U.S. Fish and Wildlife Service
Rhode Island National Wildlife Refuge Complex

MAIDFORD SALT MARSH RESTORATION

DRAFT PROJECT DESCRIPTON

May 2015

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For

U.S. Fish & Wildlife Service
Rhode Island National Wildlife Refuge Complex
50 Bend Road, Charlestown, RI 02813

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Sachuest NWR Maidford River Resiliency Project - Proposed Actions

U.S. Fish and Wildlife Service
50 Bend Road, Charlestown, RI 02813
Land lines approximate

0 250 500 1,000 Feet

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1.0 Purpose of Action

The U.S. Fish & Wildlife Service (Service) is proposing to restore salt marshes, coastal dunes and related resources within and adjacent to the Sachuest Point National Wildlife Refuge (Refuge) in Middletown, RI. The proposed action is necessary to preserve and restore fish and wildlife habitat, water quality, public use and public safety. These resource functions are being lost and degraded due to natural and anthropogenic factors, including sea level rise, severe coastal storms and water pollution. The proposed action fulfills the responsibility of the Service under the National Wildlife Refuge System Administration Act of 1966 (16 U.S.C. 668dd-668ee) as amended by the National Wildlife Refuge System Improvement Act of 1997 (Public Law 105-57), which requires the Service to undertake "conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats" on Refuge lands. The proposed action is funded by the Disaster Relief Appropriations Act of 2013 (Public Law 113-2) and is consistent with the Comprehensive Conservation and Management Plan for the Sachuest Point National Wildlife Refuge (USFWS 2002). This Project Description describes the proposed action and will serve as the basis for environmental permitting as required by federal law.

1.1 Restore Salt Marsh Habitat Conditions for Fish and Wildlife

Salt marshes are some of the most ecologically important wetland habitats on Narragansett Bay (Schwartz 2009). These wetlands support the coastal estuarine ecosystem because of their role in providing food, space, and refugia for a wide variety of terrestrial and aquatic species (Teal *et al.* 1999). Salt marshes buffer and protect estuarine waters and habitats from land-based pollutants (USEPA 1993). The location of salt marshes between river and upland sites provides a buffer during storm events, and aid in reducing nitrogen inputs from uplands into estuaries (Wigand *et al.* 2004). Salt marshes along the Atlantic Coast of the United States provide habitat for a diversity of wildlife species including several salt marsh obligate species such as the saltmarsh sparrow (*Ammodramus caudacutus*), a species of high conservation concern (USFWS 2008). Salt marshes are also valued as open space and provide scenic vistas.

Salt marshes in the Maidford River are declining due to rapid sea level rise, invasive species, water pollution and a history of hydraulic modification. These factors degrade marsh habitat directly, by causing more frequent and extended marsh flooding, and indirectly, by causing loss of native marsh vegetation and reduced faunal biodiversity. The proposed action will reverse this decline and protect high-value species by restoring habitat quality and ecological resilience in the marshes of the Refuge. This will be accomplished by restoring marsh surface elevations, restoring marsh vegetation, controlling invasive species, restoring more natural drainage patterns, and reducing water pollution. In addition to addressing current trends, the proposed action will protect fish, wildlife and habitats from the impact of future natural and anthropogenic events, including climate change and frequent, intense storms. The proposed action will provide adaptive management to prior restoration areas, by adjusting marsh surface elevations to current tidal elevations.

1.2 Restore Saltmarsh Sparrow Nesting Habitat

The proposed action is needed to preserve and restore nesting habitat for the saltmarsh sparrow. The Maidford River salt marsh historically provided important high marsh nesting habitat for this species; however, frequent marsh flooding and poor drainage has altered the vegetation compositions resulting in a loss of high marsh nesting habitat. Female sparrows place their nests close to the ground making them particularly susceptible to tidal flooding. Flooding is a major cause of nest failure when the Maidford River outlet becomes blocked with sand and floods the marsh surface for extended periods of time during the nesting season. Consequently, reproductive success for saltmarsh sparrows nesting within the Maidford Marsh is relatively low, and the marsh may currently act as reproductive sink for this species. Sea level rise is expected to further reduce the amount of suitable nesting habitat for saltmarsh sparrows in the near future, and increase the vulnerability of their nests to tidal flooding. The proposed action is needed to re-establish high marsh vegetation suitable for saltmarsh sparrow nesting, and improve sparrow reproductive success in order to preserve and restore populations of this species at the Refuge and regionally.

1.3 Improve Water Quality

The principal source of fresh water to the project area salt marshes is the Maidford River, which is classed as impaired by the R.I. Dept. of Environmental Management due to elevated levels of fecal coliform and low biodiversity (RIDEM 2011). Pollution from the Maidford River is a factor in causing beach closures at Third Beach in Middletown. The proposed action is necessary to reduce storm water pollution into the marshes and coastal waters of Sachuest Point, in order to protect and restore salt marsh habitat, biodiversity and recreational uses of coastal waters.

1.4 Protect Public Use, Safety, and Access

The proposed action is also necessary to protect public safety, preserve recreational quality, and restore public access to the Refuge and other coastal assets such as recreational beaches. There are limited roads and parking lots in the Sachuest Point area, despite intense use, particularly in summer. Existing roads are unsafe, subject to flooding and ice formation, with one dangerous intersection. By raising roads and parking lots, improving drainage and infiltration, and reconfiguring an intersection, the proposed action is needed to reduce the chance of vehicle/vehicle and vehicle/pedestrian accidents, improve emergency access, and reduce road-generated pollution of recreational beaches.

Altered marsh hydrology and plugged drainages increase mosquito production and potential disease vectors. In recent years, potentially deadly mosquito-borne diseases such as West Nile Virus and Eastern Equine Encephalitis have increased in Rhode Island. By improving flushing of existing marsh channels, the project will reduce mosquito production and potential disease transmission, thereby reducing a serious threat to public health.

2.0 Affected Environment

2.1 Project Area

The proposed project is located on the North side of the Refuge **(Appendix 1: Project Area Map and Proposed Actions, provided above and with appendices)**. For purposes of the proposed project, coastal wetland areas totaling approximately 37 acres within the project area are divided into three management units: the North, Middle, and South Marshes, as described under “Salt Marsh Habitats,” below.

The marshes are bordered to the east by Third Beach on the Sakonnet River. The North and Middle Marshes are flooded and drained by a channel system that connects to the Maidford River, which

flows along the north edge of the project area before entering the Sakonnet. The South Marsh is flooded and drained through a separate channel system that connects to the Sakonnet through a water control structure at the south end of the project area. The Connector Road separates the North and Middle Marshes during most tides. The Middle and South Marshes are separated by topography at lower tides, and connected at higher tides.

2.2 Sea Level Rise Trends and Impacts on Marshes

Throughout the Northeast, salt marshes are losing vegetated habitat due to natural and anthropogenic impacts. On Narragansett Bay, long-term monitoring shows rapid decline of high marsh or salt meadow, replaced by stressed vegetation and un-vegetated areas. A recent comparative study attributes "excessive waterlogging, vegetation shifts, and dieback" in Narragansett Bay salt marshes to accelerated sea level rise, and suggests that fish and wildlife habitat will be impacted by these changes (Raposa et al 2014). The study also suggests that "management actions…to augment marsh elevations" can mitigate some of these impacts). The Maidford salt marshes exhibit these trends; marsh surfaces are at insufficient elevation (relative to sea level) to support robust growth of historic high marsh vegetation. Poor drainage has exacerbated this condition; historic drainage features have clogged with deposited sediments, leading to increased soil waterlogging and vegetation loss. The South Marsh, which was restored to saltmarsh during the Sachuest Point Landfill remediation project completed in 2004, suffers from elevations insufficient to support high marsh vegetation, and is currently dominated by mudflat and low marsh vegetation.

2.3 Salt Marsh Habitats

Salt marsh has been present on this site throughout history, as evidenced by soil core samples taken with the assistance of the Natural Resources Conservation Service (NRCS) **(Figure 1).** These cores show layers of peat interspersed with layers of sand, suggesting prior overwash events. During the Sachuest Point landfill remediation in 2004, thick deposits of peat were found two to three feet below the surface.

Fig. 1: Salt Marsh Soil Cores, Maidford River Salt Marshes

The areas of the North, Middle and South Marsh management units are as follows:

Fig. 2: Table of Areas, North, Middle, and South Marsh Management Units

Management Unit	**Area (Acres)**	**Notes**
North Marsh	9.521	Historic salt marsh
Middle Marsh	6.101	Historic salt marsh
South Marsh (vegetated area)	11.697	Restored salt marsh excavated from former landfill
South Marsh (mudflat)	10.078	Restored salt marsh excavated from former landfill
Total	**37.397**	

The North Marsh is characterized by a mix of high and low marsh vegetation, while the Middle marsh is dominated by high marsh and invasive *Phragmites* reeds. In the South Marsh, vegetated areas are dominated by low marsh vegetation, specifically *Spartina alterniflora.* High marsh is present only on the edges of the South Marsh. Large unvegetated mudflats are also present in the South Marsh as noted in the table above. **Appendix 2** provides a map of vegetative cover within the project area, while **Appendix 3** provides the same information in table format.

High marsh areas are dominated by salt meadow hay, *Spartina patens*; other common high marsh species present include *Distichlis spicata* and *Juncus gerardii*. High tide bush (*Iva frutescens*) and *Phragmites australis* are present along edges and higher areas, while both Intermediate/high and low forms of *Spartina alterniflora* are present in lower areas. Newly formed bare pannes are present in the lowest, most degraded areas of the marsh**.**

Marsh vegetation within the project area has changed significantly since the late 1990's to the present. A study by Save The Bay (2014) documented substantial decrease in *S. patens*, the dominant high marsh vegetation and important sparrow nesting habitat, coupled with strong increases in *S. alterniflora, Salicornia spp.*, and bare pannes. The same study noted a decline in water table depths; high mosquito production; and low-quality habitat conditions. Taken together, these trends indicate a transition from high marsh to low marsh; increased impoundment of surface water from the Maidford River; and degradation and loss of marsh habitat. The study concludes that marsh accretion is not keeping pace with sea level rise and that habitat conditions will continue to deteriorate under present trends (Save The Bay 2014).

Appendix 4 provides complete information on marsh surface elevations based on RTK surveys completed by the Service in 2015.

As described above, the salt marshes in the project area are flooded and drained by two main channel systems. Sedimentation of these systems has reduced drainage and aeration of marsh soils, exacerbating subsidence and accelerating the loss of marsh vegetation. Poor drainage also leads to longer periods of standing water in the channels, attenuation of both high and low tides within the marsh, increased mosquito production throughout the project area, and is the principal factor causing flooding of salt marsh sparrow nests and poor reproductive success of this species.

2.4 Wildlife Resources

The saltmarsh sparrow is a habitat specialist occurring exclusively in tidal marshes along the Atlantic coast of the North America. It is considered a species of high conservation concern due to its limited distribution, and its dependence on salt marsh habitat which is threatened by sea level

rise. Southern New England represents the core of its breeding range where an estimated 50 percent of the worldwide breeding population occurs (Partners in Flight 2000)

Saltmarsh sparrows nest on the ground and require high marsh for nesting habitat. Nests typically occur near the high tide line at the base of saltmarsh cordgrass (*Spartina patens*) and saltmeadow rush (*Juncus gerardii*), The saltmarsh sparrow is declining in population; the species is listed as "vulnerable" by the International Union for the Conservation of Nature, and as a species in need of immediate conservation action by Partners in Flight. The species is particularly susceptible to anthropogenic impacts such as sea level rise, coastal development, alterations in marsh tidal flows, and habitat degradation from invasions of non-native *Phragmites australis*

Research throughout the range of this species has documented a steady decline in nesting habitat and reproductive success. Population viability analyses currently underway predict that sparrows will be unable to breed successfully in tidal marsh habitats without intervention by approximately 2050, given current rates of sea level rise and assuming that marsh elevations remain stable. (Field and Elphick 2014 pers. comm.).

The Maidford marshes historically supported a significant breeding population of saltmarsh sparrow, but reproductive success is now very low due to frequent flooding. Sparrows are evolved to lay their eggs and fledge their young in the period between spring tides; more frequent flooding of the high marsh surface leads to high rates of reproductive failure. Sparrow eggs have the ability to survive brief periods of nest flooding. Once incubation begins and the embryos are developing, Elphick (2014 pers. comm) observed eggs remaining viable after flooding events lasting up to 90 minutes, presuming the eggs remained in the nest cup and females resumed incubation shortly after flood waters receded. If eggs float out of the nest, the eggs will not survive. Chicks less than five days of age are susceptible to drowning since they not yet developed enough to climb higher in the nest or on surrounding vegetation to avoid rising waters.

Frequent flooding of the Maidford marshes is caused by clogging of the Maidford River at Third Beach which, in combination with clogged drainages within the salt marsh, prevents storm and rainwater from draining into the Sakonnet River. This flooding has been recorded to last as long as 8 days. Other factors include relatively low marsh surface elevations and sea level rise.

2.5 Marine, Estuarine and Aquatic Resources

Marshes within the project area support several nekton species typical of Narragansett Bay marshes. **Appendix 5** provides data from nekton surveys by the Service in 2012 and 2014. Note that the "Maidford Marsh" data refer the North Marsh unit, while the "Restored Marsh" data refer to the Middle and South Marsh units combined.

The most abundant nekton species sampled were daggerblade grass shrimp, *Palaemonetes pugio,* in the North Marsh, and mummichog, *Fundulus heteroclitus,* in the Middle and South Marshes. Alewife, *Alosa psuedoharengus*, was present in very low numbers in the North Marsh, while American eel, *Anguilla rostrata,* was present with very low numbers in the Middle and South Marshes. No winter flounder (*Pseudopleuronectes americanus*) were found.

The fresh water habitat of the Maidford River upstream of the project area supports several species of fish typical of degraded small freshwater systems. In 2010 the R.I. Dept. of Environmental Management (RIDEM) sampled eight species: three-spined stickleback *(Gasterosteus aculeatus)*, four-spined stickleback (*Apeltes quadracus),* nine-spined stickleback *(Pungitius pungitius),*

American eel, golden shiner *(Notemigonus crysoleucas)*, pumpkinseed *(Lepomis gibbosus)*, banded killifish *(Fundulus diaphanus)*, and guppy (*Poecilia reticulata*) (Lake 2015 pers. comm.).

In addition to species identified in the nekton and RIDEM surveys, a study by Roman et al. (2002) within the salt marsh identified white mullet *(Mugil curema)*, inland silverside *(Menidia beryllina)*, shiner *(Notropis spp.)*, Atlantic menhaden *(Brevoortia tyrannus)*, black sea bass *(Centropristis striata)*, rainwater killifish *(Lucania parva)* and seaboard goby *(Gobiosoma ginsburgi)* in the Maidford marshes.

A shellfish survey in Fall, 2014 found very low densities of shellfish in the project area, as shown in **Appendix 6.** Atlantic horseshoe crab (*Limulus polyphemus*) has been observed in the North and South Marsh segments.

The Sakonnet River supports approximately 90 species of estuarine fish and shellfish. **Appendix 7** lists all species identified by RIDEM trawl surveys from 1979 – 2014. The National Oceanic and Atmospheric Administration Habitat Mapper lists the lower Sakonnet River as Essential Fish Habitat for 11 species. These are listed in **Appendix 8**. None of the potential EFH species listed by NOAA are present in the Maidford River marshes.

2.6 Endangered Species

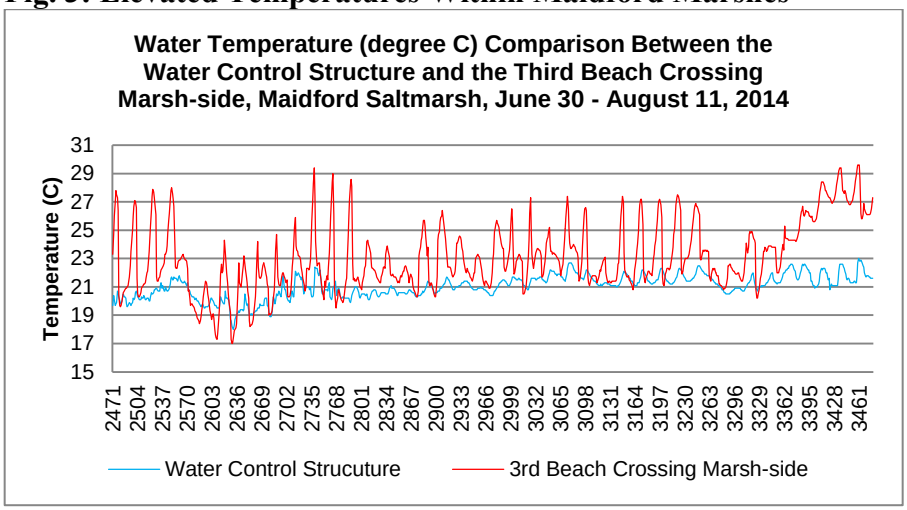
Piping plover (*Charadrius melodus)* is a shorebird species currently classified as a Threatened Species under the Endangered Species Act of 1973 (as amended). This species is dependent on beach strand habitat, and has historically nested along Third Beach adjacent to the Maidford marshes. Productivity on this beach is very poor, despite average or above average hatching success. Nestlings are typical lost within 15 days of hatching. Dogs off leash have been identified as a major area of concern in past years. No successful nests were found in the 2013 season on this beach (USFWS 2013).

2.7 Water Quality

Due to elevated levels of fecal coliform bacteria, the Maidford River does not meet state water quality standards and has been identified as impaired for bacteria by RIDEM (2011). There are several potential sources of bacteria in the Maidford River watershed including agricultural activities, wildlife and domestic animal waste, storm water runoff from roads and developed areas, and illicit discharges. This bacterial contamination has negative impacts on recreation as well as fish and wildlife habitat in the Sachuest Point area. Third Beach was closed due to contamination 92 days from 2000-2013 (RIDOH 2015), while the lower Maidford River has also been assessed by RIDEM (2011) as not meeting water quality standards for biodiversity. The Town of Middletown is currently completing a watershed assessment of the Maidford River watershed with the purpose of identifying contaminant sources and designing best management practices (BMPs) to abate pollution.

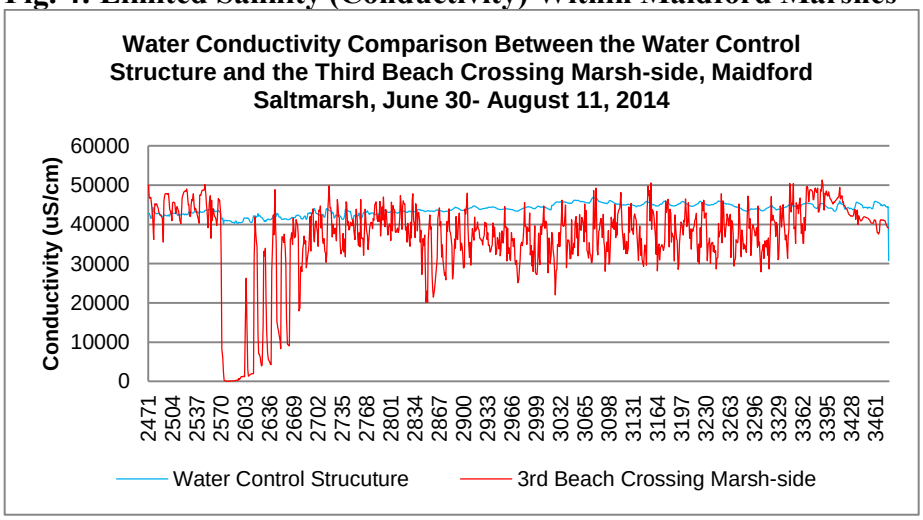
Comparatively, water temperatures in the Maidford River are as much as 10 degrees higher than levels measured at the water control structure at the south end of the project area. Water temperature in the river increases significantly when the Maidford River outlet at Third Beach is blocked, and water becomes stagnant and trapped on the marsh, as shown on the right side of the graph in **Figure 3**.

Fig. 3: Elevated Temperatures Within Maidford Marshes



As shown in **Figure 4**, the salinity of water in the North Marsh is much lower than water in the South Marsh, due to greater fresh water inputs from the Maidford River and more restricted tidal flushing.

