Salinity

Surface water salinity was measured at most of the zero stations, which were located on the creek banks. As anticipated, there was a definite stratification in the section of the creek near the culvert (transects S1E, S2E, and S3W) with fresher water on the top and higher saline water on the bottom. The data indicate a definite decrease in surface water salinity concentrations upstream of transect S3W (Figure 3). At the time of monitoring, the creek was fairly deep with a very muddy bottom.

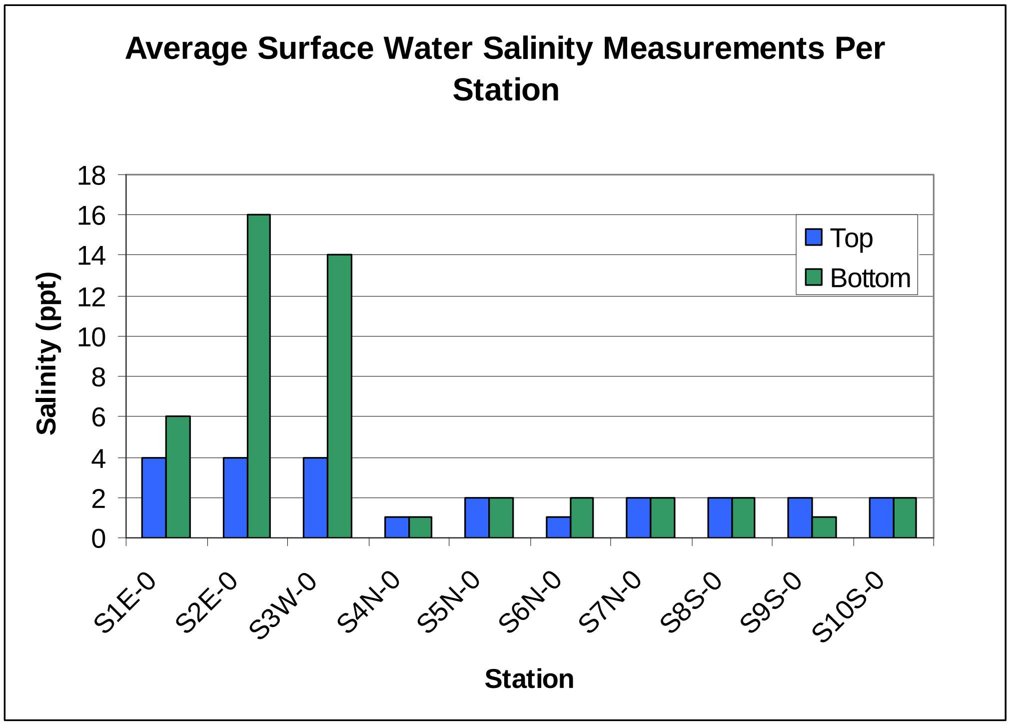


Figure 3. Average surface water salinity measurements at stations in Mayo Creek salt marsh, 2010.

Pore Water Salinity

Pore water salinity measurements were taken from 10 cm below the marsh surface. Again, a definite trend is seen where salinity concentrations fall sharply upstream of transect S3W (Fig 4). The stations S1E-14 and S1E-28 were dry the entire season; it was not possible to obtain even a single sample from the 10 cm depth at either of these stations.

