Old Creek Salt Marsh Assessment and Management Plan for Salem State University

Phase III: Restoration Assessment and Strategy

Report: June 30, 2011 – Salem Sound Coastwatch

EXECUTIVE SUMMARY – Old Creek Salt Marsh

During the past two years, Salem Sound Coastwatch working with Salem State University professor Dr. Alan Young and his students, and community volunteers has conducted monitoring of the Old Creek Salt Marsh to provide a body of knowledge on the relative biological health of the marsh. This information may be used to track any future changes in the biotic communities and to determine management activities.

Although the Lincoln Road culvert is a tidal restriction for the marsh, salinity assessments of the marsh sediments pore water and Old Creek show that the marsh is receiving a level of salinity to sustain healthy salt marsh functions. The marsh's ability to absorb water and serve as a biofilter for the area's water quality benefits the adjacent neighborhoods and campus.

While stormwater is not having a direct negative impact to the marsh proper, it does appear to be enhancing the environment for invasive plants to become established and spread. Recommendations have been made to address some of the stormwater runoff from the campus parking lots in particular and to control invasive species in the upland buffer areas.

Despite being located in an urban environment, the marsh plays a critical role in providing a refuge for diverse wildlife, including fish, crustaceans and wading birds. Egrets and herons regularly visit the marsh to feed on the plentiful fish, shrimp, clamworms and amphipods that live in the water and vegetation.

With continued stewardship by Salem State University, Salem Sound Coastwatch and community volunteers, Old Creek Salt Marsh will continue to be a healthy refuge from the surrounding urban environment.

Under the Phase III Scope of Work agreement between Salem Sound Coastwatch (SSCW) and Salem State University, SSCW conducted seasonal monitoring from August 2009 through June 2011. SSCW has trained, supervised and employed Salem State students to conduct the marsh monitoring based on protocols detailed in the Volunteer Salt Marsh Monitoring Manual.[1] SSCW, working with Dr. Alan Young and his students, have generated a body of knowledge that sets an ecological baseline for the campus' Old Creek salt marsh. As restoration activities take place and biotic communities change over time, this baseline will provide a measurement to track changes. The following report discusses how the project goals have been met and how environmental stewardship of the Old Creek Salt Marsh can continue.

Project Goals:

1. Provide a biological and hydrological inventory for the Old Creek Marsh
2. Develop a plan to guide management activities and restoration needs
3. Foster environmental stewardship within the community

1: Land Use and Resource Mapping

The resource area has a long history of industrial use, and thus it is important to understand the past uses as well as the current surrounding land use. Sasaki Associates documented the drastic improvements made to the marsh and surrounding area since industrial solid wastes were deposited in these historic tidelands.[2] From1936 to 1997 when the University acquired the property, it was owned by various companies starting with Hygrade Incandescent Lamp Company, which at one time produced 16,000 lamps per day before being bought by Sylvania Electric Products. Several mergers resulted in General Telephone & Electronics (later known as GTE) owning the marsh and land that now hosts two Salem State University dormitories.

[1] Available at http://www.mass.gov/czm/volunteermarshmonitoring.htm

[2] Sasaki Associates. 2008. Salem State College: Inventory, Assessment and Monitoring Methodology for Old Creek Salt Marsh. Salem, Ma.

From1936 to 1983, the area outlined in orange in the image below was a landfill for manufacturing wastes. From 1979 to 1983, surface water quality tests revealed pollutants and solid waste dumping from light bulb manufacturing ceased in 1983.

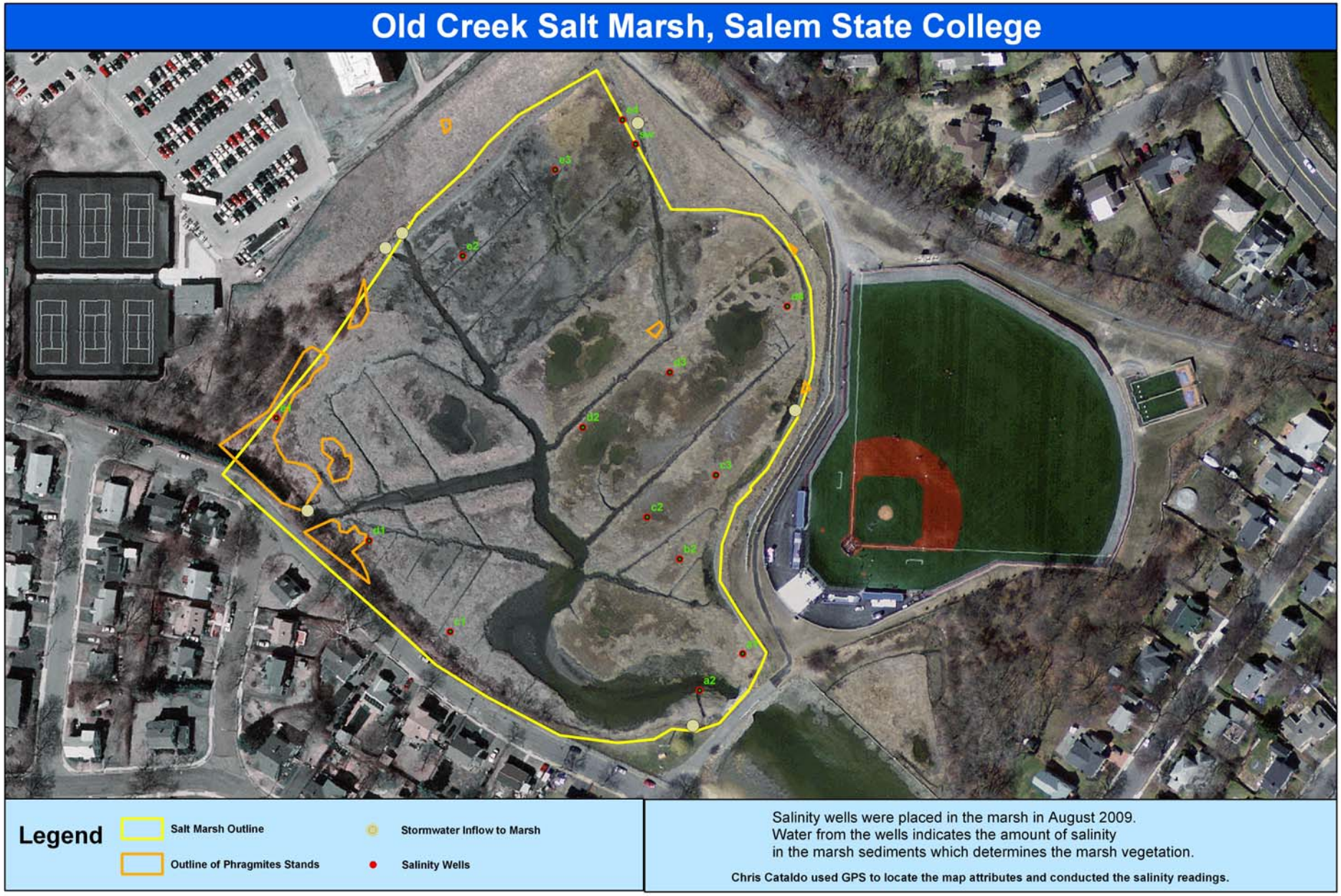
The orange line outlines landfill of solid waste deposited between 1936 and 1983 in the marsh.

