

Ecosystem Restoration Planning Guide: Saline Tidal Wetlands

USDA - Natural Resources Conservation Service, Durham, NH

Alan P. Ammann Ph.D., Biologist



Salt Marsh on Barry's Brook, Rye, New Hampshire

USDA NRCS
Natural Resources Conservation Service
(603) 868-7581 - www.nh.nrcs.usda.gov

PURPOSE OF THIS DOCUMENT

The purpose of this document is to provide guidance for planning ecosystem restoration projects in saline tidal wetlands. It is intended for professional environmental planners including NRCS field office personnel. It may also be useful as an educational tool for interested laypersons including members of town Conservation Commissions. Non-professional users of this document are cautioned that ecosystem restoration requires professional judgement based on education and experience. New Hampshire towns as well as individual landowners undertaking restoration projects should seek professional guidance.

GEOGRAPHIC AREA TO WHICH THIS DOCUMENT APPLIES

This document is intended for New Hampshire. It can be applied by knowledgeable persons to the entire New England Coast. Many of the principles and structure of this document can be adapted to other coastal areas of the United States

ECOSYSTEM DESCRIPTION

In New Hampshire, salt marshes are found along the state's 18-mile Atlantic coast, along the Piscataqua and Cochecho Rivers, and around the Great/Little Bay estuary and its tributaries. Estimates of the total acreage of salt marshes in the state vary depending on how the estimate was made. A 1954 survey conducted by the U.S. Fish and Wildlife Service and the NH Department of Fish and Game identified 5,660 acres of salt marsh. That inventory, however, measured only wetlands larger than 40 acres in size. A more recent estimate by the SCS shows approximately 6,200 acres of salt marsh in New Hampshire. This estimate is based on soil mapping conducted by the SCS as part of the National Cooperative Soil Survey Program.

Although, from a distance, salt marshes appear to be flat, featureless meadows, this is deceiving. These marshes are, in fact, complex ecosystems delicately balanced between marine and terrestrial environments and are one of the primary grassland ecosystem in the Northeast. They have adapted to a part of the landscape that regularly undergoes dramatic changes in salinity, water level, and temperature.

Marshes develop on sediment deposits in protected coastal waters that, along the New Hampshire coast, commonly occur behind rocky spits, sand bars and barrier beaches. Marshes formed behind these barriers are called back barrier marshes. Most of the sediment in these marshes is either marine sediment washed in by tides or organic material built up in the marsh itself. Some of the marine sediment consists of soil particles previously eroded from upland that has been washed out to sea.

The marshes along the Great/Little Bay Estuary and its tributaries are called estuarine marshes. A major source of sediment for marsh development in estuarine marshes is soil particles from upland or shoreline erosion. In addition, organic sediment is produced by the marsh itself.

In geologic terms, salt marshes are relatively young ecosystems that have developed over the last three to four thousand years. They are part of the re-colonization by plants and animals following the melting of the most recent glaciers some 10 to 15 thousand years ago.

Historically, the marshes have been in a dynamic balance with the rise in sea level that has occurred in New England over the last thousand years. As the sea level rose, salt marshes moved inland maintaining the same relative position with respect to tides. Along the coast, it is possible to visit marshes occupying areas that were once inland, forested wetlands but, because of the rising sea level, are now subject to periodic tidal flooding. Future inland migration of many of these wetlands is problematic given the present level of human development around them.

When undisturbed, the marshes are typically laced with a network of tidal creeks that drain fresh water from the marsh and provide a conduit for tidal water to be distributed throughout the wetlands. Generally the salinity of surface and ground water within a salt marsh is 18 parts per thousand (ppt) or greater. The term brackish marsh is used in this document to describe tidal marshes having salinities below 18 ppt. but greater than 0.5 ppt. When left undisturbed, marshes have a greater capacity to maintain themselves.

Although appearing flat, marshes actually rise slightly in elevation from seaward to landward. Along this elevation gradient, the frequency of tidal flooding decreases resulting in a distribution of plant species that tends to be arranged in zones reflecting varying degrees of tolerance to inundation by salt water. Based on the frequency of this inundation, salt marshes can be divided conveniently into low marshes and high marshes.

Low marshes typically are found as fringes along tidal creeks or estuaries where the surface elevation is below the level of normal mean high tide. As a result, these marshes are flooded at each high tide or twice daily.

The plant most commonly associated with low marshes in New Hampshire is a tall form of salt marsh cordgrass (*Spartina alterniflora*). Over time, as this grass grows dies and subsequently sinks into the mud, layers of organic material and trapped sediment are formed causing the surface of the marsh to rise. As the marsh elevation rises and the depth of tidal inundation decreases, low marsh may develop eventually into high marsh.

The point at which the marsh elevation equals that of normal high tide marks the seaward edge of high marsh. Unlike low marsh, high marsh is inundated only several times every other week during spring tides or by storm tides (surges).

High marsh has a more complex plant community than low marsh. At marsh elevations near normal high tide there is usually a zone dominated by salt meadow cordgrass (*Spartina patens*) or the short form of salt marsh cordgrass. Continuing inland, the next vegetation zone, flooded even less frequently and therefore less saline is dominated by spike grass (*Distichlis spicata*) and black grass (*Juncus gerardii*). Finally, there may be a transition zone in which species adapted to infrequent inundation or slightly brackish conditions grow. This landward border of a salt marsh may be transition to upland, brackish wetland, or freshwater wetland depending on local conditions.

Interspersed through the high marsh are pannes or intertidal pools that retain water between the infrequent flooding tides. In some cases these pools may become very saline because of evaporation. Glasswort (*Salicornia spp.*) and Widgeon grass (*Ruppia maritima*) occur in pannes. Both plants are eaten by waterfowl with Widgeon grass being an especially important food item.