Fig. 4: Limited Salinity (Conductivity) Within Maidford Marshes



2.8 Hydrology and Tidal Dynamics

Hydrology

The Maidford River and salt marshes have had a long history of manipulation. Prior to development of Gardner and Nelson Ponds (drinking water reservoirs) in the early 1900's, historic Coast Survey maps show that the Maidford River originally drained into Sachuest Bay at the western end of Second Beach (now known as Surfers' End). With development of the reservoirs, the Maidford River was rerouted to its present location, exiting into the Sakonnet River. Discussions with long-term residents indicate that the Navy, which previously owned much of the area, and later the Town of Middletown, frequently dredged the mouth of the Maidford River to keep water flowing out of the Maidford and into the Sakonnet. More recently, the City Of Newport reconstructed a pipeline that diverts water from the Maidford River along Paradise Avenue (about a mile to the west of the project area). This structure is capable of diverting all non-flood flows into

the reservoirs. Downstream of the diversion structure, base flows in the Maidford River are comprised of groundwater, surface flows from the Paradise Brook sub-watershed, and possible leakage from the reservoirs.

The current road system, including the Connector Road which bisects the marsh, can be seen in early (1939) aerial photos of the area. In the early 1970's, the Service installed a water control structure underneath the Connector Road and another south of Third Beach and connected them with a ditch in the hopes of connecting all of the marsh segments together with adequate salt water flows to control phragmites and to improve salt marsh habitat (USFWS 1975). Subsequent analysis showed the structure underneath the connector road to be undersized, and the ditches could not be fully connected because of the presence of trash and debris associated with the Sachuest Point Landfill.

Another salt marsh restoration effort was launched in this same area in the 1990's by a variety of partners including the Service, RIDEM, NOAA, University of Rhode Island, and others, designed to reduce mosquito production and reduce the prevalence of *Phragmites* in the Middle Marsh. This effort included installing two additional culverts underneath the connector road and creation of a ditch system (now called the turkey foot) and small pools for fish production. Subsequent monitoring (Roman et al 2002) found that the increased saltwater flows into the Middle Marsh reduced the extent and robustness of *Phragmites*, although mosquito production remains an issue today.

Finally, in 2004 the Service completed enhancement of salt marsh in the South Marsh segment as part of a landfill remediation project. Much of the area around Third Beach Parking lot was excavated to remove tons of waste including tires, stoves, refrigerators, stumps, and household refuse. The area was backfilled and planted with salt marsh vegetation, and a new water control structure was installed south of Third Beach to allow for tidal flows. This water control structure has required very little maintenance since its construction.

Lacking a thorough investigation of the entire salt marsh (as has now been done), no effort was made in 2004 to connect the Middle and South Marshes. Subsequent analysis as part of this current restoration effort has demonstrated that target elevations for salt marsh restoration (using *S. patens* as a goal) were not met by the 2004 restoration, and that many of the elevations in the restored South Marsh are too low to support high marsh vegetation and habitat.

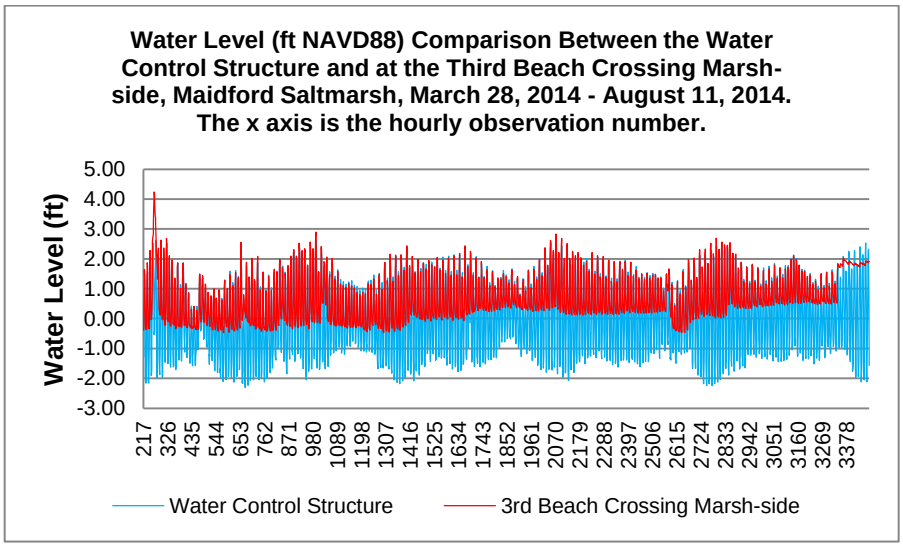
Tidal Dynamics

A 2015 study by Grilli and Spaulding examined tidal dynamics in the Maidford River salt marshes. The study found that the North and Middle Marsh units are connected to each other through culverts beneath the Connector Road, and that they connect to the Maidford River at all points in the tidal cycle. These two units therefore receive fresh water, storm water and contaminants from the Maidford River watershed at all tides, and flood and ebb through the Maidford River outlet to the salt water of the Sakonnet River **(Appendix 9).** The South Marsh unit connects to the Sakonnet primarily via a water control structure south of Third Beach, through which it floods and ebbs. The three units are connected at higher tides; however the study found that the North and Middle Marsh units have little interchange with the South Marsh unit except after storms. At such times, the study predicts through modelling that 62% of flood water exits the system via the south channel and water control structure, while only 38% exits through the Maidford River outlet. The study noted that storm events open the sand bar at the Maidford outlet, but that the outlet returns to equilibrium (closed) conditions within several days, quickly re-establishing susceptibility to extended periods of flooding on the surface of the marsh. A principal cause of this rapid closure is the location of the

Maidford River mouth at the transition point between an erosional beach environment to the south of the outlet, and a depositional beach to its north. The study also noted that the South Marsh maintains more open water during the tidal cycle than the North and Middle units, due to its lower surface elevation **(Appendix 9).** The study also concluded that the culvert under Third Beach Road at the Maidford River outlet is undersized. This appears to contribute to marsh flooding as well; after large storms, the road acts as a dam across the marsh, preventing larger storm flows from exiting the marsh quickly.

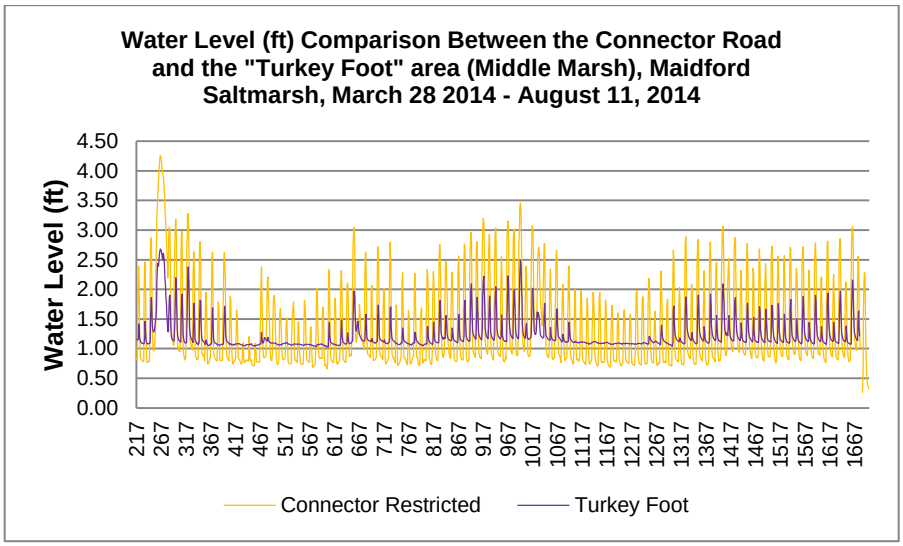
Water level monitoring by the Service reveals that low tide heights in the North and Middle Marshes are higher as compared to low tide levels at the water control structure, which generally mimics tides in the Sakonnet River (Grilli and Spaulding 2015) **(Figure 5).** The attenuated low tide is typical of tidally restricted marshes: while tide waters are still receding in the marsh, rising water levels in the Sakonnet during the next tide cycle prevent the salt marsh from fully draining. Water levels during peak high tide at both the water control structure and at Third Beach closely align with each other. Note the gradual increase in minimum water level height from observation 2714 to 3372. This is due to sand blockage of the Maidford outlet at Third Beach, which prevented water from draining out of the marsh. The outlet was completely blocked for an extended period from observation 3372 to at least 3600, signified by the persistence of high (flood) waters across the marsh in **Figure 5.**

Fig. 5: Attenuated Low Tides in Maidford Marshes



In the Middle Marsh, amplitude of both low and high tides also appears restricted, and is believed to be caused by clogged drainages that prevent all but the highest tides from influencing this section of the marsh **(Figure 6).** Salt marsh surface elevations are similar between the North and Middle Marsh segments.

Fig. 6: Tidal Attenuation Within "Turkey Foot" Area



2.9 Public Use and Visitor Safety

The Sachuest Point area is an important location for public use and recreation, particularly in the summer. Roads in the area are used to access Second and Third Beach, which host hundreds of thousands of visitors per year and are an important source of income for the Town of Middletown. Third Beach and Navy Beach parking lots are both within the project area and are important to coastal use and access. Roads at Sachuest Point also service the Refuge and Norman Bird Sanctuary **(Map, Appendix 1).** Roads are at relatively low elevations and therefore are vulnerable to sea level rise, flooding during summer storms and icing during winter. The triangle intersection of the Connector Road and Third Beach Road is dangerous; the northern portion of the triangle enters Third Beach Road at an acute angle with poor visibility. Runoff from roads and parking lots is also a source of contaminants to marshes and coastal waters. Marshes within the project area are significant breeding areas for mosquitos (Save The Bay, 2014). Mosquitos require stagnant water such in which to lay their eggs and in which their larvae mature for a period of 7-10 days. Stagnant pools on the surface of the Maidford marshes, and clogged tidal channels, provide habitat for abundant mosquito production.

2.10 Cultural Resources

To date no significant cultural resources have been identified within the project area. The Service reviewed proposed drainage restoration and TLD actions and found no potential impact by these actions on cultural resources. The Service will conduct an archaeological survey in advance of any excavations into native soil, such as realignment of the Connector Road, as recommended by the R.I. Historical Preservation and Heritage Commission in a letter dated 30 December 2014 (**Appendix 10).**

3.0 Proposed Action: Restore Maidford Salt Marshes, Water Quality, Public Access, Health and Safety

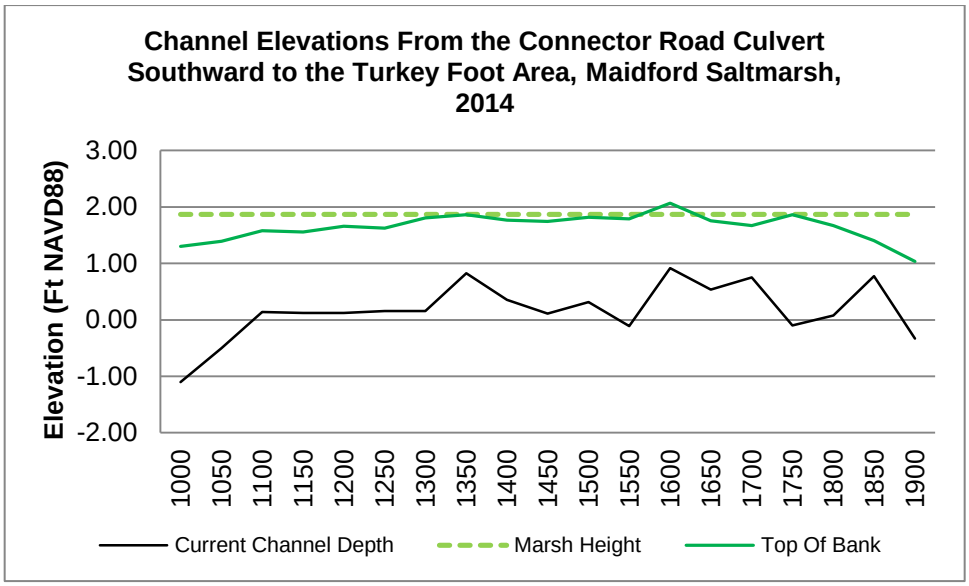
The Service is proposing to complete an integrated set of actions to restore and enhance approximately 37 acres of salt marsh at Maidford River as well as associated uses, functions and values such as water quality, public access, public health and public safety. These actions are detailed individually below; however they are designed to work together to accomplish the proposed purpose of the action. Therefore the greatest project benefit will be provided by completion of all actions in a coordinated fashion.

Action 1: Restore Marsh Drainage

Reduced marsh surface drainage and low elevations, particularly in the South Marsh, is causing extended saturation or "waterlogging" of marsh soils, a principal cause of marsh vegetation loss. Waterlogging is caused by 1) sedimentation of existing drainage features which clogs existing channels and reduces channel drainage; and 2) low marsh surface elevations relative to sea level.

For example, the main channel running from the Connector road into the Turkey Foot area in the Middle Marsh segment has both silted in and may also not have been constructed to a consistent depth. **Figure 7** shows the minimum and maximum ditch heights/depths compared to average salt marsh surface elevation.

Fig. 7: Channel Depths in Middle Marsh Unit



The Service is proposing measures to restore marsh drainage by addressing each of these factors. This action is intended to restore a more natural tidal flooding regime to support native salt marsh plant communities, reduce ponded water areas on the marsh surface, reduce waterlogging of soils, allow adequate drainage in Thin Layer Deposition (TLD) restoration areas, divert freshwater flows to maintain correct soil salinities, accelerate marsh drainage after storm events, and maintain perimeter ditches as necessary to prevent the spread of invasive *Phragmites*. Drainage restoration is also designed to connect pooling areas on the marsh, which will improve fish access and habitat while reducing mosquito production.

The Service is proposing to restore marsh drainage by 1) deepening existing drainage features such as tidal channels and historic ditches that have become non-functional due to sedimentation, and 2) developing limited new drainage features, primarily "runnels" or very shallow channels on the surface of the marsh, along with very limited deeper excavations to connect existing marsh segments and channels. **Appendix 11** provides maps and approximate quantities of these excavations. More drainage restoration will take place in the North and Middle Marsh units due to relatively higher surface elevations in these areas.

Drainage restoration actions will facilitate ebb tide processes and accelerate flood drainage after storms. In the North and South Marsh management units, existing non-functional channels will be cleared to a maximum depth of 1.5 feet (18") beneath the marsh surface. In the Middle Marsh management unit, drainage restoration depths may be as deep as 1.9 feet (22"), in order to establish depths equal to the invert (bottom) of the culverts beneath the Connector Road (-0.51 NAVD88).

Runnels will be constructed to a maximum cross section of approximately one foot by one foot on the surface of the marsh. This approach has been used successfully to restore salt marshes on Narragansett Bay and in the South Shore salt ponds of Rhode Island by Save The Bay. This will help drain salt marsh soils and connect surface pools.

All excavation will be accomplished using a small bucket on a low-ground-pressure excavator, as is typically done for mosquito control, or with hand tools. Drainage restoration work will be performed primarily outside of the saltmarsh sparrow nesting season of April 1- August 15, and in the fall and winter of 2015-2016.

Excavated sediment or soil will be placed in low spots on the marsh as needed; placed in small piles or "islands" to create high marsh habitat (but will not create upland habitat); and used to supplement TLD applications as described below. Materials that are expected to contain *Phragmites* rhizomes, particularly in the Middle Marsh unit, will be placed to minimize spreading of this plant, either in subtidal areas to prevent regrowth, on upland sites, or in areas currently occupied by *Phragmites*.

Action 2: *Phragmites* Control

The invasive common reed, *Phragmites*, is prevalent in the project area. Under existing permits, the Service maintains ongoing measures to treat and kill Phragmites using herbicide and mechanical means. The goal of this action is to improve marsh habitat for nesting salt marsh sparrows and other wildlife, and to restore native plant biodiversity. The effectiveness of these treatments will be enhanced by the tidal flow and drainage restoration measures described above, which are expected to raise soil salinities.

Herbicide treatment consists of application of a 1-1.5 % solution of glyphosate (trade name Rodeo) applied to select stands of *Phragmites* in late summer (August-October), when plants are in full bloom. For the densest stands it may be necessary to apply an Imazapyr/glyphosate combination if no native marsh plants are in the understory. Herbicide will be applied using backpack sprayers when possible. In areas where *Phragmites* is less dense, and there are considerable numbers of high marsh plants growing in the understory, herbicide will be applied using stem injections and by hand swiping, to avoid adverse effects to desirable species. The potential for using an ATV with a boom sprayer in areas of dense *Phragmites* will be considered if feasible without damaging the marsh. Herbicide will be applied on low-wind days to minimize drift onto adjacent native marsh plants. Mechanical treatment will be conducted after herbicide treatment. Treated stands will be

mowed 2-4 weeks after herbicide application to remove dead plants, reduce shading and allow for the reestablishment of native plants. In the South Marsh management unit, dune areas with *Phragmites* on the dune will be replanted with native vegetation after treatment to ensure stabilization. The Service will conduct spot treatments, repeating *Phragmites* control measures in subsequent years as necessary.

This action will treat approximately 10.4 acres of *Phragmites*, of a total of 12.42 acres present on site. **Appendix 14** provides maps and tables describing ongoing, permitted *Phragmites* treatment measures.

Action 3: Improve Roads and Parking Lots

As noted above, flooding and runoff from roads and parking lots in the project area impacts public use, access and safety, as well as coastal water quality. To address these impacts, the Service is working with the Town of Middletown to raise the Connector Road; reconfigure its intersection with Third Beach Road; raise the Navy Beach (north) parking lot; and install pervious pavement at the Navy Beach lot.

The surface of the Connector Road will be raised to reduce flooding and icing during storms to federal and state standards. No expansion of the existing fill slopes will be allowed; the maximum height of the road raising will be limited by this constraint. Storm water Best Management Practices (BMPs) will be installed as required for new roadwork.

Where the Connector Road meets Third Beach Road, the present triangle intersection will be converted to a "T" by removing the north leg of the triangle. Where the road is removed it will be graded to existing elevations to restore dune habitat, and the remaining intersection reconfigured to establish a safe three-way intersection. This action will significantly reduce paved area and is not expected to require a BMP.

At the former Navy Beach (north) parking lot, the parking lot will be raised to reduce flooding and icing, and pervious pavement will be installed. A BMP is not expected to be needed due to the pervious pavement.

Taken together, these road improvement actions will provide significant ecosystem benefits by reducing runoff, increasing infiltration and reducing water pollution. They will enhance public access and safety by reducing road flooding and icing, and reducing the chance of automobile accidents, particularly at the intersection.

The Service will avoid construction activities on roads, parking lots and marshes during the busy summer season (Memorial Day to Labor Day) in order to minimize impacts on public use and access. The Service will consult with the Town of Middletown to ensure adequate traffic control during construction.

Engineering for all of these road improvement measures is currently underway through the Town of Middletown to establish new design elevations. These actions will be permitted separately to adhere to all federal requirements.

The Service will conduct archaeological surveys in areas of ground disturbance to comply with Section 106 of the National Historic Preservation Act.

Action 4: Restoration of Maidford River Outlet

As described above, a hydraulic restriction at the Maidford River outlet causes extended flooding periods on the marsh surface that are detrimental to salt marsh sparrow reproduction. The outlet is crossed by Third Beach Road, which is supported by a round 6.5 foot diameter culvert that the River flows through at the inland edge of the beach. The culvert is dated 1941 and was found by Grilli and Spaulding (2015) to be undersized for higher flows; moreover the outlet frequently closes due to beach sediment transport processes.

The Service examined potential options to reduce the hydraulic restriction and allow for the natural interchange between beach strand habitat and salt marsh processes.

The first option considered was the installation of a riprap-lined channel from the existing structure to mean low low water. Consultation with others and examination of beach profile data suggest that this option would not be successful in preventing blockage of the Maidford channel with sand, would degrade aesthetics, and could reduce habitat quality for piping plover. This option did not receive further analysis.

Option 2 was to install approximately 800 feet of culvert from the existing road crossing out underneath the beach and outside of the natural deposition area. At the terminus, a riser would be installed so that sand fouling would be prevented. While this option would allow sand in the intertidal zone to move freely along the shore, this type of structure would likely prevent movement of marine life into and out of the North Marsh unit. This option did not receive further analysis.