Osram Sylvania developed plans to cap the landfill to prohibit the movement of landfill pollutants into the groundwater in 1992-1993, and a section of the marsh was restored by partial excavation, regrading and planting in 1996. The University acquired the property in 1997.

The Old Creek salt marsh is now surrounded by urban land use, consisting of homes, conservation land, a small park, a bike path and of course, the Salem State University Central Campus.

SSCW hired Chris Cataldo, a Salem State Biology student, to map the marsh resources. Chris used Salem State University's Trimble GeoXT GPS unit and worked with Dr. Marcos Luna, Geography Department (GIS), to delineate the wetland resource area and the adjacent upland border between the dormitory and the marsh. He also mapped the areas of the invasive species, *Phragmites australis* (common reed) and located stormwater inflows. Aerial photographs were acquired from the MassGIS website (MassGIS.gov) to accurately construct a map of the study area by uploading the GPS data to ArcMap. The margin of error of approximately 2 meters was adjusted in ArcMap.

Figure 1. Wetland Evaluation Area at Old Creek Salt Marsh. mapped by Chris Cataldo.



2: Hydrologic Assessment

Located in the Salem Sound watershed, the Old Creek Salt Marsh is part of the Forest River Estuary, which flows into Salem Harbor at Lafayette Street. Old Creek is tidally influenced and receives fresh water inputs from Salem State University's Central Campus surface runoff as well as the City of Salem's stormwater drainage infrastructure. Old Creek is tidally restricted at the Lincoln Road culvert. However, to replace the Lincoln Road culvert would require extensive design, engineering and permitting and would be a very expensive project. Extreme care would be needed to avoid increasing potential flooding to the campus and local neighborhoods as is evident from the photo of the marsh during a 2006 storm tide event.

Old Creek Salt Marsh at Flood Stage, January 31, 2006. Photo credit: Barbara Warren

3: Water Chemistry: Surface and Groundwater Monitoring

Fifteen shallow ground water wells were installed in the marsh to measure pore water salinity, and salinity readings were taken from the wells and the creek. The following page has a map of the well locations and average salinity readings for each well. Students installed the wells and used a refractometer to measure salinity in parts per thousand (ppt). The wells are inserted into the ground 16 inches so that the water in the sediment pores can be measured. This shows what the plant roots are absorbing.

Pore water well

Salem State students, M. Rolo and C.Cataldo, set salinity wells.

Salinity is considered the most important chemical parameter in salt marshes and can explain the diversity, distribution, and abundance of plants and animals in a marsh system. Brackish to fresh water marshes have salinities of 18 ppt to 0.5 ppt, while salt marsh plants have adapted to salinities as high as 35 ppt.[3]

Data collected over two summers indicate that the average salinity in the marsh sediments ranges between 24 and 32 parts per thousand (ppt). The lowest readings were at well E1, which is located in the northwest corner at the edge of the largest *Phragmites australis* stand, an invasive common reed (see the following page for map). The average salinity at E1 was 18 ppt, a level *Phragmites* can easily tolerate (page 15).

Salinity measurements taken from Old Creek upstream of the Lincoln Road culvert show more dynamic fluctuations than the marsh sediments. The measured creek salinity varied from 5 to 30 ppt depending on the tidal cycles and weather conditions. Salinity readings were highest on a flood tide and estuarine water was refilling the marsh.

[3] Tiner, R.W. Jr. 1987. A Field Guide to Coastal Wetland Plants of the Northeastern United States. The University of Massachusetts Press, Amherst, MA.

Figure 2. Salinity wells at Old Creek Salt Marsh; by C. Cataldo.

Average Salinity (18 sampling days)	
Well	***PPT***
A1	**27.3**
A2	**24.8**
B2	**29.9**
C1	**28.1**
C2	**29.9**
C3	**25.9**
D1	**24.5**
D2	**30.6**
D3	**32.1**
D4	**23.9**
E1	**17.9**
E2	**27.1**
E3	**26.5**
E4	**31.6**
SW	**27.6**

Table 1. Average salinity readings at Old Creek Salt Marsh; September 2009 & August 2010

Stormwater Assessment

The marsh receives inflows from four stormwater drains, which have been located using GPS and mapped – see Figure 1. The major stormwater input comes during high stormwater events when water is diverted to the Forest River through the Rosie's Pond Bypass to prevent flooding in the downstream reaches of the South River. This bypass flows into the marsh south of the dormitories, in the northwest section of the marsh boundary via two culverts pictured below. This is fully explained in the City of Salem's South River Drainage Report.[4]