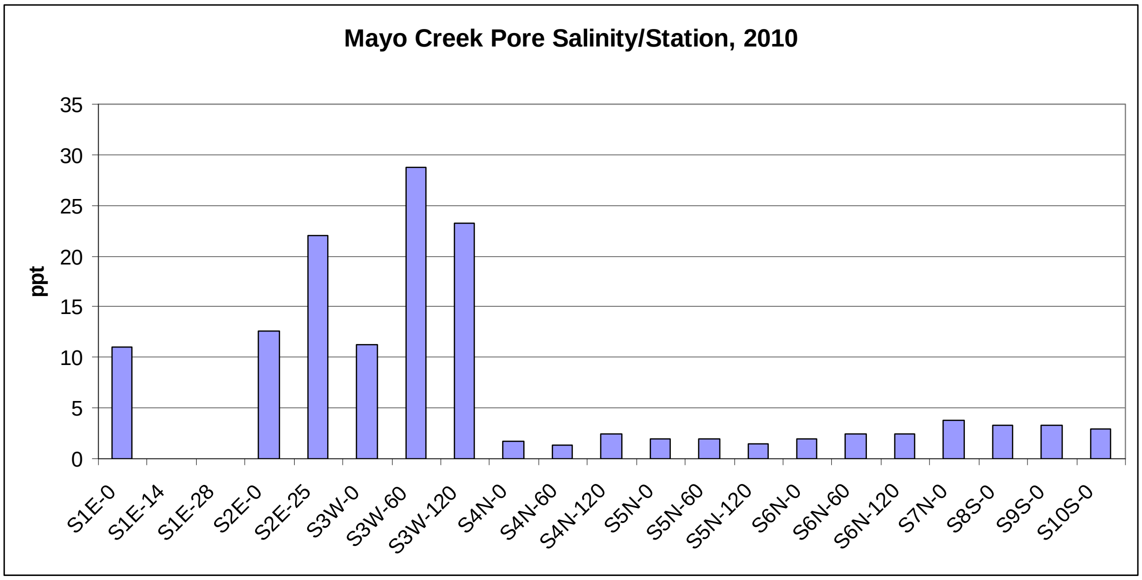


Figure 4. Average pore water salinity measurements at stations in Mayo Creek salt marsh, 2010.

Pore and surface water salinity measurements taken at Herring River in Wellfleet during the summer of 2009 were used as reference data. In Figure 5 the difference in salinity values between the unrestricted side of Herring River and the restricted side of Mayo Creek can readily be seen.

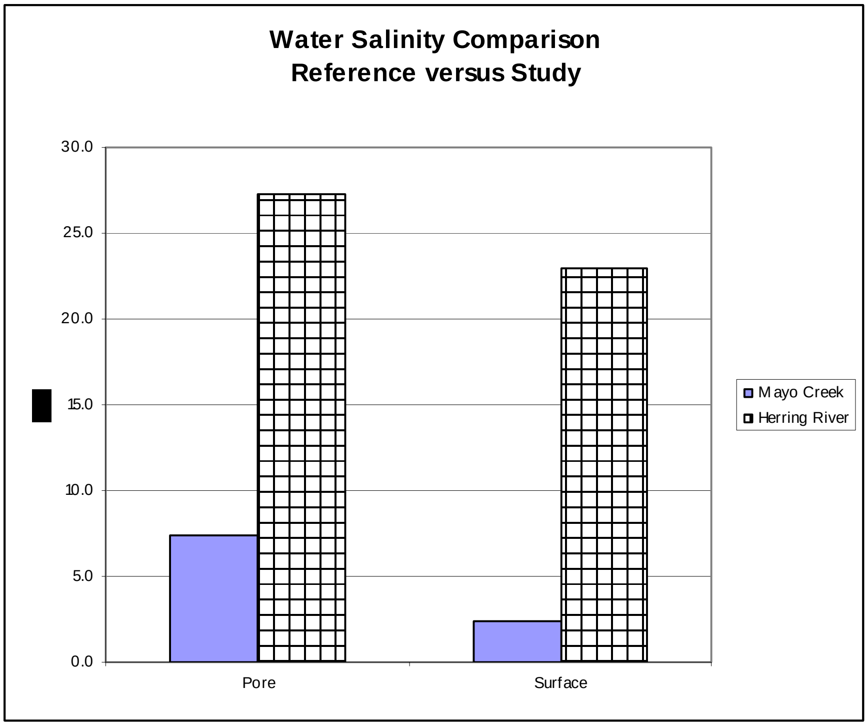


Figure 5. Herring River reference salinity data and Mayo Creek study salinity data.

<u>Water Quality</u>

Using a YSI multi-probe water quality was measured in the surface water of Mayo Creek at three stations, two on the study side and one near the culvert on the unrestricted side of the marsh. The parameters measured included temperature (Figure 6), dissolved oxygen (Figure 7), salinity (Figure 8), and pH (Figure 9).

The water surface temperature measurements show no particular pattern or trend, with the exception of a slight decrease in temperature at all sites after September 2, 2010 (Figure 6). In fact, it seems surprising that S-WQ2 station is consistently the coldest given its shallowness and stagnation.