A third option considered was to install a long box culvert to the low water line, which has shown to have moderate success at a site in Connecticut (Woods Hole Group, 2012). Recent information suggests that this structure has not been meeting expectations, and similar to Option 2, it is unclear whether this type of structure would be effective in this area. Unlike Option 2, this type of structure would allow for interchange of marine fauna.

Option 4 under consideration is removal of the existing road crossing and undersized culvert at Third Beach, and to install a bridge span or bottomless culvert across the Maidford River outlet in its current location. This option is believed to have the following benefits:

It will facilitate much more rapid draining of the salt marsh during large storm events. While the typical beach profile lies approximately two feet above the surface of the marsh, large storm events will likely be sufficient to re-open the channel should it become blocked at the beach. This alternative also provides for the maximum interchange between sand on the beach and material entering the marsh system. Sedimentation and transport of materials into the marsh, primarily during spring tides and storms, will allow for natural salt marsh surface accretion. Because the beach profile is typically higher than the salt marsh in a natural deposition area, net sediment transport will likely be into the marsh. While salt marsh flooding over time resulting from the blockage of the channel along with gradual water inputs would still occur, improvements in channel clearing and ditch connections will abate this issue.

The final option considered is the no-action alternative. This will result in continuation of current conditions: delayed draining of the marsh during large storm events, blockage of the channel during small events and gradual freshwater inputs. Material transport between the beach and the marsh will remain limited. This option did not receive further analysis.

Figure 7 summarizes the pros and cons of the various options considered. In consideration of these factors, the Service is proposing to implement Option 4, and will move forward with engineering and design. Permitting will be undertaken when engineering and design work are complete.

Fig. 8: Comparison of Alternatives Considered: Maidford River Outlet at Third Beach

Option	Type	Resolves Large Storm Flooding	Resolves Small Storm / Gradual flooding	Provides for Marine life Movement	Provides Sand / Marsh Transport	Probability of Effectiveness
1	RIPRAP CHANNEL	YES	PARTIAL*	YES	YES	LOW
2	800 FT CULVERT	YES	YES	NO	NO	HIGH
3	BOX CULVERT	YES	YES	YES	NO	MOD
4	SPAN	YES	PARTIAL*	YES	YES	HIGH
5	NO ACTION	NO	NO	YES	NO	LOW
*/ Improved channel connections and clearing will remove waters over time.						

Action 5: Thin Layer Deposition (TLD)

The proposed action will apply a thin layer of sediment to the surface of the South Marsh and a portion of the North Marsh management units, raising intertidal elevations in order to mimic and augment natural accretion processes. This method has been successfully used on Delaware Bay, DE, Chesapeake Bay, MD, and Jamaica Bay, NY, to restore marshes adversely affected by accelerated sea level rise (ACOE 2014; Frame *et al.* 2006; Frame 2007; Wilson 2014).

In the North Marsh, elevations are insufficient to support robust high marsh vegetation due to rapid sea level rise and increased water impoundment (Save The Bay 2014). In this area, TLD will restore historic marsh elevations relative to sea level. In the South Marsh, elevations were established by a landfill remediation and wetland restoration project completed in 2002. TLD in this area is an adaptive management measure to improve marsh surface elevations established during the earlier project. In both cases, TLD will re-establish marsh habitat resiliency for ongoing sea level trends and other impacts.

Target elevation for TLD in both marshes is 2.2 to 2.3 NAVD88. This is the high end of the elevational range for existing *S. patens* habitat in the Maidford marshes as documented with RTK and vegetation analysis **(Appendix 13),** and was selected to maximize the resiliency of the restored habitat in the face of continued sea level rise, while maintaining true wetland elevations and minimizing the potential for invasive species establishment within restoration areas. Establishment of target elevations will require TLD applications ranging in thickness from zero to an approximate maximum one foot depth plus an amount to accommodate compaction. The final amount will, in part be based on a result of a compaction analysis currently being undertaken in the Narrow River.

In the North Marsh management unit the Service is proposing to treat approximately 1.64 acres of marsh with TLD, while in the South Marsh the Service will treat approximately 14.9 acres. Greater thicknesses and more material will be required in the South Marsh management unit due to lower existing elevations and larger area of treatment. An estimated total of approximately 492 cubic

yards (c.y.) will be required for TLD in the North Marsh, and approximately 13,459 c.y. in the South Marsh.

Appendix 13 provides the marsh elevation and RTK elevations, maps and approximate quantities describing proposed TLD treatments. Refer also to **Appendix 9**, showing modeling results of the Grilli and Spaulding study (2015).

TLD will be applied with a gentle crown on the marsh to maintain a minimum 1% slope. This will allow for adequate drainage of the marsh at low tide and prevent water logging of the soil and hyper-saline conditions. Slopes between 1-3% are recommended for establishment of marsh vegetation (Broome et al 1988; Copeland 1998). Observations in mature marshes, however, document slopes of as much as 10% in the low marsh areas adjacent to creek banks, with the high marsh flattening out to closer to 1% slope (Niedowski 2000).

Where there is a high potential for *Phragmites* establishment, the Service will set restoration elevations at the lower end of the target range. Material will be placed to avoid impoundment of water on the surface of the marsh in order to provide the best conditions for marsh vegetation establishment.

The Service expects restored TLD areas to be colonized by typical high marsh grasses such as *S. patens, J. gerardii,* and *D. spicata.* Where TLD application thickness is greater than four inches, the Service will plant native marsh species to accelerate recovery and minimize invasive species establishment. In these areas the Service will install plugs of *S. alterniflora* and *D. spicata,* planted in a grid with maximum spacing of 30 inches between plants. Planting density will be increased if determined necessary and sufficient plant material is available. Plugs of *S. alterniflora* will be planted along the channels to reduce erosions from daily tides, beginning at elevations that will be inundated with tidal flow on a daily basis, beginning at a minimum elevation of 1.3 feet and extending approximately 20 to 50 feet into the low marsh, to a maximum elevation of 1.9 feet. Planting will occur from April through June to ensure establishment success.

The Service will secure source material for TLD from local quarries, using sand with similar grain size to that which occurs naturally on Third Beach. Material may be stockpiled briefly at the Third Beach parking lot before construction, in the off season and with permission of the Town. The TLD application will mimic a natural washover of beach dune material on to the marsh, as occurs during larger coastal storms. The sand may be modified with loam or other modifier with slightly higher organic content, such as leaf compost (10-25%) to facilitate growth. Excavated material from drainage restoration will also be used as source material for TLD.

Work on the North Marsh will be completed during the coldest months of winter, 2015-2016 (November through February) when the surface of the marsh is frozen. This area is extremely soft and operation on frozen ground will prevent damage to the marsh surface. The South Marsh management unit is much firmer; therefore restoration will begin after Labor Day, 2015, and will be completed by April 1, 2016 in order to minimize impacts on recreational uses and to avoid impacts to salt marsh sparrows, piping plovers and other coastal wildlife.

Action 6: Monitoring

The Service has conducted extensive monitoring of the project area and will continue to do so through construction and site recovery. Overall monitoring efforts by the Service and other partners at this site, at the Narrow River restoration site (see USFWS 2014), and at Ninigret Pond are intended to compliment each other. Specific monitoring parameters chosen for this site include:

- Water level loggers to record water surface elevations in tidal channels;
- Porewater salinity measurements;
- RTK or laser level surveys along marsh transects to track marsh elevations;
- SET (surface elevation table) monitoring to track marsh accretion;
- Vegetation species composition, abundance and community mapping;
- Vegetation plant height and stem densities to measure above-ground production (robustness) of vegetation;
- Photo plots to track vegetation changes and effectiveness of invasives control;
- Nekton species composition and abundance.
- Water quality monitoring before, during, and after storm events.

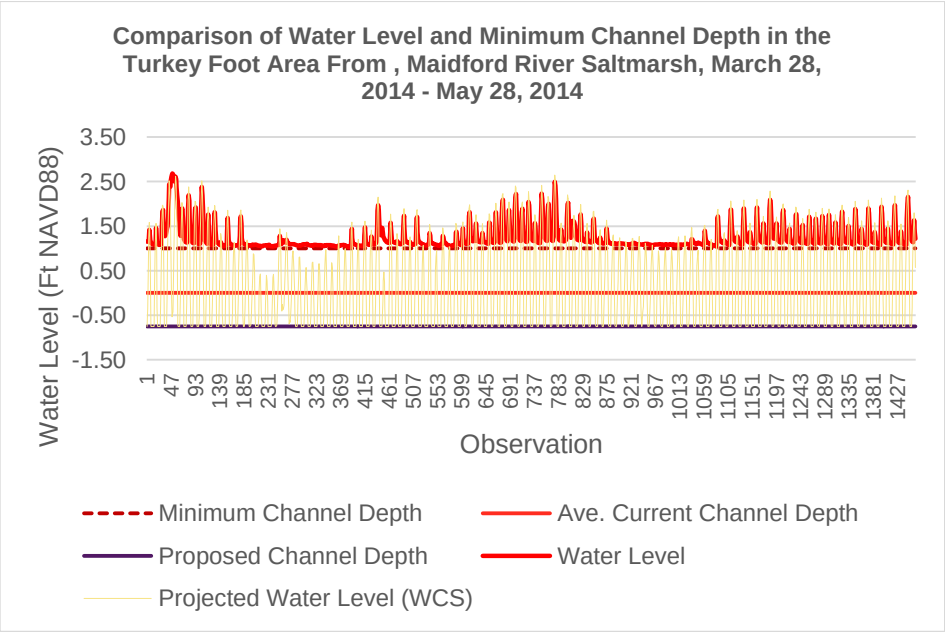
4.0 Environmental Consequences

4.1 Salt Marsh Habitats

The proposed action will restore or enhance more than 37 acres of vegetated salt marsh habitat by 1) restoring surface drainage; 2) controlling invasive *Phragmites;* 3) restoring historic marsh elevations relative to tide levels; and 3) replanting once suitable surface conditions have been established. These measures will work in concert to restore, improve or re-establish more than sixteen acres of native high salt marsh habitat.

Restoration of drainage features through channel deepening and runnel development will reduce standing water areas on the marsh surface, while reducing "waterlogging" and improving aeration of soils. This action will also create better flow conditions throughout the marsh, and allow for improved access of higher tidal flows in the Middle Marsh, while improving draining during the ebb tide. As shown in **Figure 9,** clearing of the existing channel and connecting this channel to the South Marsh is expected to increase flow of saltwater into this segment, primarily from the South Marsh's water control structure. This enhanced flow of saltwater will aide in the natural control of *Phragmites*.

Fig. 9: Expected Changes in Water Level in Middle Marsh Unit



These measures will promote the growth and survival of native high marsh species such as *S. patens*. Treatment of the highly aggressive *Phragmites* will provide space for re-establishment of *S. patens* and other native marsh grasses. The combination of phragmites control and the improvement in saltwater flow throughout the marsh will provide for long term control of this invasive species. TLD will target elevations where *S. patens* is now robust at Sachuest Point and is therefore expected to establish suitable conditions. Experience in other areas has shown that TLD thicknesses of less than 4 inches should allow for survival of existing *S. Patens* plants, while thicker areas will be planted to ensure high marsh re-establishment, as described above. Taken together, the proposed actions will restore resiliency to the Maidford salt marshes by re-establishing health high marsh habitat able to withstand ongoing sea level rise trends, occasional intense coastal storms, and other natural and anthropogenic impacts.

Removal of the current, undersized culvert at the Maidford River outlet will allow for the rapid drainage of the marsh and reduction of flooding following major storm events. During low-flow periods, improved drainage through the channels will likely limit the incidence of gradual flooding caused by base flows.

Removal of the current restriction will also allow for the improved transport of sand and sediment from the beach and into the marsh, providing materials for natural accretion of the salt marsh, and allowing it to better keep pace with sea level rise. Because of the higher natural profile of the beach as compared to the salt marsh surface, a net increase in materials brought into the marsh, as opposed to out of the marsh, is expected.

4.2 Wildlife Resources

The proposed action is expected to restore nesting habitat and reproductive success for salt marsh sparrow. Sparrows are present in the project area but nest success is low due to frequent and extended flooding of the marsh surface. The project will reduce the extent and duration of marsh flooding. Increased marsh elevations will restore flooding periods typical of high marsh, while restored *S. patens* and other high marsh grasses will provide suitable nesting habitat for the ground-nesting birds. Nest survival and reproductive success of salt marsh sparrows is expected to improve, with positive impacts on the local population as well as regional survival of the species.

Dune habitat adjacent to the marsh will be increased by removing a road segment at the intersection of the Connector Road and Third Beach Road, grading to the elevations of adjacent dune habitats, and planting beach dune plant species in that area.

4.3 Marine, Estuarine and Aquatic Resources

The proposed action will have a beneficial impact on fish and invertebrates using the Maidford salt marshes. Healthy salt marshes are a foundation of coastal ecosystems, providing habitat for key life stages of fish and invertebrates. However, the Maidford River marshes are presently degraded, with limited species present, as noted by Save The Bay (2014) and Roman et al. (2002). As a result of the proposed action, some shallow standing water areas on the surface of the marsh will be lost; however these are of low value to fish and wildlife, while producing large mosquito populations. Fish passage and habitat conditions in all portions of the marsh will be improved by deepening the channels and improving flushing, allowing fish and invertebrates to move more freely into and out of project area, move between the marsh units and access habitat throughout the marsh. The proposed action is therefore expected to increase abundance and diversity of nekton in the project

area, which will in turn benefit predators such as wading birds and raptors, and larger fish present in the Sakonnet River.

The proposed action will have no significant impact on shellfish, which are present in very low numbers in the project area as described in **Appendix 6.** It will have no impact on fresh water species present in the Maidford River, as it is not affecting that habitat in any way. The project will have no adverse impact on saltwater fish in the Sakonnet River, as habitat conditions there will not be altered in any way.

The proposed action will have no adverse impact on essential fish habitat (EFH). None of the EFH species listed by NOAA (2015) for the Sakonnet River are present in the project area. The proposed action will improve habitat for fish and nekton within the Maidford marshes, with beneficial impacts on marine and estuarine species in the Sakonnet River, including recreational and commercial species.

4.4 Endangered Species

The proposed action will have no adverse impacts on endangered species. Piping plover nesting areas will be unaffected, and construction operations will be halted where appropriate prior to April 1 to avoid disturbance to nesting plovers from construction noise or other secondary impacts.

4.5 Water Quality

The proposed action will help improve water quality in the project area by reducing impervious surface, increasing infiltration, reducing road-runoff, and reducing discharge of road-related pollutants such as petroleum hydrocarbons into the Maidford River marshes and coastal waters of the Sakonnet River.

Removal of the existing undersized culvert and installation of a larger span at the Maidford River outlet will allow floodwaters from major storm events to leave the drainage more rapidly, reducing water temperatures, bacterial production and algal growth. Channel deepening and ditch clearing will also foster more rapid drainage of the marsh.

While connecting channels between the Middle and South Marsh units may cause a slight increase in interchange of waters throughout the marsh, it is not anticipated that this will harm or degrade water quality at Third Beach, as compared with current conditions, for the following reasons:

1. A larger opening at the Maidford River outlet will allow more rapid drainage following storms, when the highest concentration of pollutants are present in the water. However the location and timing of this discharge will be unchanged.

2. As shown by Grilli and Spaulding (2015), the Middle Marsh receives most of its water from the water control structure at the south end of the project site, and not from the Maidford River. Flows from the Maidford River into the Middle and South Marshes will remain low, except during major storm events when conditions will be unchanged from present conditions. Enhanced drainage and increased inflows of salt water from the water control structure at the south end of the restoration area will improve water quality in the marsh by bringing clean, cooler saline water into the North Marsh.

3. Restoration of the Maidford River outlet and internal drainage features will improve flushing, reduce residence times of water in the marsh, and reduce water temperatures, leading to reduced bacteria production in the marsh and river, and reduced export of bacteria and other pollution to coastal waters.

4. Drainage channels will be connected into the large pool in the South Marsh, where at lower tides the water will have a much better mixing potential.

4.6 Tidal Dynamics

The proposed action will have no significant impact on tidal dynamics in the North and South Marsh units. Within the Middle Marsh, significant improvement in tidal range will occur on both the high and ebb tides, with more salt water entering this portion of the system from the water control structure as opposed to the Maidford River. Deepening of marsh channels and improvement of surface drainage will improve flushing and drainage of the marsh in response to tidal cycles and after storms; however the overall tidal and flow patterns described by Grilli and Spalding (2015) will be unchanged in the North and South Marsh units. Fresh water inputs from the watershed will be unchanged. Installation of the span at the Maidford outlet will reduce drainage times of flood flows during major flooding events.

4.7 Public Use and Visitor Safety

The proposed action will improve public safety, use and access, and the project is structured to avoid negative impacts on these values.

Proposed marsh drainage improvements and control of *Phragmites* will likely reduce mosquito breeding, which is currently high in this marsh (Save The Bay, 2014). Reduction of small isolated surface impoundments on the marsh and improvement of flushing in marsh channels will create unfavorable conditions for aquatic mosquito larvae and will increase predation of larvae by marsh nekton. This in turn may help reduce the incidence of potentially deadly mosquito-borne pathogens that are prevalent in Rhode Island, such as West Nile Virus and Eastern Equine Encephalitis.

Proposed road improvements will improve automobile and pedestrian safety by reducing road flooding and icing, and by reconfiguring a very dangerous intersection to reduce the probability of accidents between automobiles and other autos, cyclists and pedestrians. By reducing road and parking lot flooding, the proposed action will improve coastal recreational access.

Reduction of impervious surfaces and other BMP installations related to the proposed road improvements will reduce pollution of coastal waters, including coliform bacteria which is a typical constituent of road runoff, thereby reducing the potential for water-borne diseases and beach closures. Water quality improvements under this proposal are modest and therefore, while the Service expects an incremental improvement, it is not expected that the proposed action will completely prevent the need for occasional beach closures at Third Beach.

All construction work required to implement the proposed action which could conflict with the high public use season , including material storage, will be undertaken after Labor Day and before Memorial Day in order to avoid impacts on public use and access during the busy summer season. When construction is underway, the Service will consult with the Town of Middletown to ensure appropriate traffic management and controls.

4.8 Cultural Resources

As noted above, the Service completed review of proposed drainage improvements and TLD work and determined that these aspects of the proposed action will have no significant impact on cultural resources. Also as noted, invasives control work is already permitted and will have no impact on cultural resources as it involves no significant below-ground disturbance.

5.0 Coordination and Consultation

In carrying out the proposed action, the Service will complete coordination, consultation and compliance to meet all state, federal and local requirements. These include the following:

5.1 Federal Coastal Zone Consistency Determination

The Service has consulted with the R.I. Coastal Resources Management Council (RICRMC) throughout the project development process, and has determined that the proposed action is consistent to the maximum extent practicable with the Coastal Zone Management Act of 1972 (16 U.S.C. §§1451-1465). The Service will seek concurrence with this determination from RICRMC.

5.2 Water Quality Certification

The Service will comply with Section 401 of the federal Clean Water Act (33 U.S.C. §§1251-1387), and will seek Water Quality Certification (WQC) for the proposed action from the R.I. Dept. of Environmental Management (RIDEM). Portions of the proposed action requiring WQC are expected to be drainage restoration measures, TLD and road improvements. As the proposed action does not entail significant dredging or alteration of navigable waters, the Service does not anticipate a need for state dredging permits; however the Service will consult with RIDEM and seek approval under this requirement if needed.

5.3 Federal Dredge and Fill

The Service will comply with Section 404 of the federal Clean Water Act (33 U.S.C. §§1251-1387), Section 10 of the Rivers and Harbors Act (33 U.S.C. §403), and other applicable federal laws regulating dredge and fill activities in waters of the United States, and will seek approval of the proposed action from the U.S. Army Corps of Engineers (Corps). As the primary purpose of the proposed action is pro-active habitat restoration, it is expected to qualify for Corps review under Category 2 of the R.I. General Permit.