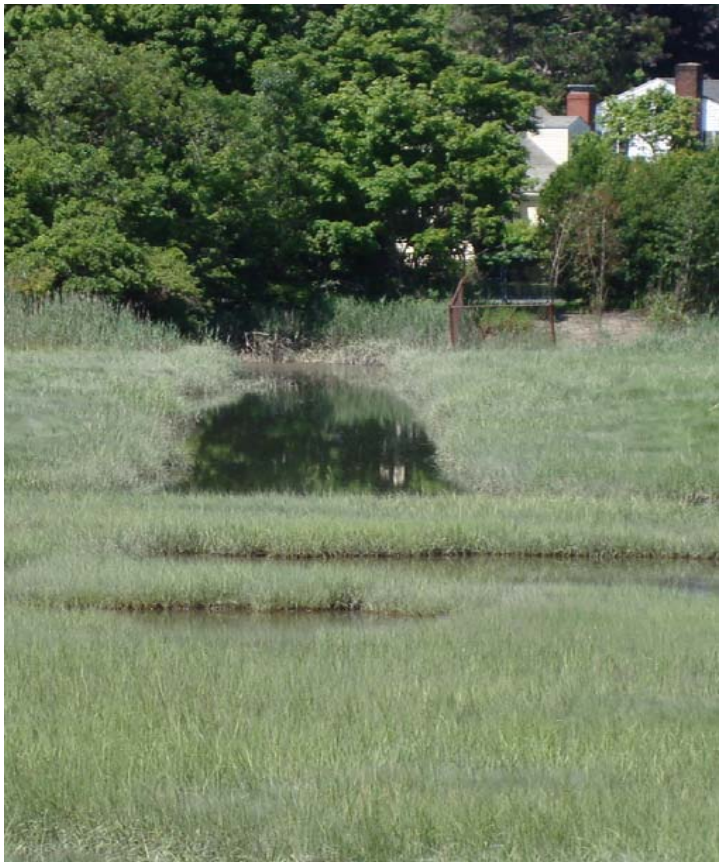
Two culverts discharge water into the marsh.

Stormwater flows from Rosie's Pond Bypass into the channel then to the Forest River estuary.

[4] Phase I Report for the South River Drainage Project. Prepared for the City of Salem, 4/9/2007 by Woodard & Curran
http://www.salem.com/Pages/SalemMA_Engineer/southriverreport.pdf

The next largest stormwater input is from the residential neighborhood of Cleveland and Monroe Roads located on the western side of the marsh. A Vortech stormwater treatment system[5] was installed in Cleveland Road in 1999. At this time, the City of Salem had the marsh ditch dredged to remove sediment that had built up from stormwater runoff. Heavy machinery was driven onto the marsh and the dredged material was left on the marsh for an extended length of time, which left large areas of the marsh devoid of vegetation. While some of the dredge pile was removed, this area is still elevated enough to have encouraged a stand of the invasive common reed, *Phragmites australis* (mapped as Stand E on Figure 3, page 17).

In June of 2009, with permission from the Salem Conservation Commission, the Northeast Massachusetts Mosquito Control and Wetlands Management District conducted maintenance dredging of the same ditch that drains stormwater from Cleveland and Monroe Roads. The Vortech stormwater treatment system installed in 1999 was also cleaned at this time. This time all dredge spoils were removed from the marsh, and the vegetation was not impacted as can be seen in the photograph to the right.



Marsh ditch receives stormwater from Cleveland and Monroe Roads

[5] *Vortech* system is a hydrodynamic separator that uses gravity separation to reduce suspended matter and target pollutants from storm water.

There are two additional smaller stormwater inflows to the marsh. One is in the southwest corner of the marsh at the intersection of Monroe and Lincoln Roads and appears to drain road runoff. There is also drainage from the baseball field into the upland buffer edge on the southeast side of the marsh. This is an area where invasive species such as *Phragmites australis*, Oriental bittersweet and pepperweed have become established. Initially, it was thought that there was another stormwater inflow to the marsh and a monitoring well (labeled SW on Figure 2) was put near this culvert. Average reading for SW was 27.6 ppt and it was later learned that this does not connect to a storm drain system.

Although the marsh has four direct stormwater inflows (marked on Figure 1), it appears that freshwater input currently is not having a strong influence on the salt marsh sediments, instead flowing into the marsh drainage ditches. Four times salinity readings were taken after heavy rainstorms (either on the same day as the rain or the day after - 9/13/09, 6/4/10, 7/11/10, 7/24/10). The average salinity of the wells did not show an influx of freshwater but remained high, 29, 25, 25 and 26 ppt respectively, while the creek always had the lowest salinity readings, 10 to 13 ppt.

However, freshwater, sediments and nutrients discharge directly to the marsh from storm drains and overland flows, particularly during rain events or snow melt. This stormwater input may result in excess sediments and nutrients, which have the potential to alter the topography and degrade water quality of the marsh. This in turn may create conditions that facilitate the establishment of invasive species, which will be discussed in the following section on vegetation.

4: Vegetation Surveys

Vegetation in the marsh was sampled in August 2009 and 2010 using one-meter^2 quadrats along five transects that were set to achieve an accurate assessment of the entire marsh. Transects ran from marsh creek to riprap edge following the well transects.

C. Cataldo and E. Gardiner record vegetation in the quadrat while Dr. Alan Young and M. Rolo work on another transect near the marsh edge.

Plants were identified to species, and percent coverage was recorded. The dominant plant in Old Creek Salt Marsh (2009-2010) was *Spartina alterniflora* (smooth cordgrass) at 44% - 47% with *Spartina patens* (salt marsh hay cordgrass) next at 27 – 31% and *Distichlis spicata* (spike grass) 20 to 22%.

The tall thick green plant is *Spartina alterniflora*, while the thinner grasses are *Spartina patens* (upper middle) and *Distichlis spicata* (bottom right) as seen in one of the sampled quadrats.

All other species were at or below 3% of cover but are important in the salt marsh vegetation diversity. The U.S. Fish and Wildlife Service National List ranks a species relative affinity to hydric (wet) conditions, and the New England Institute for Environmental

Studies Plant Community Indicator Database ranks a species tolerance to saline conditions.[6] Based on these ratings and the vegetation observed during monitoring, it is clear that the Old Creek Salt Marsh has a high tolerance to salinity and wetness.