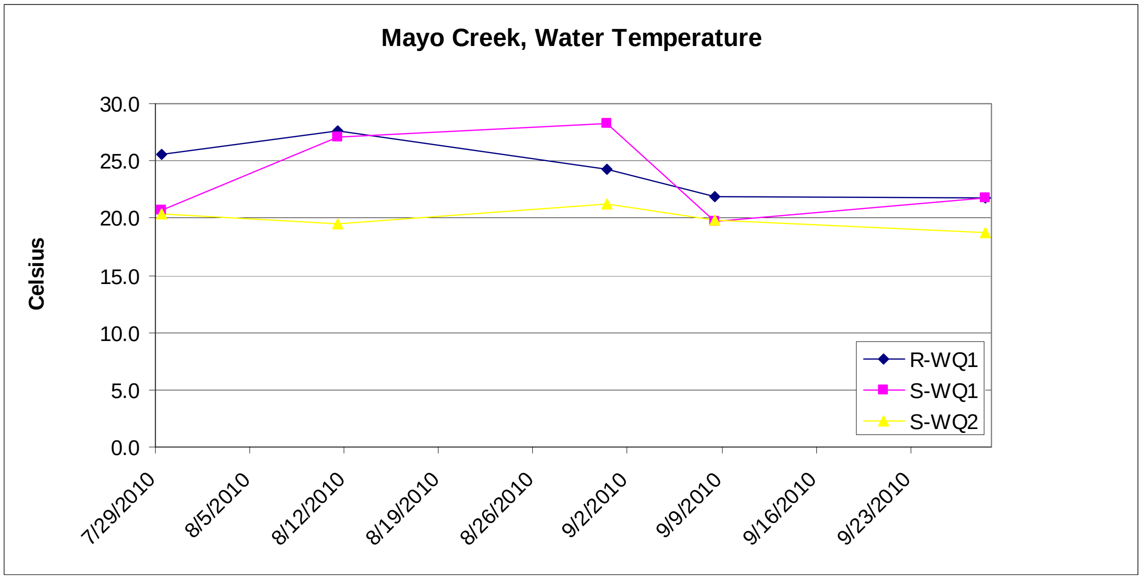


Figure 6. Surface water temperature at Mayo Creek YSI stations, 2010.

It is not surprising however, that the dissolved oxygen data at station S-WQ2 reflects dangerously low levels of dissolved oxygen in the water (Figure 7). The water level here is shallow with far more mud and muck than water. One unfortunate step off of the “board” walk by an intern demonstrated that although the water appears to be only a few centimeters deep, the muck is in fact approximately at least one meter in depth. The actual creek bottom was not determined at this station.

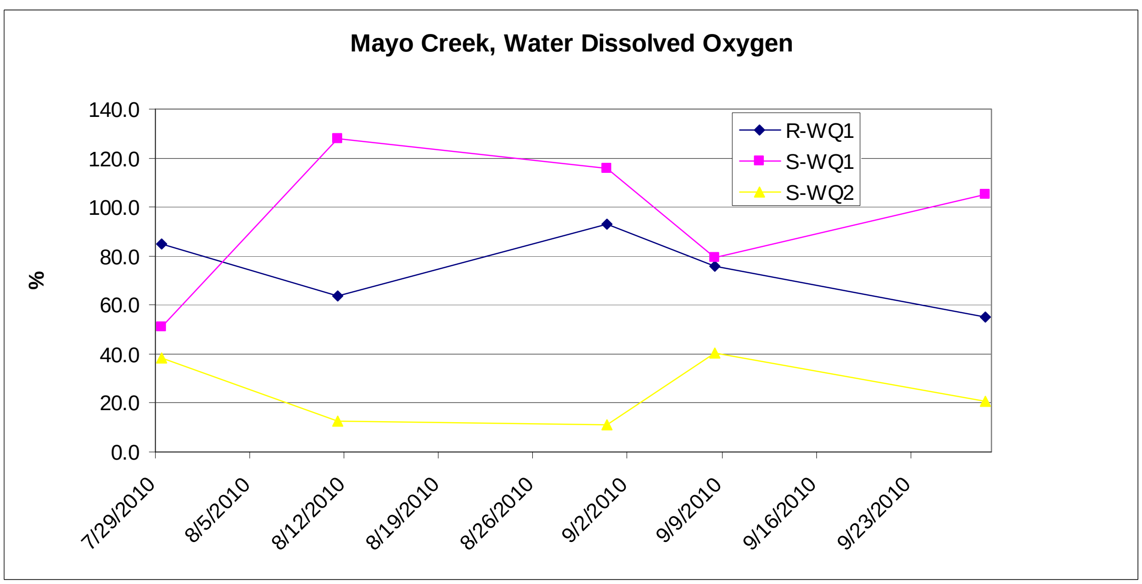


Figure 7. Surface water dissolved oxygen concentrations at Mayo Creek YSI stations, 2010.