5.4 Endangered Species Act

As noted above, the Service has reviewed the proposed action for potential impacts on endangered species, specifically piping plovers, as regulated under the Endangered Species Act (16 U.S.C. § 1531 et seq.). The Service has concluded that the proposed action will have no significant impact on endangered species; therefore no additional action is necessary.

5.5 Essential Fish Habitat

As noted above, the Service has reviewed the proposed action for potential impacts on essential fish habitat (EFH) or managed species, as regulated under the Magnuson-Stevens Fishery Conservation and Management Act (Public Law 94-265). The Service has concluded that the

proposed action will have no significant impact on EFH; therefore no additional action or consultation is necessary.

5.6 Cultural Resources

The Service has begun consultation with the R.I. Historical Preservation and Heritage Commission and the Narragansett Indian Tribe, and has determined that among the proposed actions, only the road improvements have the potential to significantly impact historical or cultural resources. Pursuant to the National Historic Preservation Act, the Service will consult with these entities and other parties as appropriate, following survey of the area to Federal standards, and prior to implementing the road improvement work.

5.6 Local Requirements

The Service has coordinated with, and will continue to coordinate with the Town of Middletown to ensure that all local requirements are met. The Service expects that such requirements will be limited to traffic management, and permission to use Town property for construction staging and materials storage during the off-season period between Labor Day and Memorial Day.

5.7 Existing Permits and Sequencing of Compliance

The Service seeks appropriate permits at this time for all actions, but recognizes that permitting roadway changes, including replacement of the existing Third Beach Road crossing with a span or open bottom arch, and completion of the road and parking lot improvements, may not be possible until engineering designs and timetables are developed for these actions.

5.8 Additional Requirements

The Service will comply with any additional requirements or coordination needs that are identified during the planning, regulatory or implementation process. Private landowner permission will be required for actions proposed on Town of Middletown and Norman Bird Sanctuary properties.

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Appendix 1

Sachuest NWR Maidford River Resiliency Project - Proposed Actions

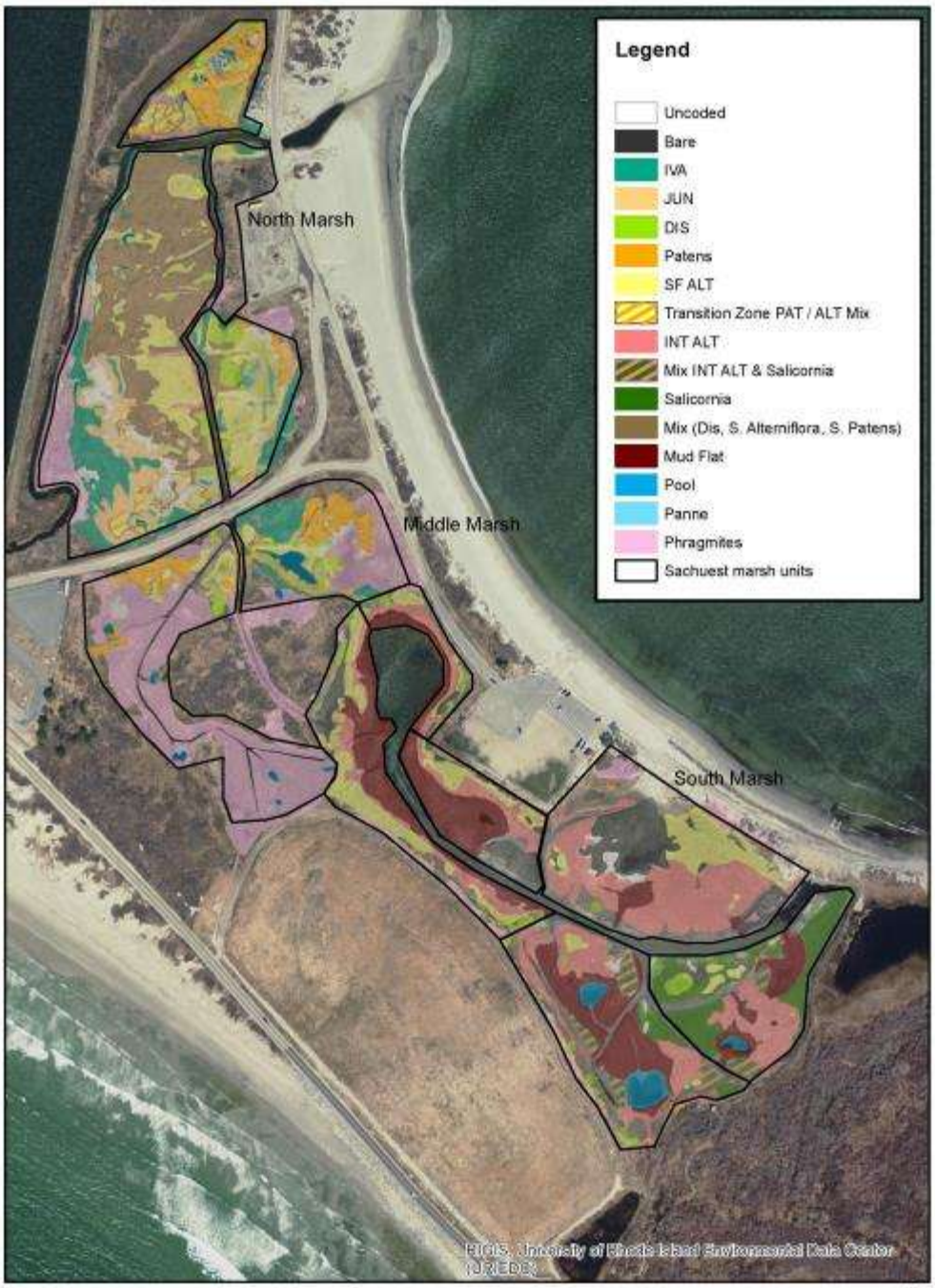
U.S. Fish and Wildlife Service
50 Bend Road, Charlestown, RI 02813
Land lines approximate

0 250 500 1,000 Feet

N

Appendix 2

Sachuest NWR Maidford River Resiliency Project - Cover Type Map



U.S. Fish & Wildlife Service
50 Bend Road, Charlestown, RI 02813
Land lines approximate

0 250 500 1,000 Feet

N

Appendix 3

Section	Marsh Unit	Cover Type	Acres	Percent
North Marsh	N1	?	0.03	1.8%
North Marsh	N1	DIS	0.09	5.9%
North Marsh	N1	INT ALT	0.05	3.6%
North Marsh	N1	IVA	0.04	3.0%
North Marsh	N1	Panne	0.01	0.7%
North Marsh	N1	Patens	0.39	25.8%
North Marsh	N1	Pool	0.03	2.0%
North Marsh	N1	roads and other upland	0.46	30.5%
North Marsh	N1	SF ALT	0.30	20.0%
North Marsh	N1	Transition Zone PAT / ALT Mix	0.10	6.7%
	N1	total	1.51	
North Marsh	N2	IVA	0.03	3.4%
North Marsh	N2	Panne	0.00	0.6%
North Marsh	N2	Patens	0.00	0.6%
North Marsh	N2	Phragmites	0.02	2.8%
North Marsh	N2	roads and other upland	0.75	86.4%
North Marsh	N2	SF ALT	0.05	6.3%
	N2	total	0.87	
North Marsh	N3	?	0.16	8.5%
North Marsh	N3	DIS	0.18	9.8%
North Marsh	N3	IVA	0.18	9.7%
North Marsh	N3	JUN	0.10	5.3%
North Marsh	N3	Mix (Dis, S. Alterniflora, S. Patens)	0.14	7.6%
North Marsh	N3	Panne	0.10	5.6%
North Marsh	N3	Patens	0.10	5.2%
North Marsh	N3	Phragmites	0.05	2.6%
North Marsh	N3	roads and other upland	0.22	11.8%
North Marsh	N3	SF ALT	0.58	31.4%
North Marsh	N3	Transition Zone PAT / ALT Mix	0.05	2.6%
	N3	total	1.86	
North Marsh	N4	?	0.63	8.4%
North Marsh	N4	DIS	0.18	2.4%
North Marsh	N4	INT ALT	0.14	1.9%
North Marsh	N4	IVA	1.00	13.5%
North Marsh	N4	JUN	0.72	9.7%
North Marsh	N4	Mix (Dis, S. Alterniflora, S. Patens)	2.53	33.8%
North Marsh	N4	Phragmites	0.59	7.9%
North Marsh	N4	Pool	0.04	0.5%
North Marsh	N4	roads and other upland	0.18	2.5%
North Marsh	N4	SF ALT	1.25	16.7%
North Marsh	N4	Transition Zone PAT / ALT Mix	0.20	2.7%
	N4	total	7.47	
Middle Marsh	M1	?	0.14	5.5%
Middle Marsh	M1	DIS	0.12	4.6%
Middle Marsh	M1	IVA	0.38	15.0%
Middle Marsh	M1	JUN	0.00	0.1%
Middle Marsh	M1	Patens	0.36	14.2%
Middle Marsh	M1	Phragmites	0.70	27.4%
Middle Marsh	M1	Pool	0.13	5.3%
Middle Marsh	M1	roads and other upland	0.50	19.6%
Middle Marsh	M1	SF ALT	0.20	7.8%
Middle Marsh	M1	Transition Zone PAT / ALT Mix	0.01	0.3%
	M1	total	2.54	
Middle Marsh	M2	?	0.11	2.5%
Middle Marsh	M2	DIS	0.05	1.1%
Middle Marsh	M2	JUN	0.02	0.4%
Middle Marsh	M2	Panne	0.01	0.3%
Middle Marsh	M2	Patens	0.28	6.3%
Middle Marsh	M2	Phragmites	2.52	57.7%
Middle Marsh	M2	Pool	0.08	1.8%
Middle Marsh	M2	roads and other upland	1.11	25.4%
Middle Marsh	M2	SF ALT	0.19	4.2%
Middle Marsh	M2	Transition Zone PAT / ALT Mix	0.01	0.3%
	M2	total	4.38	

South Marsh	S1	Bare	0.02	2.4%
South Marsh	S1	DIS	0.03	3.8%
South Marsh	S1	INT ALT	0.22	28.2%
South Marsh	S1	IVA	0.01	1.3%
South Marsh	S1	JUN	0.00	0.3%
South Marsh	S1	Mud Flat	0.20	25.8%
South Marsh	S1	Patens	0.00	0.6%
South Marsh	S1	Phragmites	0.01	1.8%
South Marsh	S1	roads and other upland	0.22	27.7%
South Marsh	S1	SF ALT	0.06	8.1%
	S1	total	0.78	
South Marsh	S2	Bare	0.20	11.7%
South Marsh	S2	INT ALT	0.32	18.8%
South Marsh	S2	JUN	0.00	0.0%
South Marsh	S2	Mud Flat	0.68	40.2%
South Marsh	S2	Patens	0.00	0.1%
South Marsh	S2	roads and other upland	0.32	19.1%
South Marsh	S2	SF ALT	0.17	10.1%
	S2	total	1.70	
South Marsh	S3	?	0.16	3.3%
South Marsh	S3	Bare	0.81	16.9%
South Marsh	S3	DIS	0.01	0.2%
South Marsh	S3	INT ALT	1.53	32.1%
South Marsh	S3	JUN	0.00	0.0%
South Marsh	S3	Mud Flat	0.17	3.6%
South Marsh	S3	Patens	0.00	0.1%
South Marsh	S3	Phragmites	0.09	1.8%
South Marsh	S3	roads and other upland	1.42	29.6%
South Marsh	S3	Salicornia	0.03	0.6%
South Marsh	S3	SF ALT	0.56	11.8%
	S3	total	4.78	
South Marsh	S4	?	0.02	0.6%
South Marsh	S4	Bare	0.10	3.8%
South Marsh	S4	DIS	0.06	2.2%
South Marsh	S4	INT ALT	0.51	18.5%
South Marsh	S4	Mix INT ALT & Salicornia	0.12	4.2%
South Marsh	S4	Mud Flat	0.44	15.9%
South Marsh	S4	Pool	0.05	1.8%
South Marsh	S4	roads and other upland	0.49	17.8%
South Marsh	S4	Salicornia	0.94	33.7%
South Marsh	S4	SF ALT	0.05	1.6%
	S4	total	2.78	

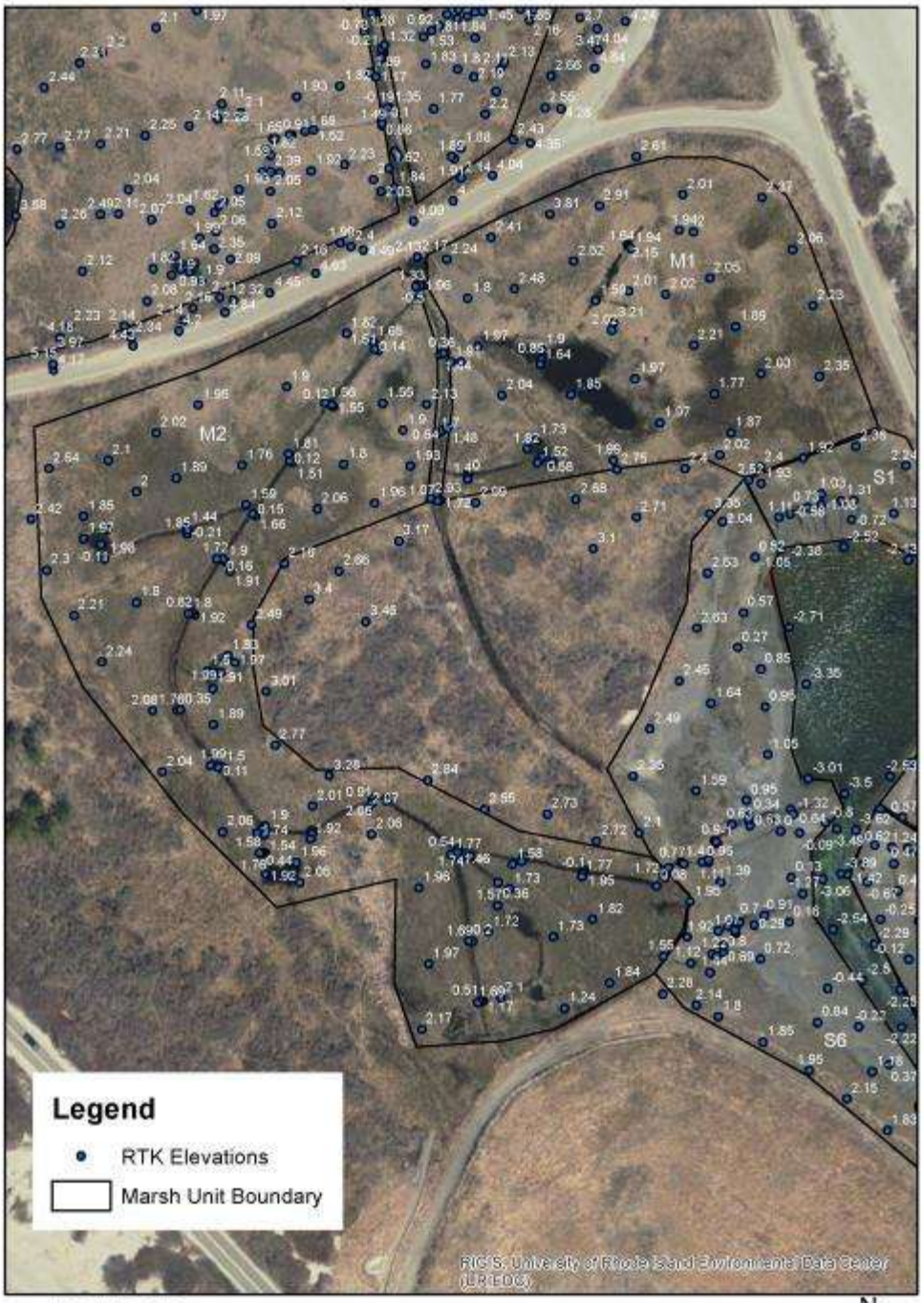
South Marsh	S5	?	0.04	1.1%
South Marsh	S5	Bare	0.03	0.8%
South Marsh	S5	DIS	0.05	1.4%
South Marsh	S5	INT ALT	0.66	17.0%
South Marsh	S5	JUN	0.00	0.0%
South Marsh	S5	Mix INT ALT & Salicornia	0.33	8.4%
South Marsh	S5	Mud Flat	0.94	24.1%
South Marsh	S5	Patens	0.01	0.3%
South Marsh	S5	Phragmites	0.03	0.7%
South Marsh	S5	Pool	0.31	7.9%
South Marsh	S5	roads and other upland	1.26	32.3%
South Marsh	S5	Salicornia	0.17	4.5%
South Marsh	S5	SF ALT	0.06	1.5%
	S5	total	3.89	
South Marsh	S6	?	0.00	0.1%
South Marsh	S6	Bare	0.15	5.8%
South Marsh	S6	DIS	0.06	2.4%
South Marsh	S6	INT ALT	0.51	19.3%
South Marsh	S6	JUN	0.00	0.1%
South Marsh	S6	Mud Flat	0.78	29.2%
South Marsh	S6	Patens	0.01	0.3%
South Marsh	S6	Phragmites	0.13	4.8%
South Marsh	S6	roads and other upland	0.50	18.6%
South Marsh	S6	SF ALT	0.52	19.4%
	S6	total	2.67	
none	none	?	0.01	0.1%
none	none	Bare	0.00	0.0%
none	none	DIS	0.00	0.0%
none	none	INT ALT	0.04	0.2%
none	none	IVA	0.18	1.0%
none	none	JUN	0.01	0.1%
none	none	Mix (Dis, S. Alterniflora, S. Patens)	0.00	0.0%
none	none	Mix INT ALT & Salicornia	0.00	0.0%
none	none	Mud Flat	0.05	0.3%
none	none	Patens	0.01	0.0%
none	none	Phragmites	1.18	6.9%
none	none	roads and other upland	15.58	91.2%
none	none	Salicornia	0.00	0.0%
none	none	SF ALT	0.01	0.1%
	none	total	17.09	

Section	Cover Type	Acres	Percent
North Marsh	?	0.81	6.9%
North Marsh	DIS	0.45	3.9%
North Marsh	INT ALT	0.19	1.6%
North Marsh	IVA	1.26	10.8%
North Marsh	JUN	0.82	7.0%
North Marsh	Mix (Dis, S. Alterniflora, S. Patens)	2.67	22.8%
North Marsh	Panne	0.12	1.0%
North Marsh	Patens	0.49	4.2%
North Marsh	Phragmites	0.67	5.7%
North Marsh	Pool	0.07	0.6%
North Marsh	roads and other upland	1.62	13.8%
North Marsh	SF ALT	2.19	18.7%
North Marsh	Transition Zone PAT / ALT Mix	0.35	3.0%
North Marsh	total	11.70	
Middle Marsh	?	0.25	3.6%
Middle Marsh	DIS	0.17	2.4%
Middle Marsh	IVA	0.38	5.5%
Middle Marsh	JUN	0.02	0.3%
Middle Marsh	Panne	0.01	0.2%
Middle Marsh	Patens	0.64	9.2%
Middle Marsh	Phragmites	3.22	46.6%
Middle Marsh	Pool	0.21	3.1%
Middle Marsh	roads and other upland	1.61	23.3%
Middle Marsh	SF ALT	0.38	5.6%
Middle Marsh	Transition Zone PAT / ALT Mix	0.02	0.3%
Middle Marsh	total	6.92	
South Marsh	?	0.22	1.3%
South Marsh	Bare	1.31	7.9%
South Marsh	DIS	0.22	1.3%
South Marsh	INT ALT	3.76	22.7%
South Marsh	IVA	0.01	0.1%
South Marsh	JUN	0.01	0.0%
South Marsh	Mix INT ALT & Salicornia	0.44	2.7%
South Marsh	Mud Flat	3.21	19.4%
South Marsh	Patens	0.03	0.2%
South Marsh	Phragmites	0.26	1.5%
South Marsh	Pool	0.36	2.2%
South Marsh	roads and other upland	4.20	25.3%
South Marsh	Salicornia	1.14	6.9%
South Marsh	SF ALT	1.42	8.6%
South Marsh	total	16.59	
none	?	0.01	0.1%
none	Bare	0.00	0.0%
none	DIS	0.00	0.0%
none	INT ALT	0.04	0.2%
none	IVA	0.18	1.0%
none	JUN	0.01	0.1%
none	Mix (Dis, S. Alterniflora, S. Patens)	0.00	0.0%
none	Mix INT ALT & Salicornia	0.00	0.0%
none	Mud Flat	0.05	0.3%
none	Patens	0.01	0.0%
none	Phragmites	1.18	6.9%
none	roads and other upland	15.58	91.2%
none	Salicornia	0.00	0.0%
none	SF ALT	0.01	0.1%
none	total	17.09	