Species richness has increased slightly since Salem Sound Coastwatch conducted vegetation monitoring at the marsh prior to this study in 1999, 2000 and 2001. Although the same monitoring protocols were used, different transects were sampled. *Phragmites* was present in the marsh borders in 1999 – 2001 but was not recorded because the transects at that time ran only 300 feet from Lincoln Road culvert whereas the transects in the latest sampling covered the entire marsh area. *Limonium nashii* (sea lavender) and *Iva frutescens* (marsh elder) grow in the high marsh upper borders and are new species, not seen in the earlier surveys. *Juncus gerardii* is now well established in the higher salt marsh areas.

1999	2000	2001	2009	2010
Spartina alterniflora	*Spartina alterniflora*	*Spartina alterniflora*	*Spartina alterniflora*	*Spartina alterniflora*
Spartina patens	*Spartina patens*	*Spartina patens*	*Spartina patens*	*Spartina patens*
Atriplex patula	*Atriplex patula*	*Atriplex patula*	*Atriplex patula*	*Atriplex patula*
Distichlis spicata	*Distichlis spicata*	*Distichlis spicata*	*Distichlis spicata*	*Distichlis spicata*
	Juncus gerardii			*Juncus gerardii*
Salicornia europaea	*Salicornia europaea*	*Salicornia europaea*	*Salicornia europaea*	*Salicornia europaea*
Suaeda linearis	*Suaeda linearis*	*Suaeda linearis*		*Suaeda linearis*
			Limonium nashii	*Limonium nashii*
			Iva frutescens	*Iva frutescens*
			Phragmites australis	*Phragmites australis*

Table 2. Species richness of marsh plants found over five years of sampling.

The movement of border marsh vegetation onto and above the riprap edge that was constructed during the 1996 marsh restoration is very interesting and is worth continued study. *Limonium nashii*, *Iva frutescens*, *Juncus gerardii* (black grass) and *Solidago sempervirens* (seaside goldenrod) are colonizing above the riprap, while in the picture to the right, *Spartina alterniflora* is well established over the rip rap. Notice that it is next to a pool so it has a ready source of high salinity water.

[6] Wetland Ecological Integrity: An Assessment Approach. 1998 http://www.mass.gov/czm/wetlandecologicalintegrity.pdf

Phragmites australis is well established in the northwest corner of the marsh.

Invasive plant species in the marsh and its buffer have been documented.

C. Cataldo mapped all stands of *Phragmites australis* (common reed) in August 2009 using GPS and created a map, Figure 3. *Phragmites australis* grows in large monoclonal stands and spreads by rhizomes and windblown seeds. It is commonly found in wet soils near marshes and has the ability to grow up to 4 centimeters per day (Shay and Shay 1986). This gives *Phragmites* the ability to drastically alter its habitats by shading out native plants, exploiting nutrients and altering the hydrology by trapping sediments, which creates a drying effect. Large stands of *Phragmites* provide little or no shelter for wildlife. Its rhizomes have been found to reach depths of 2.5 meters (Sherff 1912) below the soil surface, which enables *Phragmites* to regenerate quickly when cut or burned. However, *Phragmites* does not tolerate high salinities. Growth typically becomes a problem when salinities reach 26 ppt. (Warren et al. 2002).

Heights of *Phragmites* within each stand were measured and were found to vary depending on where they were located in the marsh. Stand E had the shortest average height of 170 cm. Averages for stands A through D were 195 cm, 324 cm, 311 cm, and 253 cm, respectively.

The majority of the *Phragmites* is located along the edge of the marsh in Stands B, C and D in the western corner. Removal of *Phragmites* from this area was attempted during the 1996-97 salt marsh remediation. The soil was covered with black plastic to prevent plant growth, but the stand was not eliminated.[7] Discussion of *Phragmites* control will continue in the "Recommendation" section. Stands B, C and D are now the largest stands within the marsh and stem heights ranged from an average of 324 to 253 cm. The well in this area (E1) had the lowest salinity readings of the 15 monitoring wells with an average of 18 ppt. The area is elevated from the marsh platform, and freshwater surface runoff is most likely coming form the campus parking lot, tennis courts area and Monroe Road. Stand E is nearby but farther out in the marsh. It appears to be a slightly elevated area from dredging material being left on the marsh when the Monroe Road stormwater ditch was excavated pre-2009.

There are also two other stands of *Phragmites* that were not mapped until 2010 and are indicated in white on Figure 3. One is directly in the marsh on a small rise. As the marsh subsides or sea levels rise, this small area of *Phragmites* may disappear, but it should be monitored annually in the fall to confirm that it is not spreading. The other area is marked with an R on the map on the next page and is located in the buffer area between the salt marsh and the baseball field.

[7] Sasaki Associates. 2008. Salem State College: Inventory, Assessment and Monitoring Methodology for Old Creek Salt Marsh. Salem, Ma.

Figure 3. *Phragmite australis* stands in Old Creek Salt Marsh mapped with GPS by Chris Cataldo.

Stand A, the isolated patch of *Phragmites* in the upland buffer behind Atlantic Hall was mapped by C. Cataldo, seen below at work. Stem heights at this stand averaged 195 cm. Since water with salinities high enough to kill off the *Phragmites* will never reach this area, other means of removal should be undertaken.

The other area of concern is in the buffer area between the ball field and the rock riprap, upper marsh border (labeled R in Figure 3 and pictured on the right). The *Phragmites* in this buffer area is also well above the reach of salt water, and therefore it should be expected to continue expanding in this area. The "Recommendation" section will discuss *Phragmites* removal for Stands A and R.

Another invasive species, *Lepedium latifolium* (perennial pepperweed), was found below the baseball field above the marsh edge and rock riprap. In 2009 and 2010, SSCW directed Salem State University and Upward Bound students to hand pull the visible pepperweed and dispose of the plants in black trash bags. These areas of pepperweed were small and controlled by repeated hand-pulling. Perennial pepperweed plant, root and seeds are salt-tolerant, which makes it a real threat to the upper marsh regions. To prevent its spread, hand pulling in June and again in September is recommended.

Lepedium latifolium (perennial pepperweed) found along the marsh edge and pulled and removed by SSCW summer interns on June 22, 2011.