The surface water salinity on the study (restricted) side of the marsh is lower than the salinity on the reference side of the marsh (Figure 8). The difference between the salinity at S-WQ1 (study side of culvert) and R-WQ1 (reference side of culvert) is as great as 29.2 ppt. The difference between the two study stations, S-WQ1 and S-WQ2, is minimal, ranging between two and five ppt.

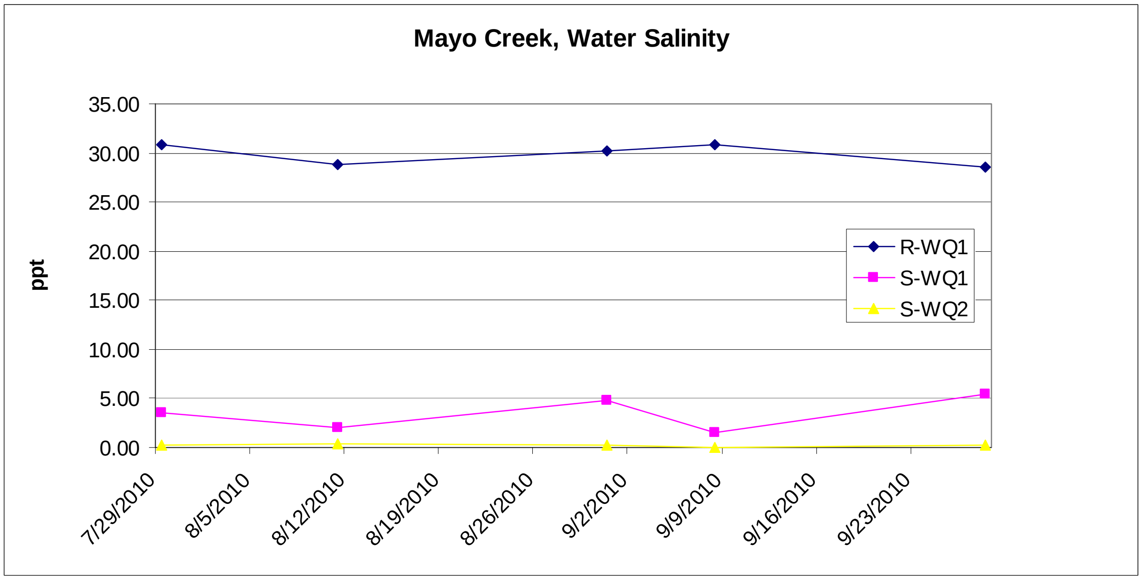


Figure 8. Surface water salinities at Mayo Creek YSI monitoring stations, 2010.

Measurements of pH at monitoring stations indicate that pH falls within a range typical of wetlands exposed to fresh and brackish water as well as seawater. Higher pH levels can be assumed to reflect seawater, which has a pH closer to 8. The pH of fresh water is typically around 7 but can be lower due to acid precipitation; ponds and lakes on Cape Cod often have a pH of 6 or so. Lower pH can also occur in salt marshes undergoing oxidation through diking or other excavation. The cause of acidification in such cases is the oxidation of iron sulfides (present in salt marsh sediments) to sulfuric acid (Portnoy, 1999). The water pH measurements at YSI stations S1 and S2 seem to be mirroring each other through out the season, where as the measurements taken at the unrestricted station, R1, are very level and consistent through out the monitoring season.