Appendix 4

Sachuest NWR Maidford River Resiliency Project - North Marsh RTK

Sachuest NWR Maidford River Resiliency Project - Middle Marsh RTK

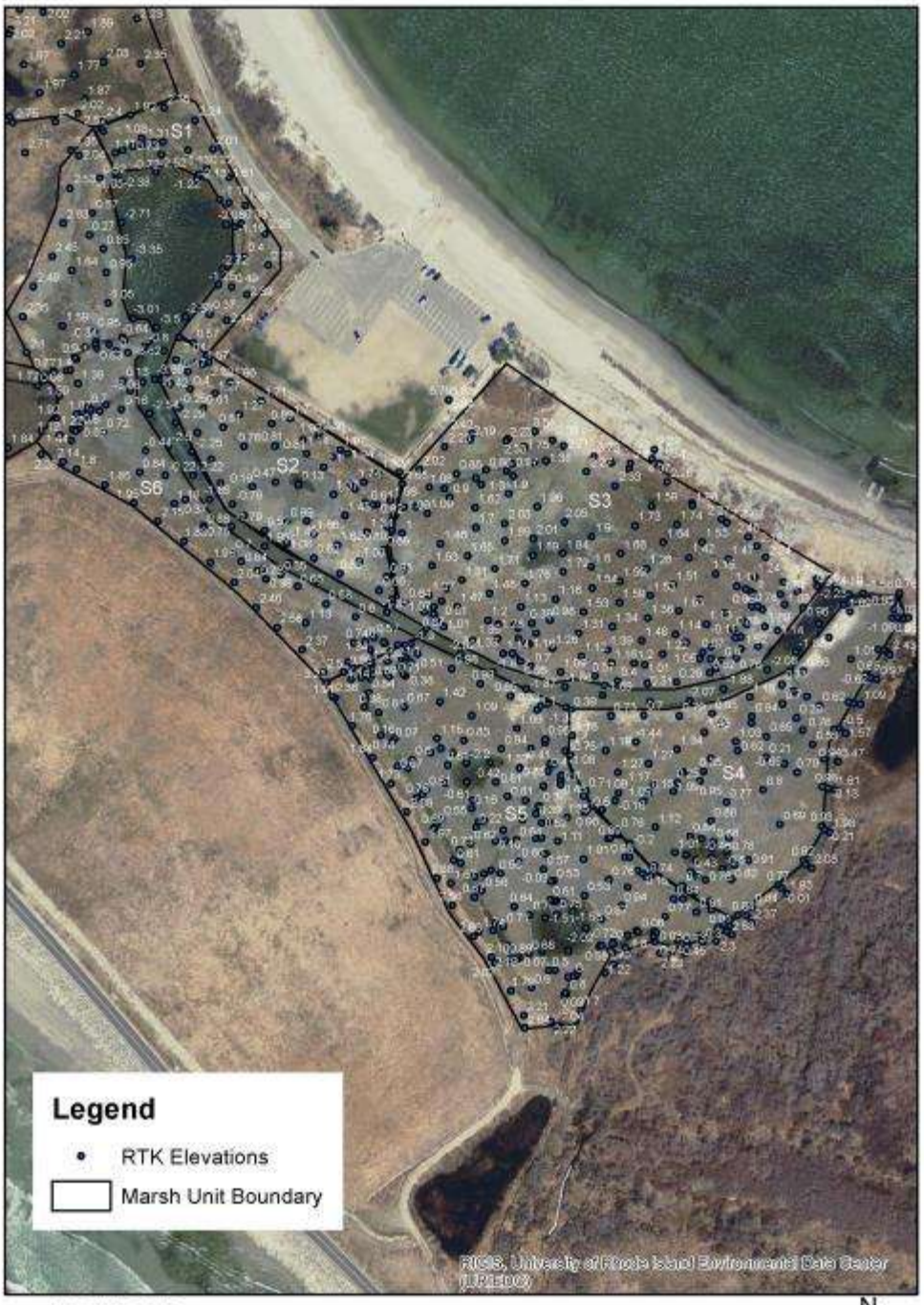


US FWS 2015
Land lines approximate

0 125 250 500 Feet

N

Sachuest NWR Maidford River Resiliency Project - South Marsh RTK



US FWS 2015
Land lines approximate

0 125 250 500 Feet

N

Appendix 5

Sachuest Point National Wildlife Refuge: Nekton Summary

Nektons (free swimming fishes and crustaceans) play an integral role in the saltmarsh ecosystem. They make up large portions of the diets of many species of marsh birds, mammals, and economically valuable fish species. Furthermore, because they link primary producers and predators that are higher up on the food chain, nektons are highly integrated within the estuarine ecosystem and may serve as effective indicators to document changes occurring in saltmarshes over time.

The Service initiated a long-term nekton monitoring program beginning in 2012 in order to evaluate changes in nekton communities over time, and to better understand the interactions between nekton and the dynamic estuarine environment. For sampling purposes, the saltmarsh habitat at Sachuest Point NWR was divided into two units, the Maidford Marsh Unit (established in 2012), and the Restored Marsh Unit (established in 2014). Within each unit, nektons are surveyed along marsh creeks, ditches, and pools at 20 randomly chosen locations (Figure 1).

Eleven species of nektons were documented between the Maidford Marsh and the Restored Marsh Units in 2012 and 2014, respectively (Table 1). The most commonly found species were Mummichog (*Fundulus heteroclitus)*, grass shrimp (*Palaemonetes pugio)*, sheepshead minnow (*Cyprinodon variegatus)*, and European Green Crab (*Carcinus maenas)* (Figure 2 and 3). Nekton density and species richness were both lower in the Maidford Marsh Unit than in the Restored Marsh Unit (Figure 3 and 4).

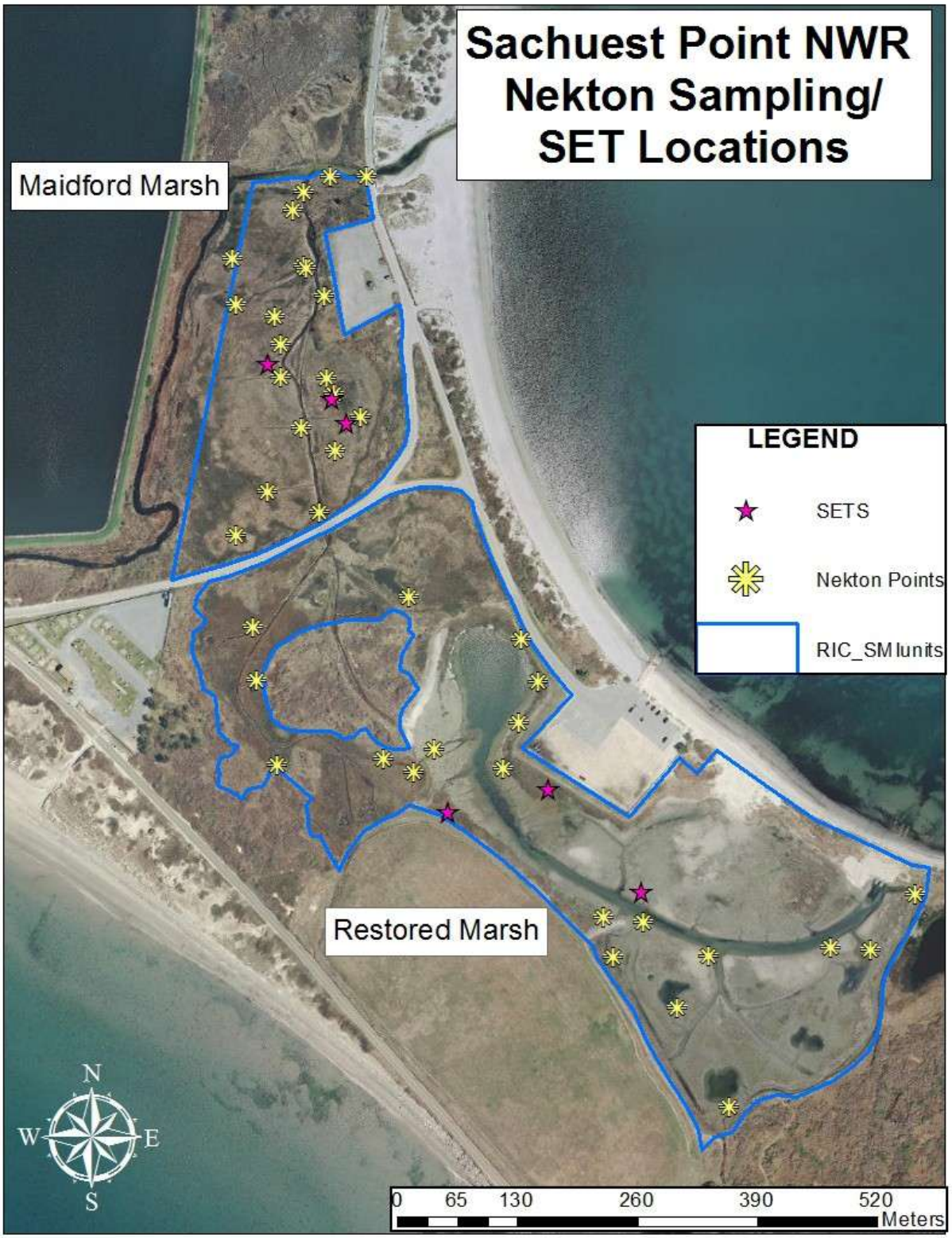


Figure 1. Nekton sampling locations at Sachuest Point NWR. The Maidford Marsh Unit was established in 2012, and the Restored Marsh Unit was established in 2014.

Table 1. Nekton species documented at Sachuest Point NWR in 2012 and 2014.

Species	Scientific Name	USFWS Maidford Marsh (2012)	USFWS Restored Marsh (2014)
Mummichog	*Fundulus heteroclitus*	X	X
Striped Killifish	*Fundulus majalis*		X
Sheepshead Minnow	*Cyprinodon variegatus*	X	X
Alewife	*Alosa pseudoharengus*	X	
Atlantic Silverside	*Menidia menidia*	X	X
American eel	*Anguilla rostrata*		X
Daggerblade Grass Shrimp	*Palaemonetes pugio*	X	X
Sand Shrimp	*Crangon septemspinosa*	X	X
European Green Crab	*Carcinus maenas*	X	X
Blue Crab	*Callinectes sapidus*		X
Asian Shore Crab	*Hemigrapsus sanguineus*		X

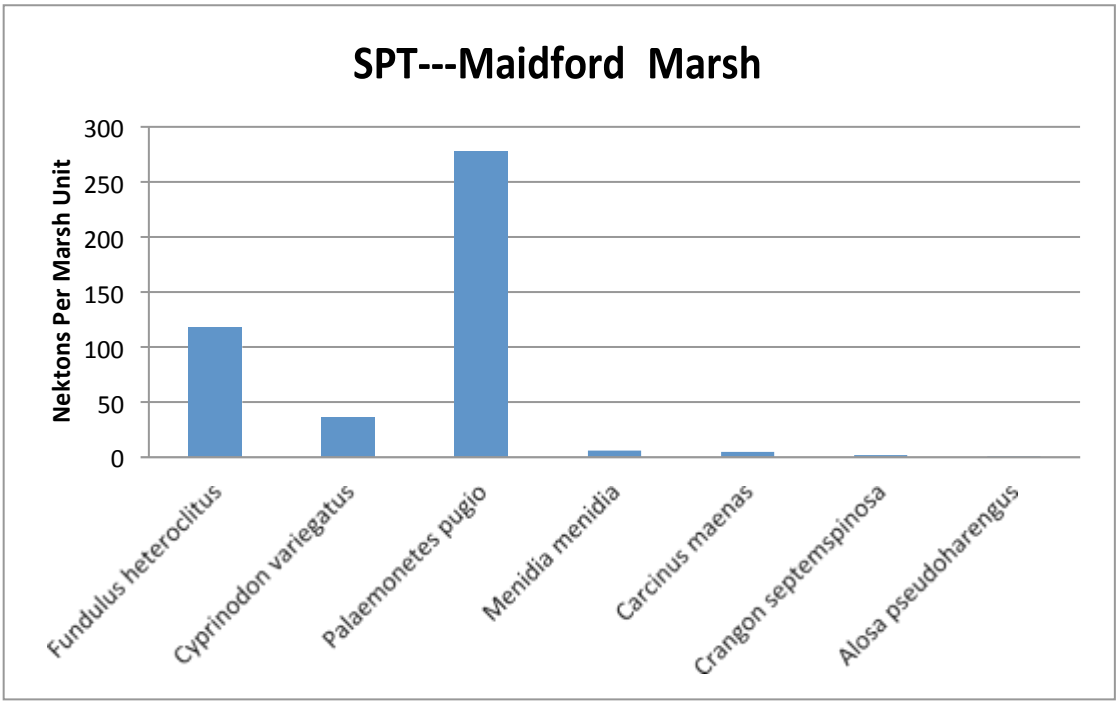


Figure 2. Nekton species sampled at Sachuest Point NWR in 2012, in the Maidford Marsh Unit

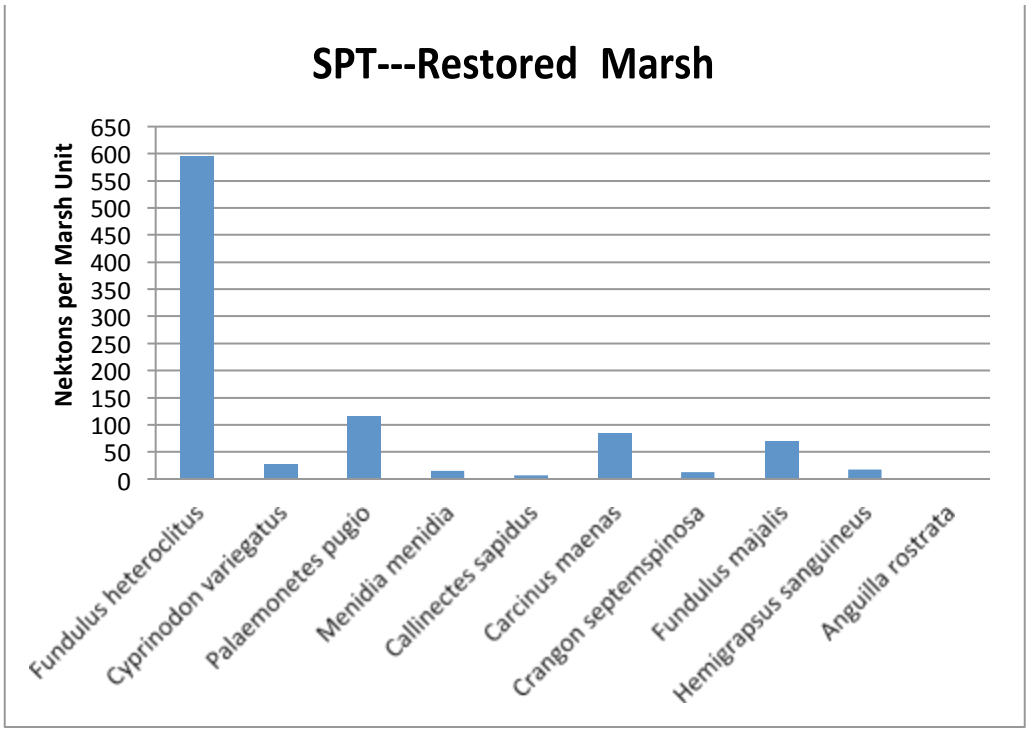


Figure 3. Nekton species sampled at Sachuest Point NWR in 2014, in the Restored Marsh Unit.

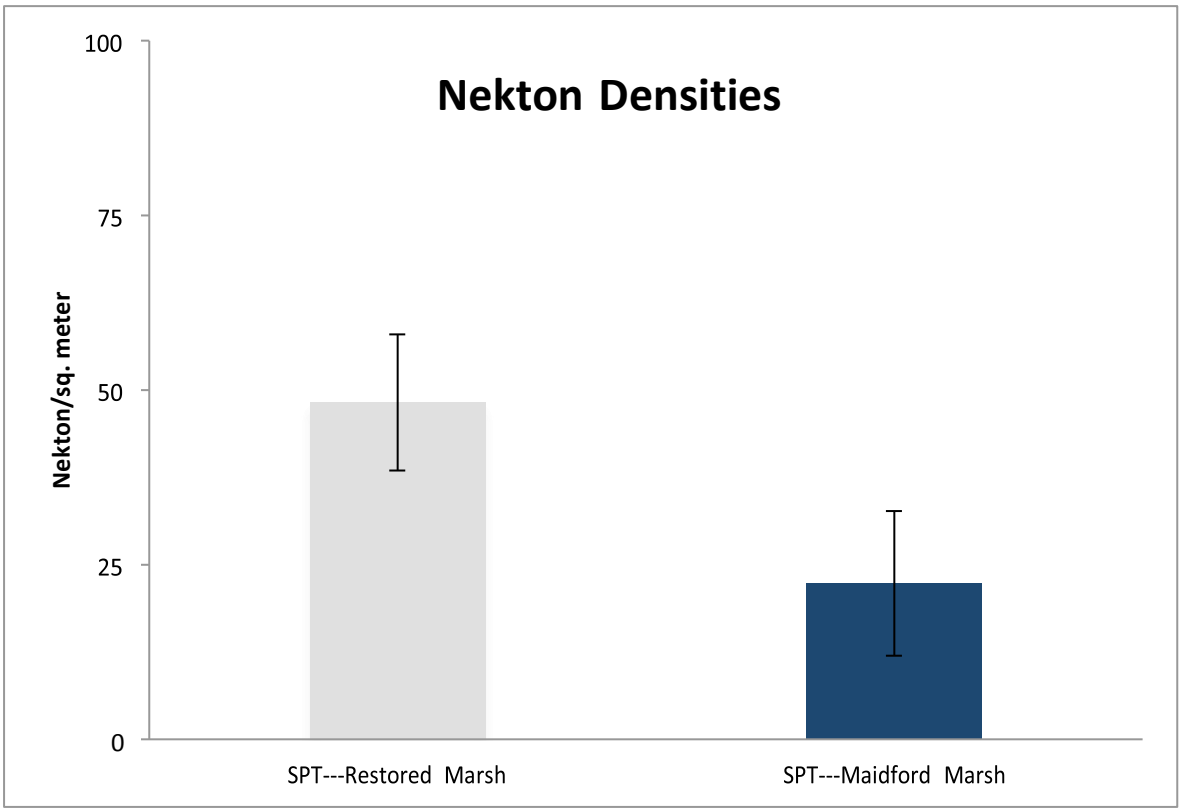


Figure 4. Nekton densities at Sachuest Point NWR. The Maidford Marsh Unit was sampled in 2012 and the Restored Marsh Unit was sampled in 2014.