The following invasive plants are also growing in the upland buffer between theball field and the rock riprap, upper marsh border:

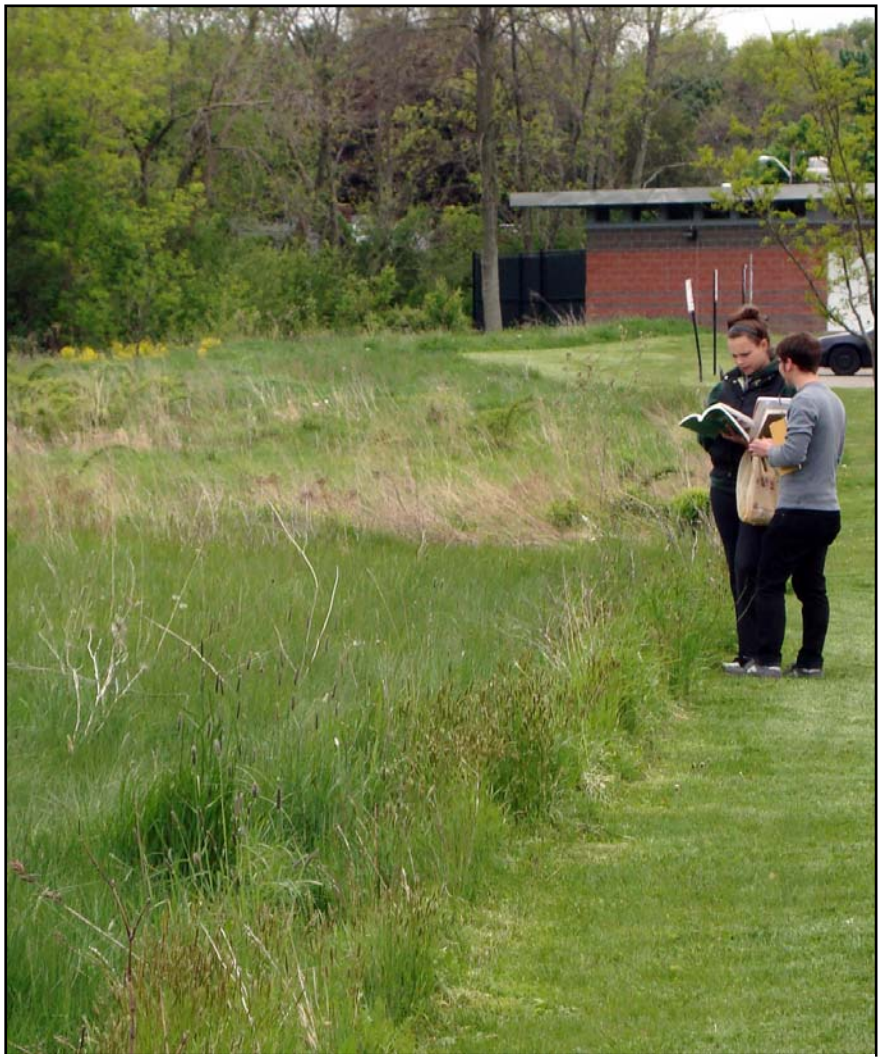
Celastrus orbiculatus (Oriental bittersweet)
Rosa multiflora (multiflora rose)
Phragmites australis (common reed)

Rosa multiflora (multiflora rose) is a thorny perennial shrub with arching stems. *Celastrus orbiculatus* (Oriental bittersweet) is a deciduous, twining and climbing woody vine that can grow up to 60 feet in tree crowns, form thicket and arbor infestations. Manual, mechanical and chemical methods can be employed to control both and will be covered in the “Recommendation” section.

Celastus orbiculatus (Oriental bittersweet) *Phragmites australis* (common reed)

Many non-invasive plants have become established in the upland buffer below the baseball stadium. Below is a large stand of milkweed, which is a necessary food for Monarch butterflies. Also, a juniper tree can be seen on the right of the photo taken in June 2011.

Vegetated Upland Buffer Between the Campus and the Marsh



Salem State students, J. Mistretta and B. Baskette, identify plants.

The upland buffer between the campus parking lot and dormitories was observed over two growing seasons.

The Salem State University Salt Marsh Restoration and Management Plan, prepared by Sasaki Associates dated 12/18/08, made recommendations for management activities associated with LEED-EB 2.0 SSc4.1 / SSc4.2. A suggestion was made to plant the upland edge with native woody vegetation that would provide habitat for wildlife and help trap litter that blows across the parking lot into the salt marsh, but it was also noted that because the soil is fill, previous planting attempts resulted in low survival rates. If planting is done, Sasaki Associates recommended fitting trees with water bags during their first growing season and hand watering shrubs during periods of drought.

Currently a 100-foot buffer around the marsh edge is not mowed. The maintenance plan was a single mow per year but for the past few years, it appears not to have been mowed except for the 10 -15 foot border on the marsh side of the fire road that is mowed the same as any other lawn on campus.

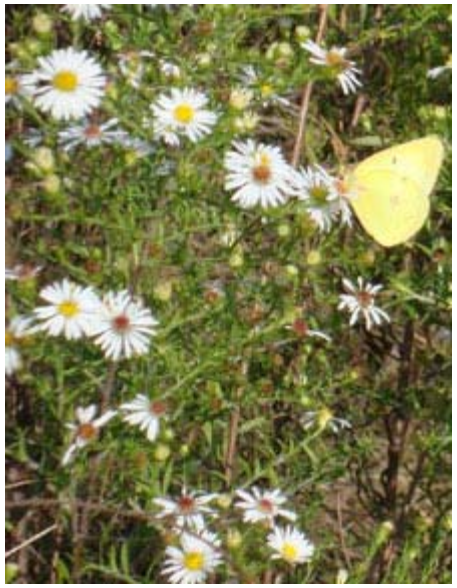
Surveys of the area where conducted in the spring of 2010 and 2011 as well as in the fall of 2010. The buffer consists of a mix of grasses and perennial flowers, shrubs and small trees. There is actually an amazing diversity of plants growing in this area and would be a great project for Salem State botany classes to do inventories and begin an herbarium.

Timothy grass is just one of the many varieties of grasses in the buffer area. Other plants include common St. Johnswort, white yarrow, Queen Anne's Lace, red clover, bedstraw, daisy, mullen, cow vetch, butter-and-eggs, thistle, and small shrub/trees such as bayberry, sumac, false indigo and locust. It has taken time for these plants to become established but despite the poor soil quality a large variety of plants have become well established, probably helped by the reduced mowing.