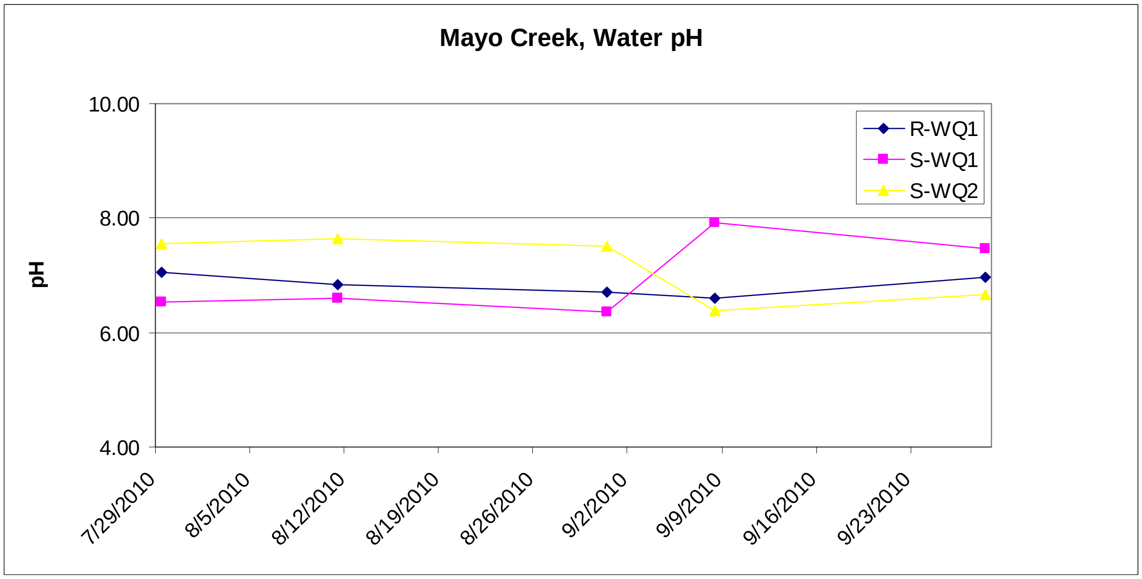


Figure 9. Surface water pH concentrations at Mayo Creek YSI stations, 2010.

Photographic Documentation

Photographs were taken at the Chequessett Neck Road intersection with Mayo Creek because this area is the uppermost region of the Mayo Creek marsh. Photographic documentation of this area will prove to be useful to document any vegetation community change that may occur. The area was extensively overgrown with invasive species (e.g., bittersweet). Photographs are in Appendix B and will also be burned onto a DVD and mailed via the US postal service.

Photographs were also taken at the sites off the dirt road access running into Chequessett Neck Road. These photographs show the stations which consist solely of Phragmites. These photographs also show the standing water left behind on the marsh surface after Hurricane Earl swept through New England late in August 2010.

Due to several camera malfunctions, photographs of the other stations were not taken. However, photo documentation of the area behind the baseball field and the culvert area of the study side of the marsh will be done in July of 2011 and sent to the Town of Wellfleet.