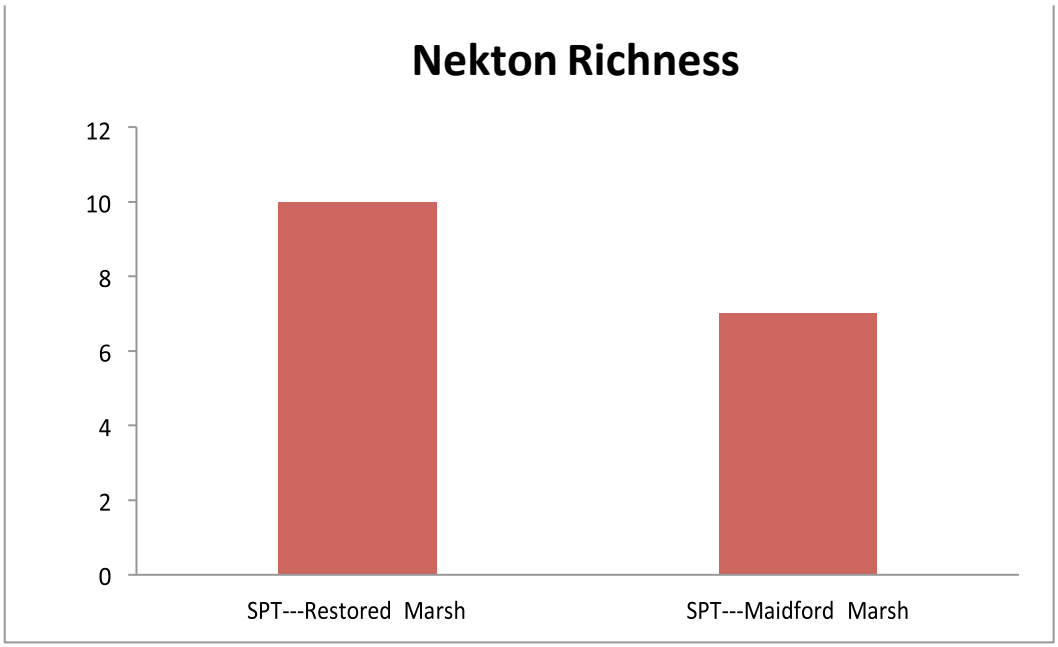


Figure 5. Nekton species richness at Sachuest Point NWR. The Maidford Marsh Unit was sampled in 2012 and the Restored Marsh Unit was sampled in 2014

Appendix 6

Sachuest NWR Maidford River Resiliency Project - Shellfish Survey

U.S. Fish and Wildlife Service
50 Bend Road Charlestown, RI 02813

0 125 250 500 Feet

N

Appendix 7: Fish Species Present in Sakonnet River from RIDEM Trawl and Seine Surveys, 1979 - 2014

Common Name	Scientific Name
Alewife	*Alosa pseudoharengus*
American Eel	*Anguilla rostrata*
American Lobster	*Homarus americanus*
American Sand Lance	*Ammodytes americanus*
American Shad	*Alosa sapidissima*
Atlantic Cod	*Gadus morhua*
Atlantic Herring	*Clupea harengus*
Atlantic Mackerel	*Scomber scombrus*
Atlantic Menhaden	*Brevoortia tyrannus*
Atlantic Moonfish	*Selene setapinnis*
Atlantic Needlefish	*Strongylura marina*
Atlantic Silverside	*Menidia menidia*
Atlantic Tomcod	*Microgadus tomcod*
Banded Rudderfish	*Seriola zonata*
Bay Anchovy	*Anchoa mitchilli*
Black Sea Bass	*Centropristis striata*
Blue Crab	*Callinectes sapidus*
Blueback Herring	*Alosa aestivalis*
Bluefish	*Pomatomus saltatrix*
Bluespotted Cornetfish	*Fistularia commersonii*
Bothids	*Bothidae*
Butterfish	*Peprilus triacanthus*
Channeled Whelk	*Busycotypus canaliculatus*
Chub Mackerel	*Scomber japonicus*
Clearnose Skate	*Raja eglanteria*
Common Mummichog	*Fundulus heteroclitus*
Crevalle Jack	*Caranx hippos*
Cunner	*Tautogolabrus adspersus*
Cusk-eel Fawn	*Lepophidium cervinum*
Dwarf Goatfish	*Upeneus parvus*
Filefish	*Monacanthidae*
Florida Pompano	*Trachinotus carolinus*
Flying Gurnard	*Dactylopterus volitans*
Four-Spine Stickleback	*Apeltes quadracus*
Fourspot Flounder	*Hippoglossina oblonga*
Gizzard Shad	*Dorosoma cepedianum*
Grey Snapper	*Lutjanus griseus*
Grubby	*Myoxocephalus aenaeus*
Grubby Sculpin	*Myoxocephalus*

Striped Searobin	*Prionotus evolans*
Summer Flounder	*Paralichthys dentatus*
Tautog	*Tautoga onitis*
Weakfish	*Cynoscion regalis*
White Hake	*Urophycis tenuis*
White Mullet	*Mugil curema*
Windowpane Flounder	*Scophthalmus aquosus*
Winter Flounder	*Pseudopleuronectes americanus*
Winter Skate	*Leucoraja ocellata*

Appendix 8: Potential EFH Species Present in Sakonnet River (NOAA Habitat Mapper 2015)

Common Name	Species Name	Life Stage
Atlantic Cod	*Gadus morhua*	Adult, ALL
Bluefin Tuna	*Thunnus thynnus*	Juvenile, Adult
Common Thresher Shark	*Alopias vulpinus*	ALL
Ocean Pout	*Zoarces americanus*	Juvenile, Adult, Eggs, Larvae, ALL
Red Hake	*Urophycis chuss*	Larvae, Juvenile, Eggs, ALL
Sand Tiger Shark	*Carcharias taurus*	Neonate, ALL
Sandbar Shark	*Carcharhinus plumbeus*	Adult, ALL
Silver Hake	*Merluccius bilinearis*	Larvae, Juvenile, ALL, Eggs
White Shark	*Carcharodon carcharias*	ALL
Window Pane Flounder	*Scophthalmus aquosus*	Juvenile, Adult, ALL
Winter Flounder	*Pseudopleuronectes americanus*	Larvae, Eggs, Juvenile, Adult, ALL

Appendix 9: Excerpts from Grilli & Spaulding Presentation

Application of an inlet-basin hydrodynamic model to predict circulation in the Maidford River - Sachuest Marsh System

Annette Grilli[1] and Malcolm L. Spaulding[2]

[1]Research Associate Professor, Ocean Engineering, University of RI, Narragansett, RI

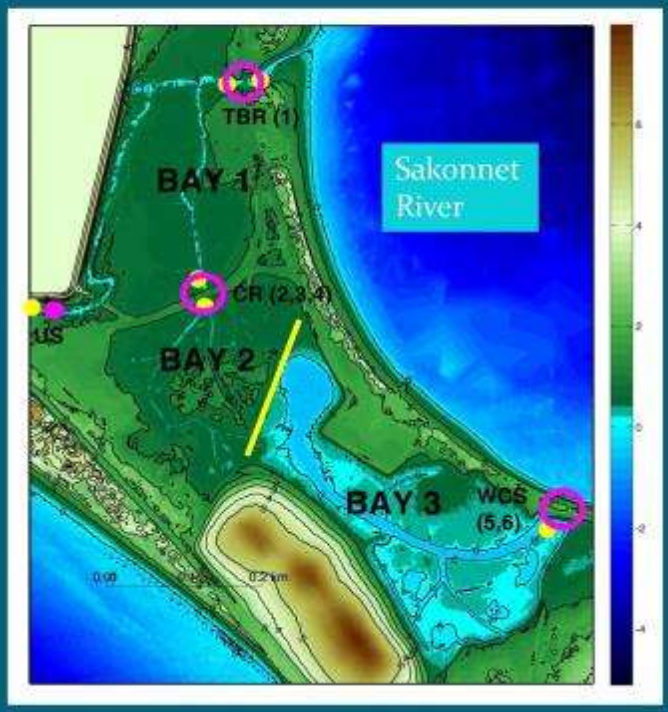
[2]Professor Emeritus, Ocean Engineering, University of RI, Narragansett, RI and Spaulding Environmental Associates (SEA), LLC, Wakefield, RI

The Nature Conservancy
159 Waterman Street
Providence, RI

U.S. Fish and Wildlife Service
50 Bend Road
Charlestown, RI 02813

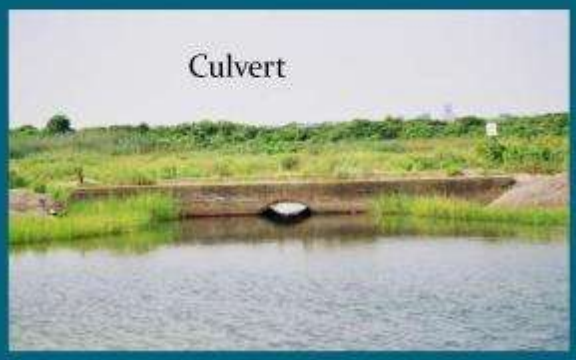
March 11, 2015

Maidford River – Sachuset Marsh System
Location and Elevation



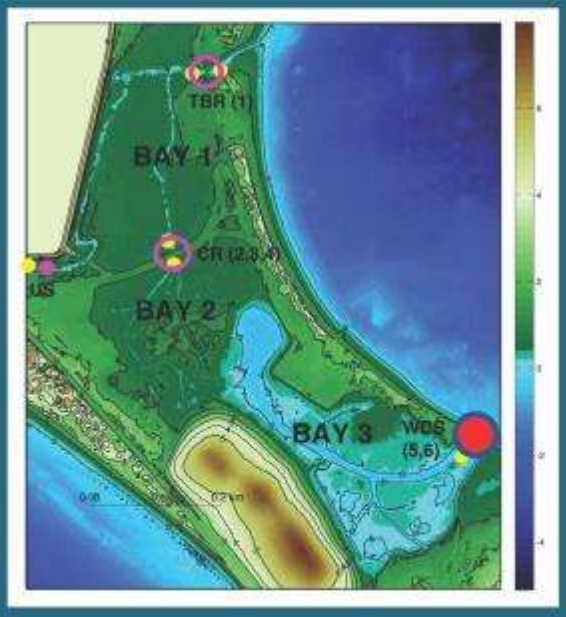
US- Maidford River Discharge
Bay 1- unrestricted marsh
TBR- Third Beach Road culvert(1) and inlet
CR- Culverts(2,3,&4) at Connector Rd
Bay 2- northern end of restricted marsh
Bay 3- southern end of restricted marsh
WCS- water control structure (5&6)

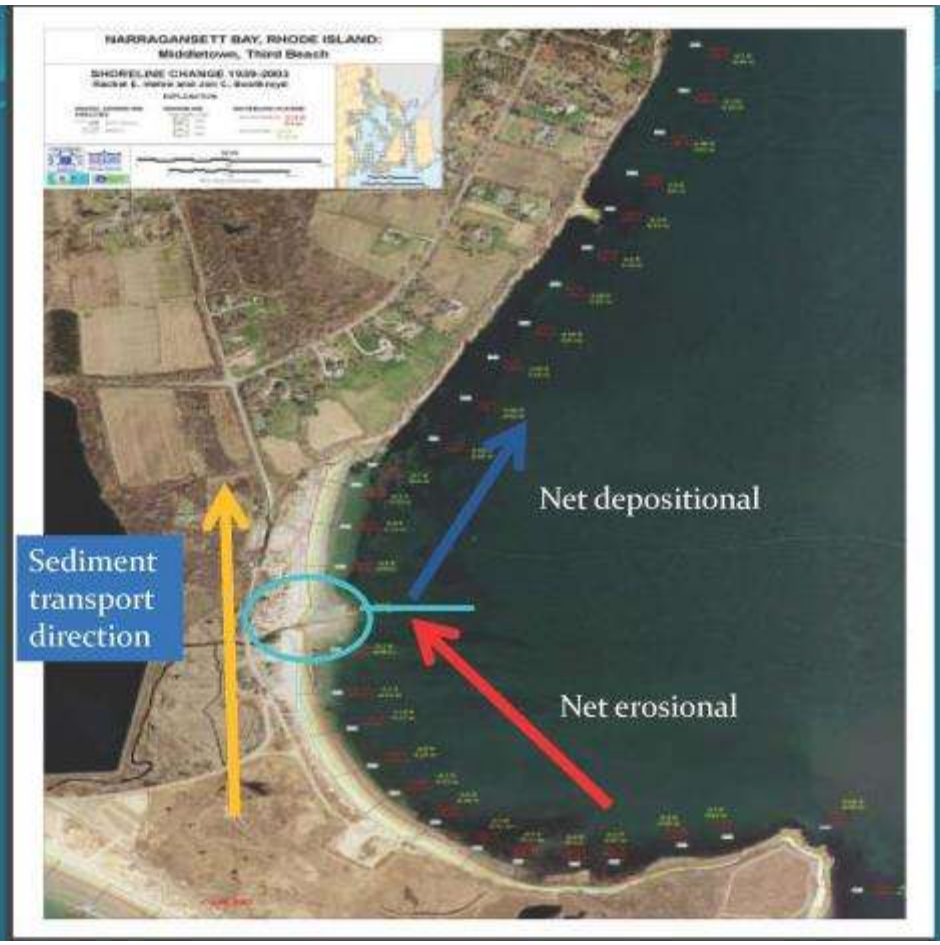
Third Beach Road Culvert(1) and Inlet



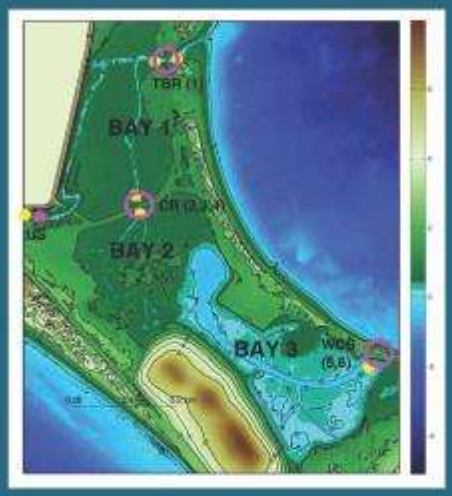
Connector Road Culverts (2,3 &4)

Water Control Structure (5&6)




NARRAGANSETT BAY, RHODE ISLAND:
Middletown, Third Beach
SHORELINE CHANGE 1939-2003
Net depositional
Sediment transport direction
Net erosional

Maidford Marsh Inlet-Basin System



Maidford River

Un-restricted marsh (basin)

Tidal culvert -inlet Third Beach Rd

Bay 1

Connector Rd Culverts

Sakonnet River

Bay 2

Restricted marsh (basins)

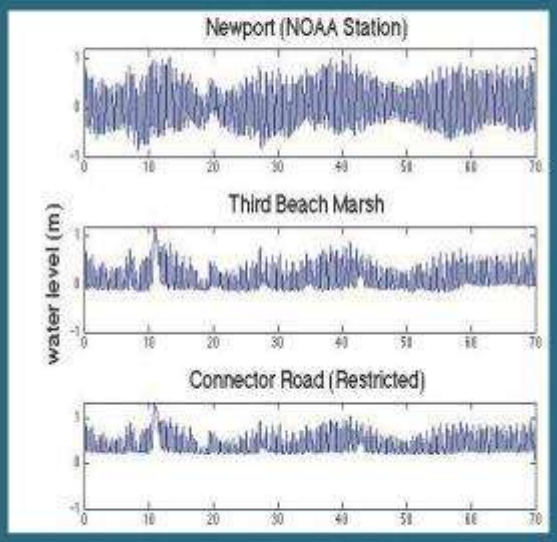
Water Control Structure

Bay 3

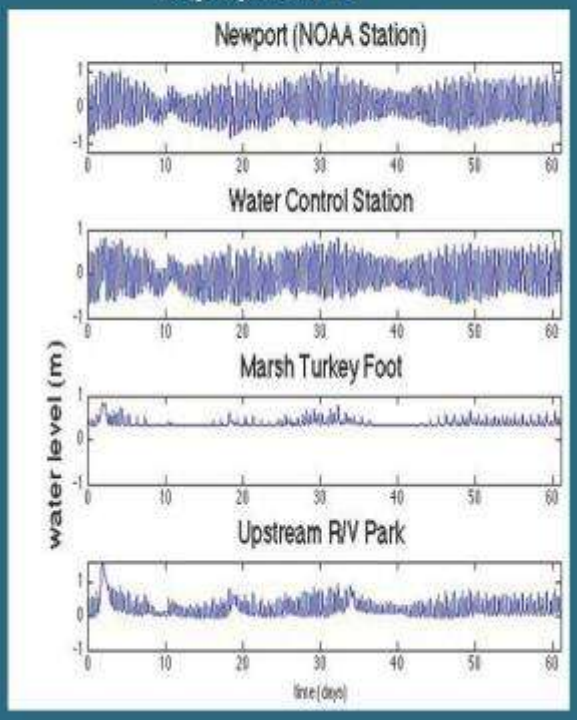
Each basin has hypsographic curve – storage capacity vs elevation

Water level- Deployment #1 and 2

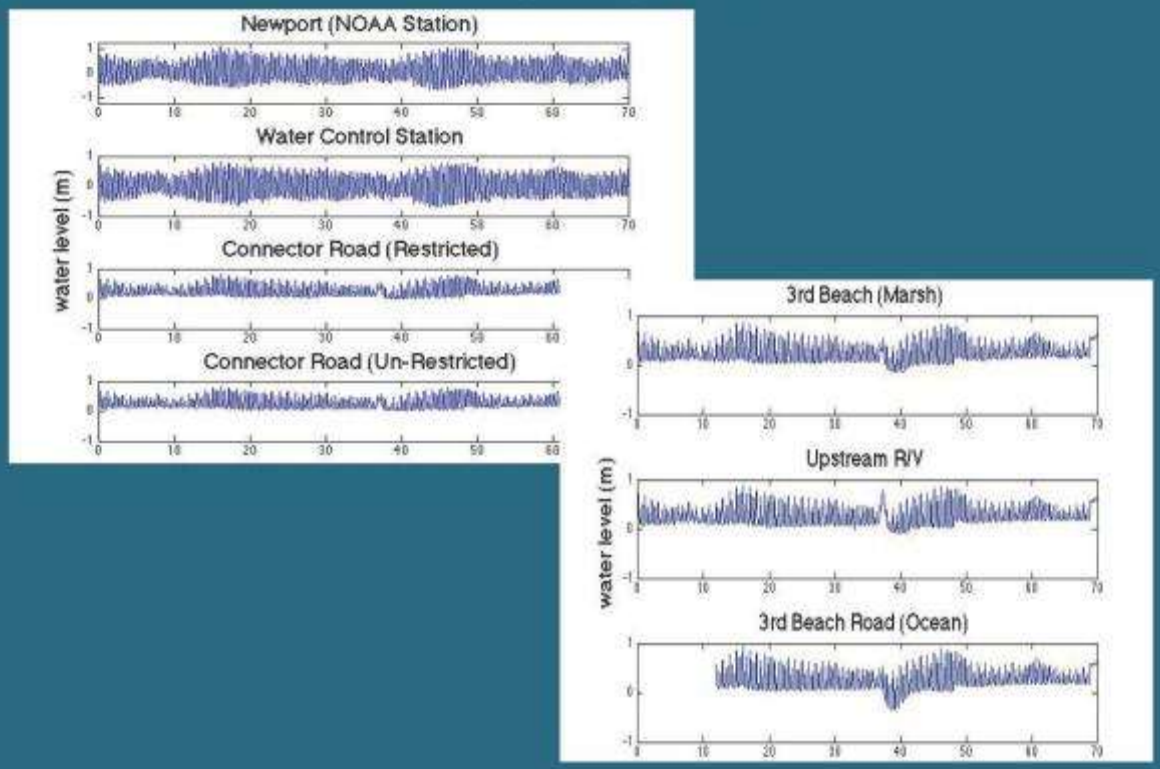
Deployment #1



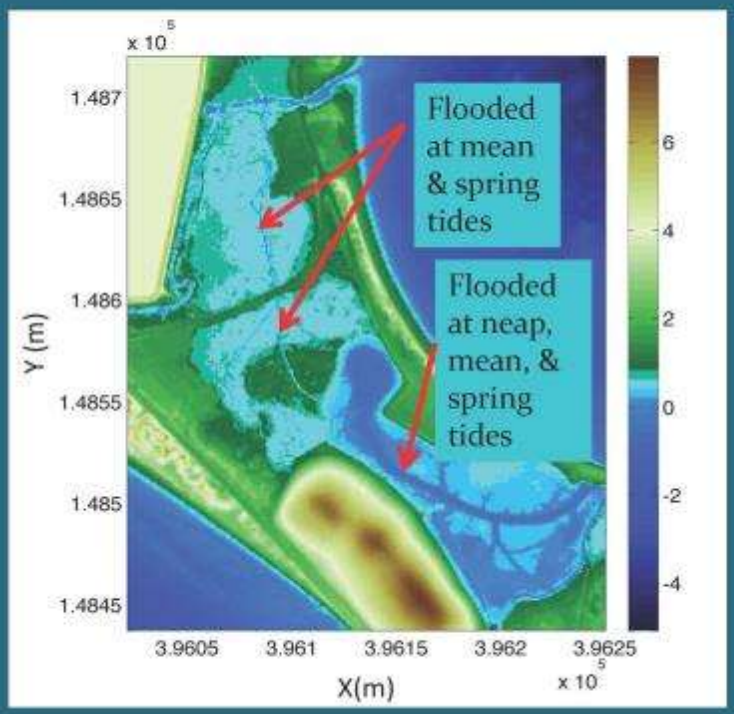
Deployment #2



Water level- Deployment #3



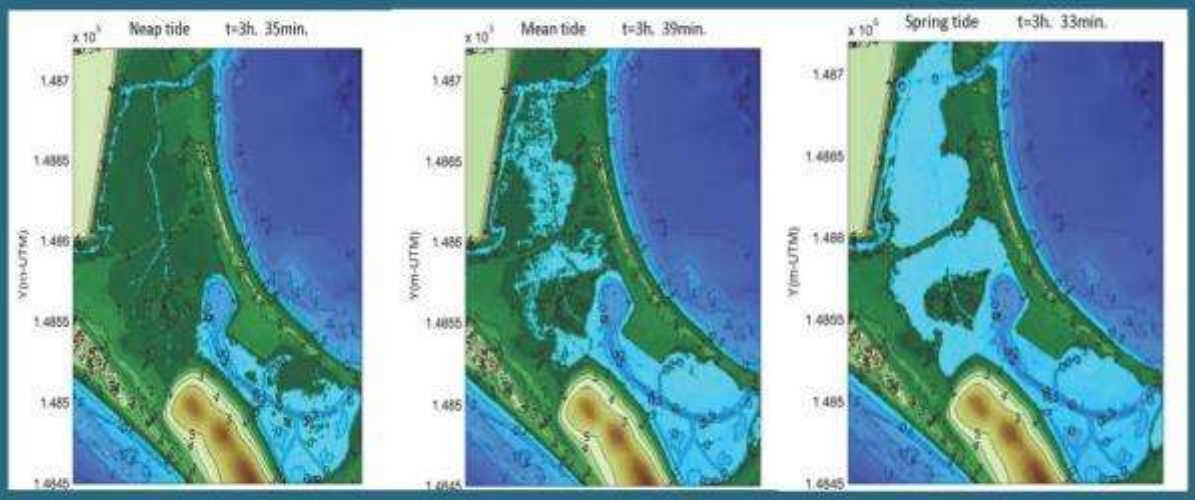
Tidal Inundation zones



Neap, mean, and spring tide -0.4 m (dark blue)
Mean and spring tide – 0.6 m (bright blue)
Spring tide -0.8 m (green-blue)