Tall seed heads of Timothy grass can be seen above other plants.

Yellow common St Johnswort and white yarrow blanket cover large areas of the meadow.

Bayberry



Aster species

Cherry tree variety

Chicory

Bayberry, also known as wax myrtle, (Myricaceae family) is thriving at the marsh edge as is false indigo. Cherry trees have seeded and begun to grow in several places in the buffer meadow. The lack of mowing has probably helped this species get established but could easily be eliminated by mowing. Discussion of these plants will continue in the "Recommendation" section.

False indigo shrubs are on either side of the bayberry at the marsh edge in the upland buffer area. The spikelike inflorescences become small olive fruit pods with red dots.

Lythrum salicaria (purple loosestrife)

Rosa multiflora (multiflora rose)

Polygonum cuspidatum (Japanese knotweed)

In addition to the area of *Phragmites*, three more invasive plants are in the upper buffer meadow although currently in controllable numbers. If not managed, they have the potential to spread by both roots and prolific seed production. Control will be addressed in the "Recommendation" section.

5: Nekton Monitoring

Nekton data were collected once a month in August 2009 and June, July and August 2010. Three minnow traps were set at 0ft, 150ft, and 300ft from the Lincoln Road Culvert and deployed for 2 hours on an incoming tide. Upon retrieval, all nekton were identified to species, counted, and weighed. In addition, a sub-sample of 40 of each fish species was randomly selected from each trap. The standard length of each was measured and the sub-sample was weighed. If fewer than 40 fish of a species were caught, all fish were measured and weighed.

Minnow trap set at the Lincoln Road culvert.

Mummichogs (F*undulus heteroclitus*) were the most prevalent species captured. Mummichogs are a common salt marsh fish and provide food for birds and large fishes, such as striped bass that come in with the tide.

A mummichog is being measured to the nearest millimeter. Standard length of a fish is the straight line distance from the tip of the snout to the posterior end of the vertebral column as indicated by the arrow.

Table 3 shows the species found in the five minnow trap sampling from 2009 to 2010. The average temperature of the creek water was 22^{o} Celsius, and the average salinity of the water was 26 ppt. The average standard length of all collected mummichogs was 44 mm, with a range from 21 to 78 mm. The average weight of mummichogs caught was two grams.

Nektons Species - Old Creek Marsh, Salem MA						
Scientific Name	**Common Name**	**8/12/2009**	**5/21/2010**	**6/17/2010**	**7/14/2010**	**8/11/2010**
Fundulus heteroclitus	Mummichog	107	134	6	439	90
Carcinus maenas	Green Crab	0	0	0	1	0
Pungitius pungitius	Ninespine stickleback	0	0	2	2	0
Apeltes quadracus	Fourspine stickleback	0	0	0	0	0
Crangon septemspinosa	Sevenspine Bay Shrimp	2	0	0	1	0
Palaemon elegans	European Rock Shrimp	0	0	0	0	1
Palaemonetes sp.	Grass shrimp	0	53	7	0	0

Table 3. Nekton species caught at Old Creek Marsh over two summers and five monitoring sessions

The native daggerblade grass shrimp, *Palaemonetes pugio,* was frequently captured in the minnow traps.

Daggerblade grass shrimp has yellowish eyestalks.

In August 2010, the newly discovered non-native *Palaemon elegans*, also known as the European rock shrimp, was found in a trap. The first sighting in North America of this species at Hawthorne Cove Marina took place at the end of July a few weeks before one was found in the marsh.

Note neon blue claws of the *Palaemon elegans*

In the field, this shrimp can be identified by its distinctive coloring orange or yellow spots on its body, white leg joints and neon blue claws. Its body is mostly translucent, with dark reddish-brown bands along the margins of body plates. Salem Sound Coastwatch continues to assess the population, distribution and potential ecological concerns with this new bio-invader.

In addition, SSCW staff, Salem State University students and faculty made additional fauna observations as time was spent in the marsh. For example, live *Limulus polyphemus,* horseshoe crabs, were seen in the creek during both years of observations, as well as small horseshoe crab molts. In 2000, during one of the first SSCW's macroinvertebrate sampling, a juvenile horseshoe crab (approximately 5 mm carapace width) was found and released. Although the population status of horseshoe crabs in Salem Sound is unknown, it is positive sign that they continue to be seen in Old Creek Salt Marsh.

Young horseshoe crab near Rosies Pond Bypass outfall culvert

6: Macroinvertebrate Sampling

Invertebrate sampling coincided with mid to low tide at three sample stations (0, 150, 300ft) along the creek during August, in 2009 and 2010. Three types of samples were collected at each station: an 18” x 18” quadrat samples at the top of the bank, D-net samples along the vegetated edge of the creek and auger samples in the creek bed. Samples are bagged, sorted in the lab and identified to family level.

In both years, a variety of macroinvertebrates were identified indicating the salt marsh is functioning well for marine and estuarine animals. Other than insects such as beetle and fly larvae, Nereidae (clamworms) were the most frequently collected macroinvertebrate. Clamworms were not found in an earlier survey in1999. Juvenile clams, *Mya arenaria* and *Gemma gemma* were found as well as Capitellid worms and several different families of amphipods – Talitridae, Ischyroceridae and Gammaridae. Nassariidae (mud snails) and *Geukensia demissa* (ribbed mussels) thrive in the mud of the creek bottom and banks.

Nassariidae (mud snails) on the left and *Geukensia demissa* (ribbed mussels) on the right.

7: Avian Surveys

Bird observations were made during monitoring activities. *Arclea herodias* (great blue heron) *Phalacrocorax auritus* (double-crested cormorant)*, Arclea alba (*great egret), *Egretta thula* (snowy egret), and *Agelaius phoeniceus* (red-winged blackbird) frequent the Old Creek Salt Marsh. As was evidenced from the nekton and macroinvertebrate data collected, food sources abound in the marsh.

Great egrets are identifiable by large size and orange bill.

Snowy egret with identifiable black legs flies in to one of the pannes to feed.