Conclusion

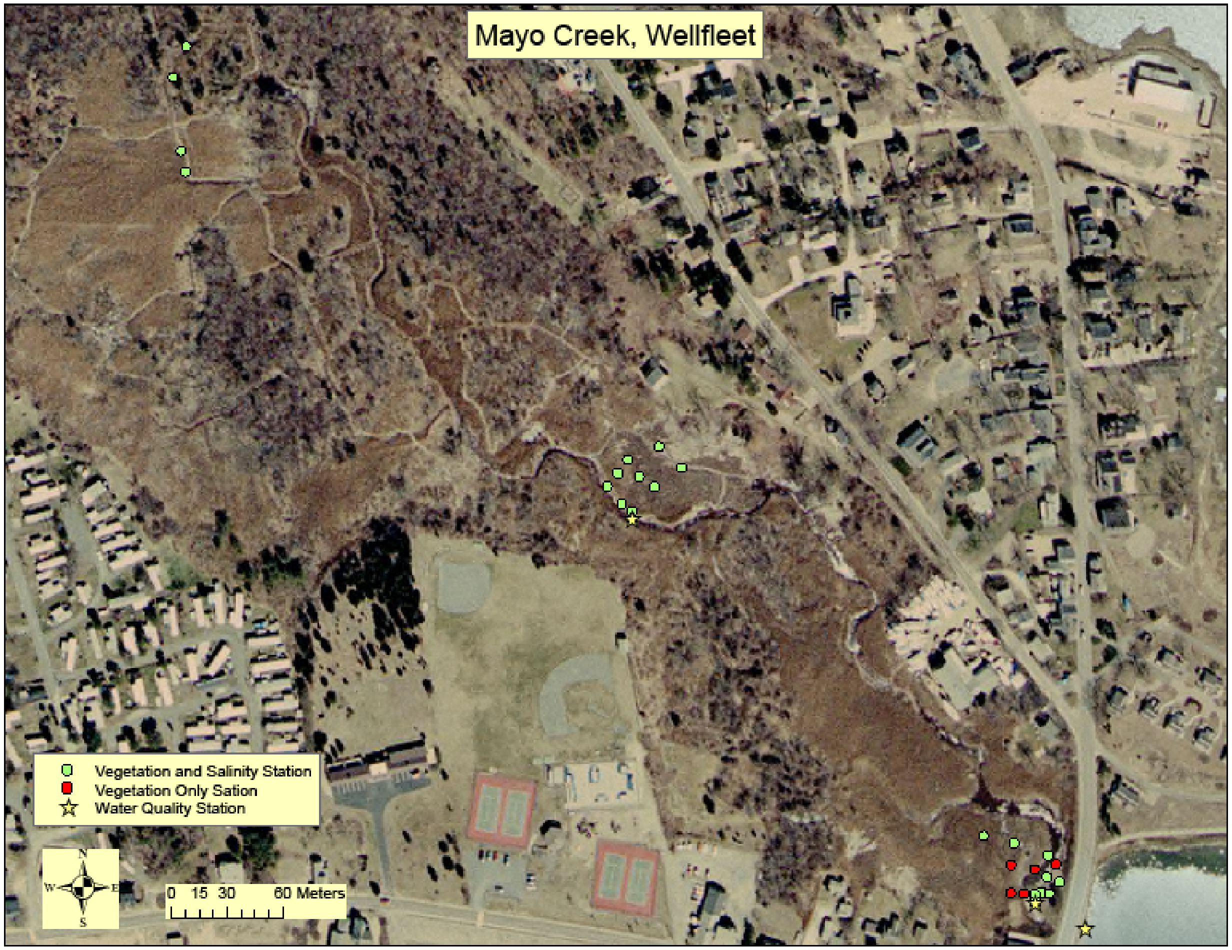
Mayo Creek marsh exhibits severe degradation from years of tidal restriction. The 70 years of tidal restriction has substantially reduced tidal flushing, reduced salinity, promoted colonization by non-native and freshwater plant species, and reduced abundance of salt marsh plants. This is evidenced by the vegetation community composition which indicates that the marsh supports a higher abundance of freshwater and brackish plants than halophytes. The top five most abundant plants in Mayo Creek are *Phragmites australis* (55%), *Scirpus robustus* (6%), *Impatiens campensis* (6%), *Solidago graminifolia* (4%), and *Typha angustifolia* (4%).

The tidal restriction is also evident from the large difference in surface water salinity between the upstream study side and the reference site. The surface salinity concentrations on the study side, both close to the restriction and far upstream from it, are markedly lower than the reference salinity measurement. Additionally, both the surface water and pore water salinity measurements taken at Mayo Creek are substantially lower than the measurements taken on the reference side of nearby Herring River in Wellfleet. These salinity trends indicate that some but not much salt water is coming through the restriction and that the marsh will likely respond quickly to an increase in tidal flushing

Aerial photography is useful for identifying Phragmites when there are high concentrations of the plant and ground-truthing has been done. However, in cases where the Phragmites percent cover is low, aerial photographs are not as definitive and on-the-ground monitoring will be necessary to get accurate percent cover data. The ability to use aerial photography to identify and map Phragmites stands would be useful. The Mayo Creek marsh is difficult and dangerous to access due to deep mucky, boggy soils that in most cases preclude either the use of a boat or walking across the surface of the marsh (unless the surface is frozen solid). Due to the inaccessible nature of most of the wetland for reasons described above, delineation of the boundaries between salt marsh, brackish marsh and shrub swamp was not feasible. It is likely that many decades of growth and decay of Phragmites organic material has contributed to the deep organic muck in this basin.