Animations of water level vs time for neap, mean and spring tides

Example: water levels at neap, mean and spring high tide



Observations

- Circulation and associated water level variations in marsh system primarily tidal.
- Little inflow from Maidford River under normal conditions.
- Bays 1 and 2 and Third Beach Road culvert-inlet operate as one unit, Bay 3 and WCS as a separate unit. Little exchange between Bays 2 and 3, except in storms
- Tidal ranges in Bays 1 and 2 comparable, 40 to 50% of Sakonnet River (truncation of low tide due to invert depth of culvert/inlet), Tidal range in Bay 3 and Sakonnet River the same.
- Freshwater input from rainfall events impact marsh for time equivalent to duration of the event.

Appendix 10

STATE OF RHODE ISLAND AND PROVIDENCE PLANTATIONS
HISTORICAL PRESERVATION & HERITAGE COMMISSION
Old State House • 150 Benefit Street • Providence, R.I. 02903-1209
TEL (401) 222-2678 FAX (401) 222-2968
TTY / Relay 711 Website www.preservation.ri.gov

30 December, 2014

Charles E. Vandemoer
US Fish and Wildlife
RI National Wildlife Refuge Complex
50 Bend Road
Charlestown, RI 02813

RE: Proposed Maidford River Saltmarsh Restoration Project
Sachuest Point National Wildlife Refuge
Middletown, RI

Dear Mr. Vandemoer:

The Rhode Island Historical Preservation and Heritage Commission (RIHPHC) staff has reviewed information that you provided for the above-referenced project.

We agree that an archaeological survey is an appropriate course of action with regard to the realignment of Connector Road. None of the other proposed activities will have any effect on any significant cultural resources. Therefore, pending the results of the archaeological survey, we have no objections to the project.

These comments are provided in accordance with the *Procedures for the Registration and Protection of Historic Properties of the Rhode Island Historical Preservation Commission* and with Section 106 of the National Historic Preservation Act. If you have any questions, please contact Charlotte Taylor, archaeologist at this office.

Very truly yours,

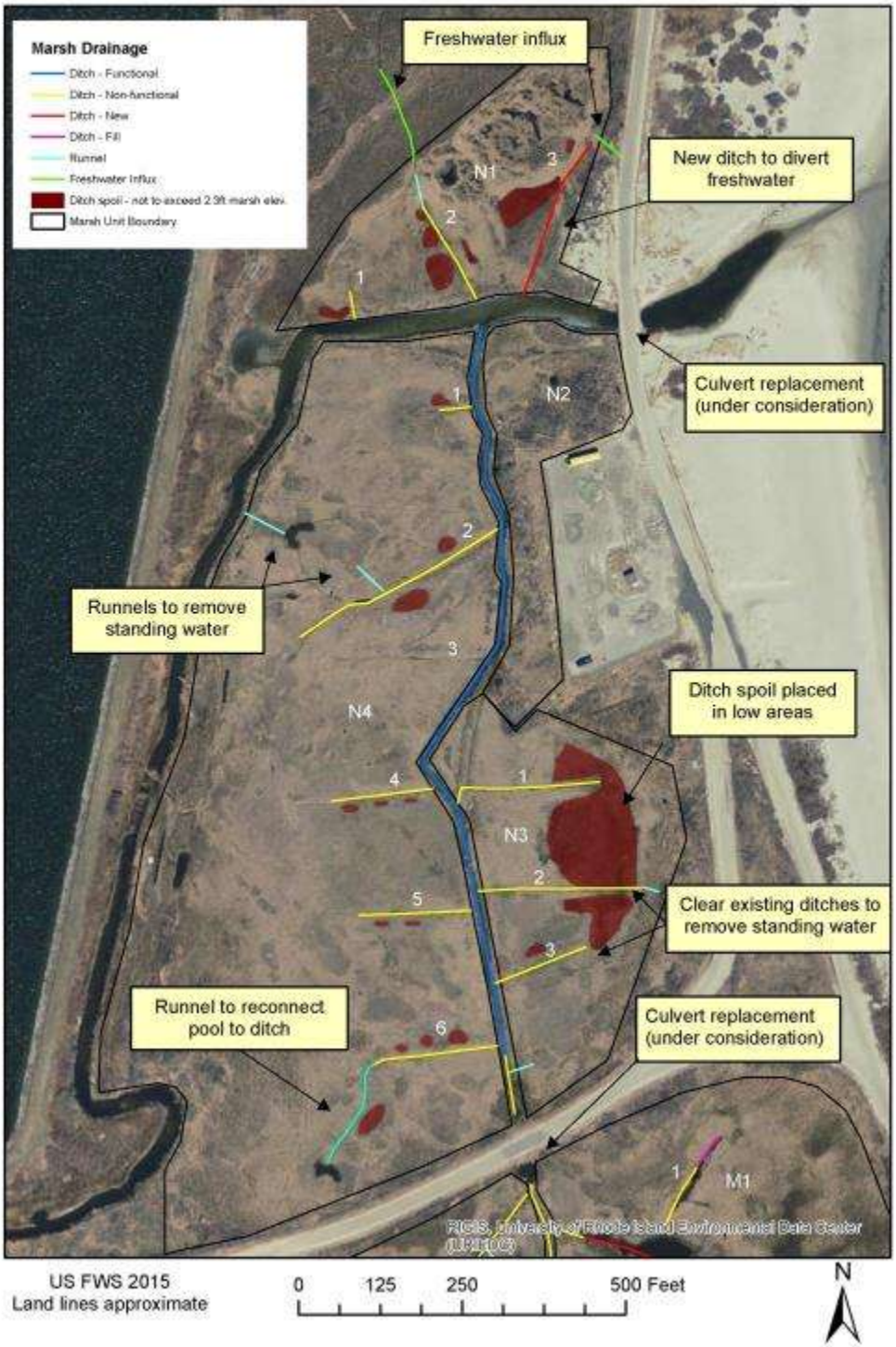
Charlotte Taylor for

Edward Sanderson
Executive Director
Deputy State Historic Preservation Officer

141230.01

Appendix 11

Sachuest NWR Maidford River Resiliency Project - North Marsh Drainage

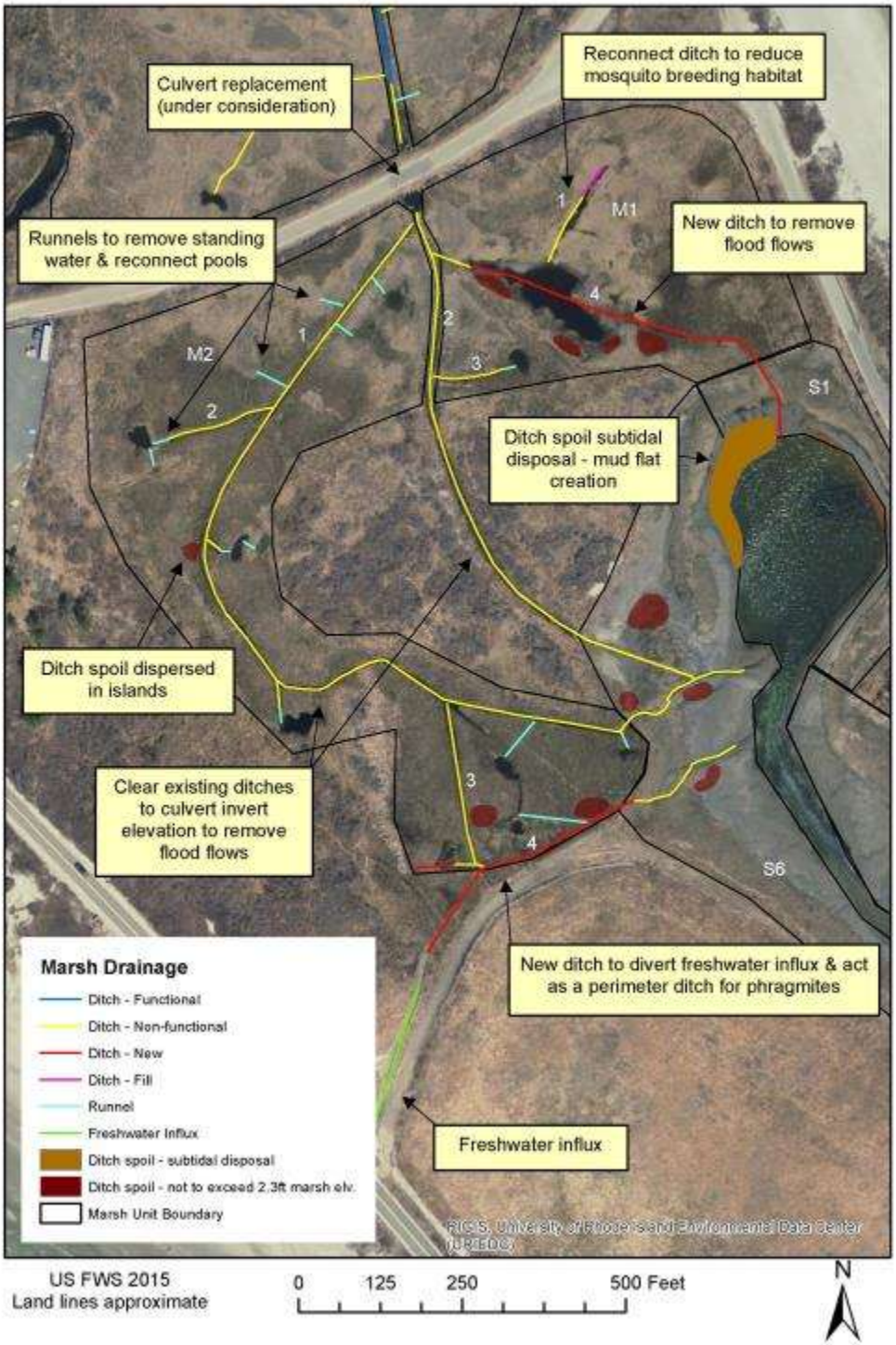


US FWS 2015
Land lines approximate

0 125 250 500 Feet

N

Sachuest NWR Maidford River Resiliency Project - Middle Marsh Drainage

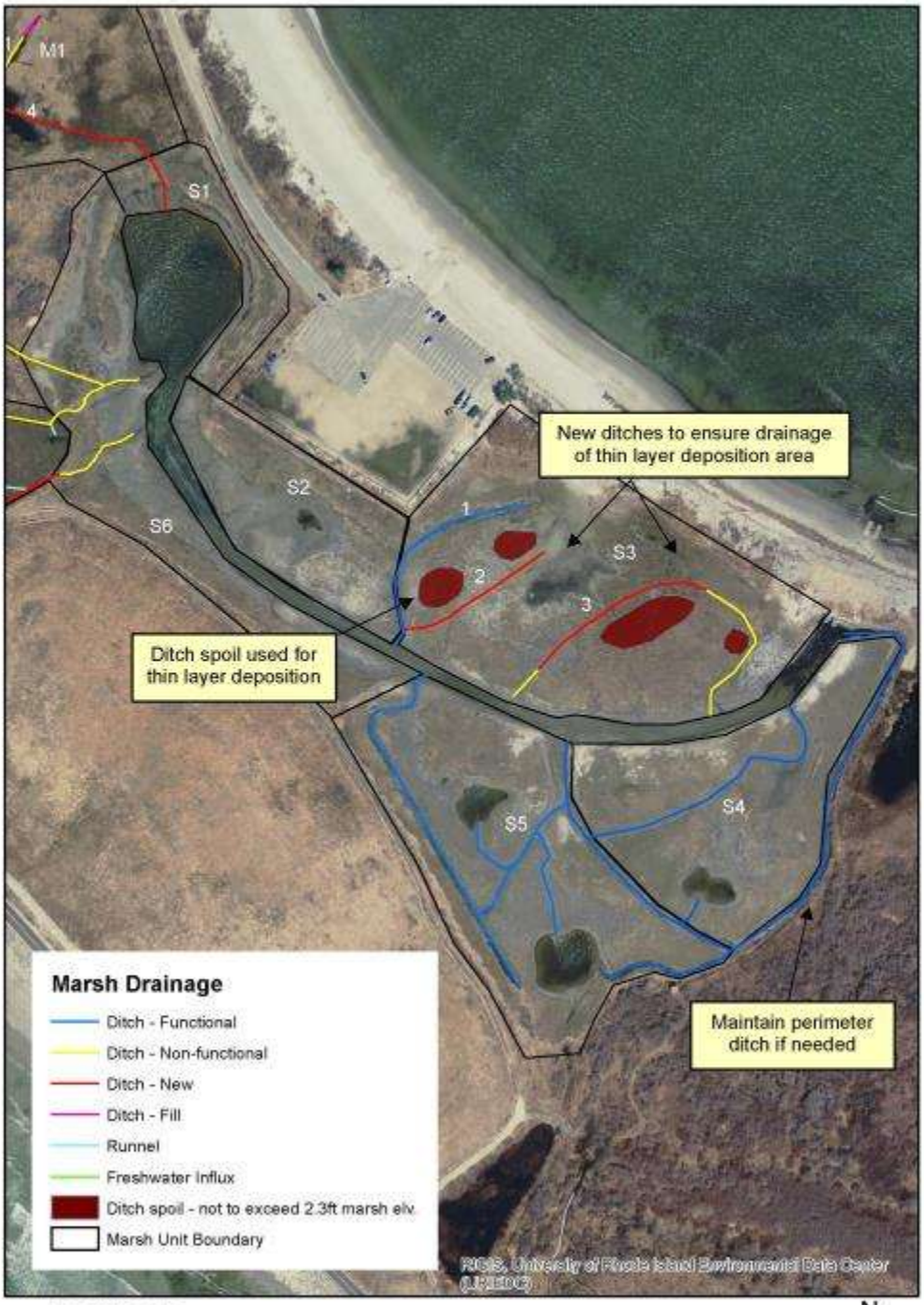


US FWS 2015
Land lines approximate

0 125 250 500 Feet

N

Sachuest NWR Maidford River Resiliency Project - South Marsh Drainage



US FWS 2015
Land lines approximate

0 125 250 500 Feet

N

Sachuest NWR Maidford River Resiliency Project - Marsh Drainage Conditions

Marsh unit	Total Acres (salt marsh)	Marsh Drainage (ft)				Conditions of Marsh Surface		Salt marsh impacted-clogged drainage	Comments
		River	Ditches and Sloughs			Well drained salt marsh habitat	Poorly drained salt marsh habitat		
			Functional	Non-FNCT	New				
North Marsh		2545	1181	1698	265				
Middle Marsh			0	2836	1127				
South Marsh		1880	4509	411	770				
Total		**4425**	**5690**	**4945**	**2162**				

Seahawk RMP Modified River Heathrow Project - Ditch Summary Non-Functional & New

Marsh-wide Ditch #	Description	Existing conditions width (ft)	Existing conditions depth (ft)	Existing conditions length (ft)	Proposed Treatment width (ft)	Proposed Treatment depth (ft)	Difference width (ft)	Difference depth (ft)	Existing conditions sq. feet	Proposed Conditions sq. feet	Difference sq. feet	Difference Cubic ft	cubic yds	Comment
N1_1	North Marsh	1.84	0.67	45	2.0	1.0	0.16	0.33	1.23	3.70	2.46	111.12	4.14	A culvert would be needed at outlet as well at this location
N2_1		3.00	1.17	110	3.00	1.0	0	0.17	3.51	4.00	0.49	53.67	2.0	
N3_1_New	Short Hydroplane	0.00	0.00	290	1.0	1.0	1.00	1.00	0.00	2.90	2.90	840.71	31.08	Small ditch or short hydroplane in the tree road
N4_1		1.00	0.83	67	2.0	1.0	1.00	0.17	0.83	2.00	1.17	78.34	2.9	
N5_1		1.17	0.83	152	2.0	1.0	0.83	0.17	0.97	3.00	2.03	308.67	34.03	Note: Ditches expand to 1.1 width is a maximum. 0.25 width may be sufficient. Same for clearing depth of 18"
N6_1		1.00	0.67	180	2.0	1.0	0.00	0.33	1.00	3.70	2.70	180.00	18.19	
N7_1		1.00	0.83	400	2.0	1.5	0.13	0.67	1.30	3.70	2.39	35.31	1.48	
N8_1		1.25	0.50	640	2.0	1.0	0.80	0.50	1.04	3.30	2.26	867.20	31.53	
N9_1		1.33	0.91	120	2.0	1.0	0.68	0.09	1.21	3.70	2.49	299.08	10.19	No clearing
N9_4		1.80	0.80	152	2.0	1.5	0.20	0.70	1.50	3.70	2.20	334.50	12.39	
N9_5		1.08	1.00	170	2.0	1.0	1.00	0.00	1.08	3.70	2.62	445.54	16.17	
N9_6		0.00	0.80	180	2.0	1.0	0.00	0.20	0.00	3.70	3.70	666.00	24.66	
Total North Marsh				**2363**									**185.75**	
Non-functional				**1598**										
New				**765**										