8: Environmental Stewardship

During the past two years, Salem State students and volunteers of all ages from the community have been given the opportunity to learn about salt marsh ecology while working with Salem Sound Coastwatch to conduct seasonal monitoring. Other members of the community also learned about the Old Creek Salt Marsh when SSCW led a Trails and Sails field trip in September 2010. Of the more than 35 people in attendance, many although residents of Salem had never seen the marsh before. Also, Dr. Alan Young led a group of estuarine scientists on a tour of the marsh in May 2009 as part of the New England Estuarine Research Society's biannual meeting. All agreed that Salem State University is fortunate to have such a unique natural resource in the midst of its urban campus setting.

The beautiful and informative signage that Salem State University installed on the walking path above the marsh is an excellent way to help the community understand the value of Old Creek Salt Marsh and its need for continued protection. Stewardship activities such as field trips, debris cleanups and pepperweed pulls will continue to engage the community. Through this project, opportunities were created for curriculum and research involvement as part of students' and professors' academic mission. Salem State University can continue to utilize the salt marsh as a living laboratory to provide hands-on educational opportunities, while contributing to the long-term stewardship of the marsh.

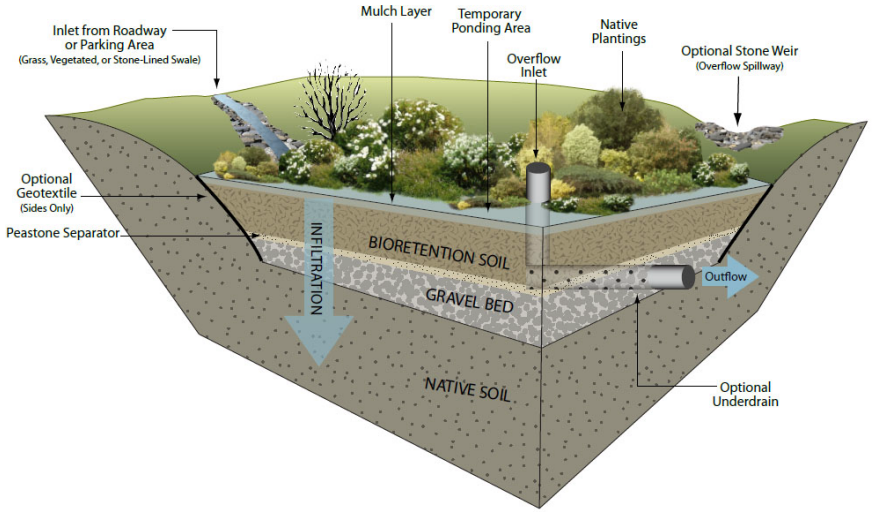
SSCW volunteers enjoy the shade and company before pulling minnow traps.

9: Recommendations

Land Use Impact Reduction with Bioretention Cells

In the southeast corner of the student parking lot next to the new LEED certified dormitories, water accumulates and puddles as it runs off the impervious parking lot toward the marsh. There are four traffic control islands in the lot that are begging to be part of the solution. Currently, the tree islands are above the parking lot and are stressed from lack of water.

If these islands were reworked to become bioretention cells, surface runoff from the pavement would drain to the islands and recieve treatment as water percolates through the soil; and nutrients, sediments and contaminants are processed by the plants.



The drawing of a bioretention cell to the left was drawn by *GeoSyntec Consultants* and more information can be found at http://www.mass.gov/dcr/watersupply/ipswichriver/demo3-paving.htm. This is just one of the Low Impact Development techniques that retain water on-site, reducing sediment deposition and pollution from adjacent impervious surfaces to wetland resources.

Invasive Species Management

Phragmites australis along the marsh's western edge has been present since the 1990's, and attempts to remove it have so far been unsuccessful. This area (Stands B, C, D, E) should be inspected every year to evaluate if it is spreading into the marsh, but no treatment is recommended at this time. However, it is recommended that efforts be undertaken to control *Phragmites* in the two upland buffers; Area R and Stand A.

A joint collaboration between Salem Sound Coastwatch and Dr. Alan Young in the conservation land salt marsh opposite Pickman Park found that *Phragmites* populations initially responded to regular cutting and applications of Burnout™ on cut stems on the plant. Burnout™ is an organic herbicide that is generally considered safe around aquatic resources. However, once the cutting and application stopped, *Phragmites* began to reclaim the area.

The most effective method is to apply an herbicide directly into cut *Phragmites*' stems in the fall because at this time plants are translocating nutrients back to the rhizomes in preparation for winter. The US Fish and Wildlife Service uses a 2% glyphosate application combined with an aquatic surfactant. The only glyphosate-containing aquatic pesticide registered for use in Massachusetts is Rodeo™. Herbicidal control of *Phragmites* may require consecutive application over multiple years to remain effective. Burning after an application of herbicide to reduce standing dead stem material is not recommended because of the close proximity to the residential neighborhood. Mowing and raking of the area may help to remove the dead stalks and debris if herbicide control is used. Any activity in Old Creek Salt Marsh will, of course, require review and approval by the Salem Conservation Commission.

Celastrus orbiculatus (Oriental bittersweet) is still manageable in the upland buffer but needs to be either pulled out by the roots, cut repeatedly or treated with systemic herbicides. If an herbicide is applied to *Phragmites,* bittersweet could be targeted at the same time. If not, annual repeated root pulling starting in the spring through autumn could be tried, but once pulling of any invasive is begun, there must be vigilant monitoring and removal since the plants will grow more vigorously after in response to the pulling.

Polygonum cuspidatum (Japanese knotweed) is limited at this time to the upper edge of *Phragmites* Stand C, near the tennis courts. This invasive is very aggressive in expanding by rhizomes and thousands of tiny seeds. Like *Phragmites*, the application of Rodeo™ to cut stems is the most effective control method.

Lepedium latifolium (perennial pepperweed) is also in the buffer Area R but has been controlled by repeated hand-pulling in June and again in September. It is recommended that this stewardship activity continue. With the University's permission, Salem Sound Coastwatch will continue to monitor and remove pepperweed when it is found.