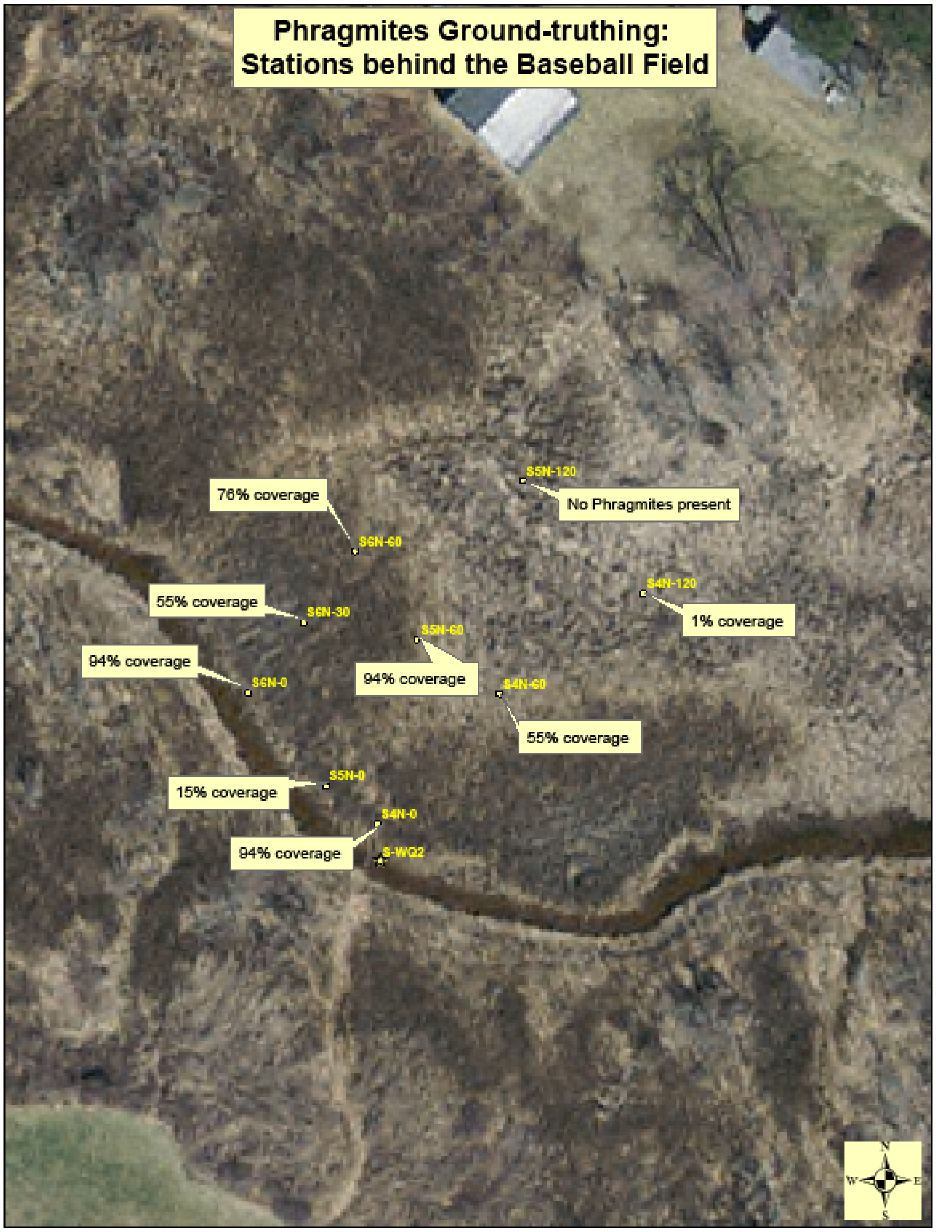
Appendix A – Maps

Map 1. Mayo Creek stations



Map 2. Phragmites cover at stations on the study side near the culvert.

Map 3. Phragmites cover at stations on the study side behind the baseball field.



Map 4. Phragmites cover at stations on the study side off of the dirt road.

Appendix B – Photographs

Photograph 1. View from Chequessett Neck Road looking east.

Photograph 2. View from Chequessett Neck Road looking north.


Photograph 3. View from Chequessett Neck Road looking north.

Photograph 4. View from Chequessett Neck Road looking south.

Photograph 5. Station S7N-0.

Photograph 6. Station S8S-0.

Photograph 7. Station S9S-0

Photograph 8. Station S10S-0

References

Portnoy, John W. 1999. *Salt Marsh Diking and Restoration: Biogeochemical Implications of Altered Wetland Hydrology*, Environmental Management Vol. 24, No. 1, pp. 111-120.