M1_1	Middle Marsh	2.50	0.41	150	2.50	1.5	0.00	1.09	1.03	3.75	2.72	414.00	15.33	
M1_2_NW	Through-NW	0.70	1.40	180	0.70	2.900	0.00	1.500	0.97	10.14	9.17	1650.00	61.11	
M1_3	Side channel	4.30	1.01	110	4.30	1.2	0.00	0.19	4.34	5.17	0.83	91.30	3.38	
M1_4_New_1	pond	0.00	0.00	90	2.0	2.479	2.00	2.48	0.00	5.00	5.00	445.80	16.51	Western ditch set to invert elevation of connector culverts
M1_4_New_2	Through Pond	0.00	0.00	170	2.0	1.810	2.00	1.81	0.00	3.62	3.62	615.40	22.79	Western ditch set to invert elevation of connector culverts
M1_4_New_3	Through-marsh	0.00	0.00	400	2.0	2.400	2.00	2.40	0.00	4.80	4.80	1920.00	71.11	Western ditch set to invert elevation of connector culverts
M2_1	Main ditch NE	2.13	1.10	190	3.00	1.91	0.87	0.81	2.34	5.73	3.39	643.53	23.83	Western ditch set to invert elevation of connector culverts
M2_2	side channel	4.43	1.01	170	4.43	1.0	0.00	0.19	4.48	4.43	0.05	8.50	0.31	
M2_3	Turbo-tow	4.43	1.01	280	4.43	1.2	0.00	0.24	4.48	5.31	0.83	232.40	8.61	Min possible width for other side pond widths
M2_3_New	Turbo-tow	0.00	0.00	91	3	1.0	3.00	1.00	0.00	4.50	4.50	409.50	15.17	Perimeter ditch for phragmites
M2_4		2.00	1.40	180	2.0	1.40	0.00	0.00	4.04	4.00	0.01	1.80	0.06	
M2_4_New_1	Short hydroplane	0.00	0.00	200	3	1.5	3.00	1.50	0.00	4.50	4.50	900.00	33.33	New ditch in short hydroplane is not away from phragmites & set up a perimeter ditch for phragmites
Total Middle Marsh				**2062**									**470.37**	
Non-functional				**1034**										
New				**1127**										

S1	South Marsh													
S1_1_New	Large new area	0.00	0.00	600	2.0	1.0	2.00	1.00	0.00	3.70	3.70	1332.00	49.33	
S1_3_New		0.00	0.00	470	2.0	1.0	2.00	1.00	0.00	3.70	3.70	1739.00	64.41	
S1_5_1	Muskrat	2.00	1.00	700	2.5	1.5	0.50	0.50	3.75	5.75	2.00	1750.00	64.81	
S1_5_2	Jetting Drain	2.00	0.00	800	2.0	1.0	0.00	0.00	3.64	3.70	0.06	1616.00	59.84	
Total Strawberry				**2570**									**238.39**	
Non-functional				**400**										
New				**770**										
Total				**7127**									**708.3**	
Non-functional				**4032**										
New				**2662**										

Sachuest NWR Maidford River Resiliency Project - Ditches Functional

Marsh unit Ditch #	Description	Existing conditions width (ft)	depth (ft)	length (ft)	Comment
North marsh main ditch				1181	
Total - North Marsh				**1181**	
S3				484	
S4				2217	
S5				1808	
Total - South marsh				**4509**	Also the large main channel is 1880ft long and functional
Total				**5690**	

Sachuest MWR Maidford River Resiliency Project - Runnels

Marsh unit Ditch #	Existing conditions (ft) width (ft)	depth (ft)	length (ft)	Proposed Treatment width (ft)	depth (ft)	Difference width (ft)	depth (ft)	Existing conditions sq. feet	Proposed Conditions sq. feet	Difference sq. ft	cubic ft	cubic yds	Comments
N1	0.00	0.00	50	1	1	1.00	1.00	0.00	1.00	1.00	50.00	1.85	Drainage for standing water
N2			0										
N3	0.00	0.00	72	1	1	1.00	1.00	0.00	1.00	1.00	72.00	2.67	Drainage for standing water
N4	0.00	0.00	313	1	1	1.00	1.00	0.00	1.00	1.00	313.00	11.59	Reconnections to fish reservior & drainage for standing water
M1	0.00	0.00	18	1	1	1.00	1.00	0.00	1.00	1.00	18.00	0.67	Reconnection to fish reservior maintenance
M2	0.00	0.00	472	1	1	1.00	1.00	0.00	1.00	1.00	472.00	17.48	Reconnections to fish reserviors & drainage for standing water
S1			0										
S2			0										
S3			0										
S4			0										
S5			0										
S6			0										
Total			925									34.26	

Appendix 12

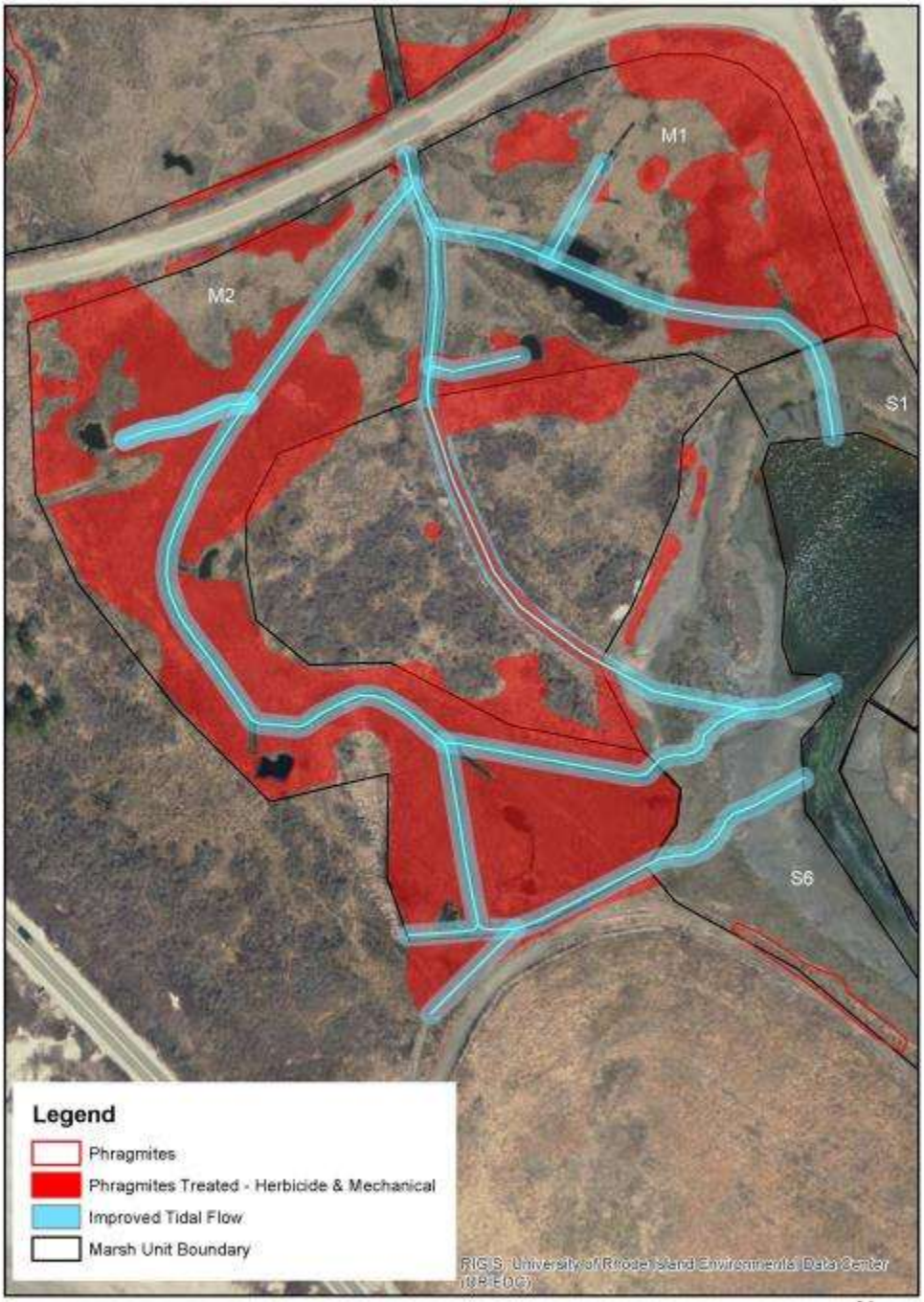
Sachuest NWR Maidford River Resiliency Project - North Marsh Phragmites Treatment

US FWS 2015
Land lines approximate

0 125 250 500 Feet

N

Sachuest NWR Maidford River Resiliency Project - Middle Marsh Phragmites Treatment



US FWS 2015
Land lines approximate

0 125 250 500 Feet

N

Sachuest NWR Maidford River Resiliency Project - South Marsh Phragmites Treatment

US FWS 2015
Land lines approximate

0 125 250 500 Feet

N

Sachuest NWR Maidford River Resiliency Project - Phragmites Treatment Summary

Marsh Unit	Description	Phragmites (Sq. feet)	Phragmites (Acres)	Treated (Sq. feet)	Treated (Acres)	Comments
N1	North Marsh	0	0	0	0	
N2		3226	0.07	3226	0.07	
N3		19,221	0.44	19,221	0.44	
N4		81,770	1.88	5,920	0.14	
M1	Middle Marsh	124,518	2.86	124,518	2.86	
M2		254,714	5.85	254,714	5.85	
S1	South Marsh	522	0.01	522	0.01	
S2		76	0.00	76	0.00	
S3		33,600	0.77	33,600	0.77	
S4		0	0.00	0	0.00	
S5		5,292	0.12	4732	0.11	
S6		18,023	0.41	7122	0.16	
Totals		**540962**	**12.42**	**453651**	**10.41**	**Approx. Total acres treated 10.41**

* 1 acre = 43,560 Sq. Feet

Sachuest NWR Maidford River Resiliency Project - Phragmites Treatment

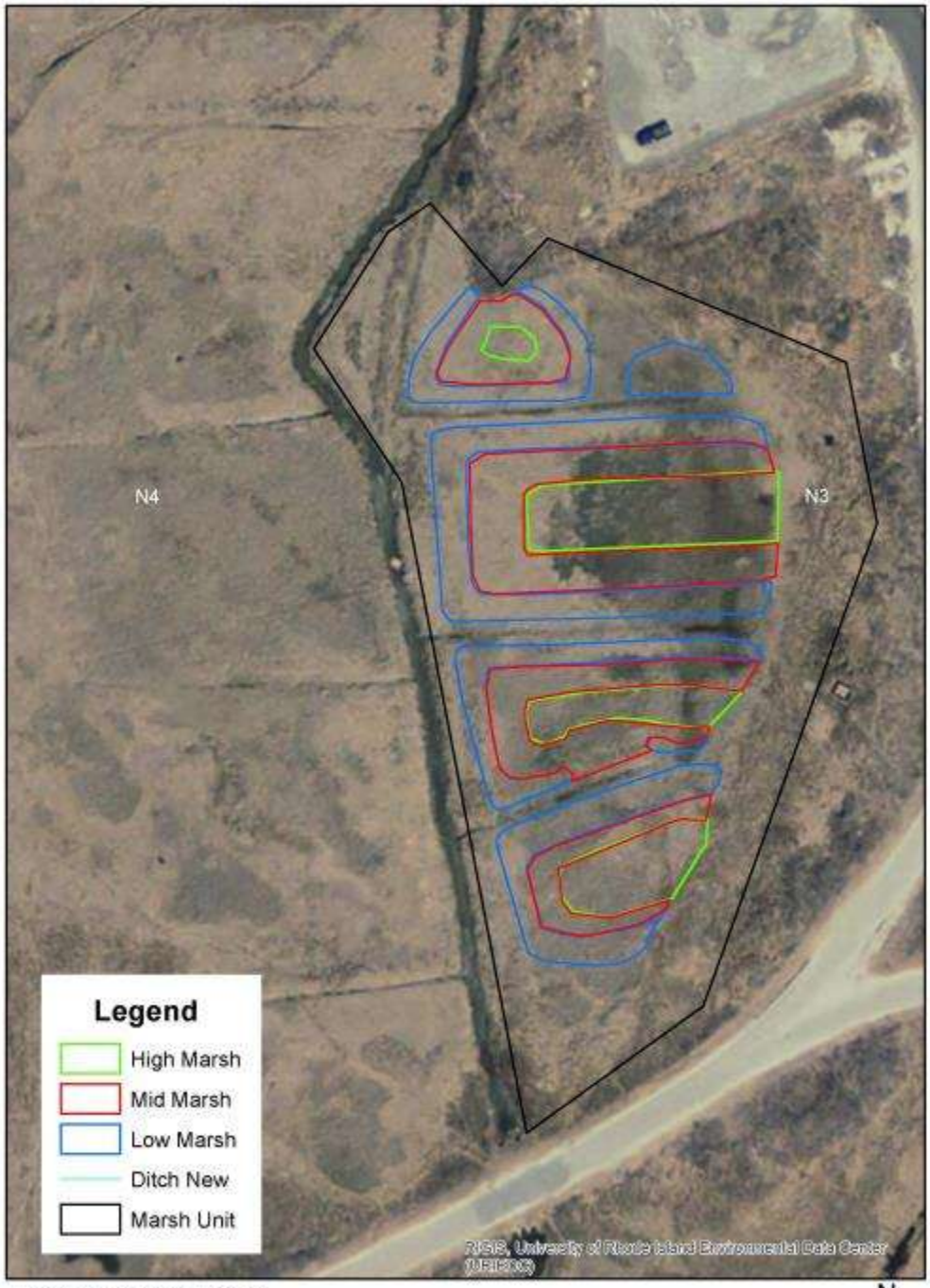
Treatment Schedule (Fall 2015 - Fall 2017)

Year 1 2015	Jan	
	Feb	
	Mar	
	April	
	May	
	June	
	July	
	Aug	
	Sep	herbicide treatment with glyphosate or imazapyr/glyphosate combo
	Oct	Mechanical treatment
	Nov	
	Dec	
Year 2 2016	Jan	
	Feb	
	Mar	
	April	
	May	
	June	
	July	
	Aug	
	Sep	spot treat with glyphosate or imazapyr/glyphosate combo (if necessary)
	Oct	Mechanical treatment (if necessary)
	Nov	
	Dec	
Year 3 2017	Jan	
	Feb	
	Mar	
	April	
	May	
	June	
	July	
	Aug	
	Sep	spot treat with glyphosate or imazapyr/glyphosate combo (if necessary)
	Oct	Mechanical treatment (if necessary)
	Nov	
	Dec	

Year 4 continue to monitor and spot treat if necessary

Appendix 13

Sachuest NWR Maidford Resiliency Project - North Marsh TLD



U.S. Fish and Wildlife Service
50 Bend Road Charlestown, RI 02813
Land lines approximate

0 50 100 200 Feet

N

Sachuest NWR Maidford Resiliency Project - South Marsh TLD

U.S. Fish and Wildlife Service
50 Bend Road Charlestown, RI 02813
Land lines approximate

0 150 300 600 Feet

N

Sachuest NWR Maidford River Resiliency Project - Dredge & TLD Summary

Unit	Description	Type	Source	Sq. Feet	Depth (ft)	Cubic Yards	Comments
S2	South Marsh	TLD		98838	0.70	2544.94	
S3_1	large bare area	TLD		55430	0.13	263.46	
S3_2	large bare area	TLD		85637	0.17	543.06	
S3_3		TLD		77105	0.46	1321.22	
S4_1	Larger more eastern area	TLD		126866	0.74	3457.89	
S4_2	Smaller area by main channel	TLD		65991	0.57	1398.69	
S5_1	Area by main channel	TLD		101744	0.87	3266.99	
S5_2	low marsh by black duck pool	TLD		37524	0.48	662.86	
N3	North marsh	TLD		71626	0.19	492.31	
Total	North & South Marsh combined	TLD		720761		13951.42	

Marsh Unit	Avg. ground elevation (ft)	Area (sq ft)	Target elevation (slope up to this mean elevation)	Target elevation range	Average target elevation (used for cubic yds calculation)	Depth (ft)	Depth (in)	Cubic Yards	Comments
S2 Low marsh	0.52	32,062	1.5	1.1-1.5	1.3	0.78	9.40	900.27	
S2 Mid Marsh	1.05	30,155	1.9	1.5-1.9	1.7	0.65	7.79	725.82	
S2 High marsh	1.45	36,611	2.3	1.9-2.3	2.1	0.65	7.80	885.68	
S2 Total	1.00	98,828				0.70		2540.98	
S3 Low marsh area 1	1.26	11,814	1.5	1.1-1.5	1.3	0.04	0.50	20.80	
S3 Mid marsh area 1	1.61	16,211	1.9	1.5-1.9	1.7	0.09	1.10	55.24	
S3 High marsh area 1	1.95	25,805	2.3	1.9-2.3	2.1	0.25	3.01	239.88	
S3 area 1 total	1.57	55,830				0.13		315.94	
S3 Low marsh area 2	1.29	23,614	1.5	1.1-1.5	1.3	0.01	0.11	8.22	
S3 mid marsh area 2	1.58	24,989	1.9	1.5-1.9	1.7	0.22	2.67	203.60	
S3 High marsh area 2	1.91	37,074	2.3	1.9-2.3	2.1	0.29	3.43	467.82	
S3 area 2 total	1.51	85,677				0.17		682.64	
S3 Low marsh area 3	1.09	35,055	1.5	1.1-1.5	1.3	0.21	2.46	266.33	
S3 mid marsh area 3	1.74	19,868	1.9	1.5-1.9	1.7	0.46	5.56	340.78	
S3 High marsh area 3	1.98	22,108	2.3	1.9-2.3	2.1	0.72	8.63	591.42	
S3 area 3 total	1.74	77,109				0.46		1198.53	
S3 Total								2117.17	
S4 Low marsh area 1	0.81	83,952	1.5	1.1-1.5	1.3	0.49	5.88	1572.73	
S4 mid marsh area 1	0.88	33,545	1.9	1.5-1.9	1.7	0.82	9.89	734.82	
S4 High marsh area 1	1.21	19,368	2.3	1.9-2.3	2.1	0.89	10.72	640.97	
S4 area 1 Total	0.96	136,866				0.74		2980.52	
S4 Low marsh area 2	0.85	38,198	1.5	1.1-1.5	1.3	0.45	5.36	612.47	
S4 mid marsh area 2	1.17	16,892	1.9	1.5-1.9	1.7	0.53	6.31	323.29	
S4 High marsh area 2	1.56	11,901	2.3	1.9-2.3	2.1	0.74	8.91	313.38	
S4 area 2 total	1.13	65,991				0.57		1265.88	
S4 Total								4247.39	
S5 Low marsh area 1	0.62	60,948	1.5	1.1-1.5	1.3	0.68	8.21	1543.55	
S5 Mid marsh area 1	0.75	24,248	1.9	1.5-1.9	1.7	0.95	11.41	853.87	
S5 High marsh area 1	1.15	16,548	2.3	1.9-2.3	2.1	0.97	11.68	592.25	
S5 Area 1	0.85	101,744				0.87		2989.68	
S5 Low marsh area 2	0.82	37,524	1.5	1.1-1.5	1.3	0.48	5.72	662.86	
S5 Total								3652.54	
South Marsh Totals								12458.63	
Total + 20%								14950.16	

North Marsh:									
N3 Low marsh	1.44	27,663	1.7	1.5-1.7	1.7	0.03	0.31	38.84	
N3 Mid marsh	1.74	26,148	2	1.7-2.0	1.9	0.16	1.94	156.89	
N3 High marsh	1.82	17,815	2.3	2.0-2.3	2.2	0.38	4.52	218.08	
North Marsh Totals	1.75	71,626				0.59		413.78	
Total + 20%								568.54	

Marsh Ratios

Marsh Unit	Low Marsh (sq. ft)	Mid marsh (sq. ft)	High Marsh (sq. ft)
North Marsh	27,663	26,148	17,815
South Marsh	324,757	155,450	168,920

Sachuest NWR Maidford River Resiliency Project - Vegetation Elevation Surveys

Marsh	Cover Type	Avg. Elevation (RTK)	Avg. elevation (RTK) above 2.0 ft NAVD88	Elevation Range		Avg. Elevation (Laser Level)	Comments
				Low End	High End		
North Marsh	S. Patens	2.094	2.195	1.849	2.419	2.15	
Middle Marsh	S. Patens	1.994	2.056	1.743	2.056	1.891	
South Marsh	S. Patens	2.038	2.202	1.667	2.363	2.158	
North Marsh	Edge of Marsh*	2.17					* Surveyor estimated- (Phrag edge and IVA line)
North Marsh	IVA			2.192*			*Limited data set