Lythrum salicaria (purple loosestrife) was identified but in very low numbers, and biocontol of this invader is happening in Massachusetts with the release of *Galerucella* sp. beetles. These plants could be hand pulled.

Rosa mutiflora (multiflora rose) can be pulled or mowed repeatedly to remove it. If left, it probably will eventually dominate the buffer meadow, blocking any view of the marsh and making passage difficult because of its thorny nature.

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Maintenance of the Upland Buffer Meadow

The lack of mowing of the buffer between the marsh and Atlantic Hall has probably encouraged the growth of a good diversity of grasses and perennial flowers, shrubs and small trees. To maintain a wild meadow, however, mowing should be done every couple of years. When mowing does occur, the person mowing must understand the plants in the meadow so small trees and shrubs are not mowed down. Also, the invasive stand of *Phragmites* (Stand A) and the multiflora rose should be cut repeatedly during the growing season until it is eradicated from the meadow. This would require a dedicated person or group who can identify the targeted plants and understand the purpose of the cutting. At the Pickman Park salt marsh *Phragmites* study project, Salem State students hired to cut the *Phragmites* throughout the growing season were very reliable and this approach might we replicated in the meadow.

Planting additional Bayberry (Myricaceae family) and false indigo shrub (*Amorpha fruticosa*) along the meadow's marsh edge is recommended. Bayberry is doing well in this area already because its preferred habitat is upland edges of irregularly flooded salt and brackish marshes as well as in sandy dune swales so it has a high tolerance for moisture and salinity variations. The false indigo shrub also grows in this kind of environment. The cherry trees already in the buffer meadow and any other desirable shrubs and trees must be marked clearly before mowing to prevent being cut down.

If taller native woody vegetation for wildlife habitat is desired, service-berry (*Amelanchier canadensis*), black oak (*Quercus velutina*), northern red oak (*Quercus rubra*), and red maple (*Acer rubrum*) could be planted, but a landscape plan should be developed with a planting and maintenance plan since there has been low survival rates in the past because of the poor soil quality and lack of regular water. *Acer platanoides* (Norway maple) should be prevented from becoming established in this meadow area since it is an invasive tree, which is growing nearby between the bike path and the fire road/walking path.

Old Creek Salt Marsh: a living laboratory providing educational opportunities

With the idea of utilizing the salt marsh as a living laboratory, several project opportunities have come to light from the SSCW assessment that could be incorporated into curriculum or student research. Ideas are to 1) study the spread of marsh vegetation into the riprap and above the riprap edge and 2) create an inventory and herbarium of upland buffer plants. In the realm of marine biology, 3) an assessment of *Limulus polyphemus,* horseshoe crab, populations in Old Creek Salt Marsh, the Forest River estuary or the entire Salem Sound could be designed and implemented over several years. 4) The new non-native shrimp, *Palaemon elegans,* distribution and frequency and use of estuarine habitat could be investigated, and 5) a more thorough bird survey for the marsh or Forest River estuary could be an ongoing activity for a Salem State University club. In the fall, 6) a yearly mapping of the *Phragmites* stands in the marsh area by a GIS class or as part of a student research project would provide important monitoring of this invasive to determine if it is expanding or receding over time.

10: Summary

This report has provided the following:

1. An evaluation of the salt marsh's condition by conducting an assessment of hydrological and biological parameters within the marsh and land use impacts surrounding the marsh. Monitoring results have been summarized. Through pictures and words, the marsh and its condition have been described. Where possible comparisons of previously collected marsh data and history have been made.

2. Recommendations for restoration opportunities have focused primarily on control and removal of invasive plants since this is currently the biggest threat to the marsh's integrity. However, opportunities to reduce polluted runoff from the dormitory parking lot by initiating low impact development practices if realized should qualify as LEED activities.

3. Salem Sound Coastwatch's model of engaging citizen volunteers in monitoring activities demonstrates how the salt marsh can be used as a living laboratory to provide educational opportunities for students and the community all with the long-term stewardship of the marsh as a final goal.

Thank you for giving Salem Sound Coastwatch the opportunity to study the Old Creek Salt Marsh and to work so closely with the Salem State University community.

11: Literature Cited

Carlisle, B.K., A.M. Donovan, A.L. Hicks, V.S. Kooken, J.P. Smith, and A.R. Wilbur. 2002. A Volunteer's Handbook for Monitoring New England Salt Marshes. Massachusetts Office of Coastal Zone Management, Boston, MA.

Carlisle, B.K. , J.S. Smith, A.L. Hicks, B.G. Largay, S. R. Garcia. 1998. Wetland Ecological Integrity: An Assessment Approach. Massachusetts Coastal Zone Management http://www.mass.gov/czm/wetlandecologicalintegrity.pdf

Cataldo, Chris. 2010. Presence of *Phragmites australis* at Old Creek Salt Marsh in Salem, Ma. Paper for Dr. Lewis' Biology Seminar.

Department of Conservation and Recreation. GeoSyntec Consultants. Demonstration 3:Permeable Paving Materials and Bioretention in a Parking Lot. http://www.mass.gov/dcr/watersupply/ipswichriver/demo3-paving.htm

Pollock, L.W. 1998. A Practical Guide to the Marine Animals of Northeastern North America. Rutgers University Press.

Sasaki Associates. 2008. Salem State College: Development of Strategies for Inventory and Monitoring Old Creek Salt Marsh. Salem, Ma.

Shay, Jennifer M., Shay, C. Thomas. 1986. Prairie marshes in western Canada, with specific reference to the ecology of five emergent macrophytes. Canadian Journal of Botany. 64: 443-454.

Sherff, E. E. 1912. The vegetation of Skokie Marsh, with special reference to subterranean organs and their interrelationships. Botanical Gazette. 53(5): 415-435.

Tiner, R.W. Jr. 1987. A Field Guide to Coastal Wetland Plants of the Northeastern United States. The University of Massachusetts Press, Amherst, MA.

Warren, R. Scott et al. 2002. Salt marsh restoration in Connecticut: 20 years of science and management. Restoration Ecology. 10(3): 497-513.

Woodard & Curran. 2007. Phase I Report for the South River Drainage Project. Prepared for the City of Salem. http://www.salem.com/Pages/SalemMA_Engineer/southriverreport.pdf