It is important to note that all of the low and high marsh plant species discussed above can grow in fresh water but cannot compete with inland plants. Long term, the salt marsh plant community do not survive in areas where soil salinity does not get above about 18 ppt for a portion of the tide cycle.

AREAS INCLUDED IN THIS ECOSYSTEM

NEW HAMPSHIRE MAPPING CONVENTIONS

Tidal Flats - areas so identified on USGS hydrography.

Salt Marshes - Soil Map Units (from the New Hampshire Statewide Numerical Legend) 397, 495, 597, 997 plus polygons of 299 and other areas (e.g. fill) identified as former salt marsh.

Pannes - Depressional areas of open water within salt marsh mapping conventions 397, 495, 597, and 997.

Saline tidal creeks - streams and ditches within salt marshes.

IMPORTANT FUNCTIONS

Salt marshes occupy only about 0.1 percent of the entire area of New Hampshire. For their rarity alone they are a valuable natural resource, but the benefits derived from these wetlands go well beyond their scarcity. Native Americans regularly hunted and foraged in tidal marshes taking fish, shellfish, birds, and other wildlife. With the arrival of European settlers, salt marshes were harvested for their grasses for use as hay and animal bedding. Cook *et al.*(1993), list the following typical functions for salt marshes.

- ❑ **Ecological integrity:** The extent of human development affecting the marsh and the surrounding upland.
- ❑ **Shore line anchoring:** The effectiveness of the marsh in controlling and preventing shoreline erosion.
- ❑ **Storm Surge Protection:** the ability of the marsh to protect surrounding upland from storm surges.
- ❑ **Wildlife, Finfish, and Shellfish Habitat:** the suitability of the marsh as habitat for those animals typically associated with tidal marshes and the upland border.

Studies indicate that, nationwide, 71 percent of the commercial fish value is derived from species dependent on coastal wetlands. The importance of salt marshes to fisheries in the Gulf of Maine, which extends roughly from Cape Cod to the Bay of Fundy and includes the Georges Bank, is not well understood. It is believed, however, that salt marshes are important to local, near shore fisheries for at least three reasons. First, salt marshes export organic matter (detritus) which may be an important microbial food source in estuarine and near shore marine ecosystems. Second, salt marshes harbor several species of "minnows" such as mummichogs (*Fundulus heteroclitus*) and Atlantic silversides (*Menidia menidia*) which

are food sources for larger fish. Third, salt marshes serve as nurseries/refuges for such important fish as winter flounder (*Pseudopleuronectes americanus*) and alewife (*Alosa pseudoharengus*).

- ❑ **Water Quality Maintenance:** the ability of the marsh to improve the quality of the water passing through the marsh.
- ❑ **Recreation Potential:** The potential of the marsh as a site for recreation. Shellfishing, canoeing, hunting and wildlife observations are among the recreational activities that may take place in tidal marshes.
- ❑ **Aesthetic Quality:** The visual and esthetic quality of the marsh.
- ❑ **Educational Potential:** the suitability of the marsh as an outdoor classroom.
- ❑ **Noteworthiness:** Those attributes that are not identified in the previous functions, but that may be locally or regionally significant.

Collectively, towns along the New Hampshire seacoast spend over \$100,000 annually for the control of mosquitoes, green head flies, and other pests that emanate from the marshes and other wetlands. Discussions with some of those responsible for this work indicate that many of these dollars are spent in marsh areas that are not functioning properly, where lack of tidal flow creates stagnant breeding pools devoid of insectivorous fish.

MAJOR STRESSORS AND THEIR IMPACTS

Many of New Hampshire's salt marshes have been damaged by human activity, some to the point where they no longer provide the myriad of beneficial functions and values with which they have long been associated. Negative impacts to salt marshes include, but are not necessarily limited to, the following:

- ❑ restrictions to tidal flow
 - A change in the species composition is one of the primary indicators of marsh deterioration. In New Hampshire, the existence of significant populations of common reed (*Phragmites australis*), purple loosestrife (*Lythrum salicaria*), or narrow leaf cattail (*Typha angustifolia*) is a good indicator that this is occurring (see Figure 2). These plants, which normally occupy a niche in the transition zone between salt and freshwater marshes, may invade the salt marsh under conditions of reduced salinity. When such plants invade a marsh they tend to dominate and eventually crowd out the characteristic salt marsh vegetation. These invasive species have a low value for wildlife and, by crowding out the salt marsh species, reduce the overall value of the marsh.



Phragmites invading a salt marsh in Rye, NH which has been partially filled and cut off from tidal flow.

□ Filling

- The obvious effect of filling is to destroy the marsh in the area actually filled. However, filling of salt marshes can cause harm beyond the area of direct impact by changing hydrology within the remainder of the marsh. For example, road fill may concentrate upland runoff and cause it to pond on a salt marsh.



Many acres of salt marsh along the New Hampshire coast were filled in the past for development. Although filling is no longer allowed the effects of past filling are still impacting remnant salt marshes as the one depicted in the foreground. This approximately two-acre marsh is in Hampton and is completely surrounded by urban land. In addition the only tidal flow is through a partially blocked culvert in the headwall in the center of the picture.

□ Increased nutrient inputs

- Invasive plants such as purple loosestrife, phragmites and cattail respond to nutrient fertilization. Leaking septic systems or sewers may exacerbate the invasion of tidally restricted salt marshes by invasive plants.

□ Excess freshwater runoff

- Excess fresh water ponded on a salt marsh causes degradation of the similar to restriction of tidal flow.



To the Left is a stand of cattails downstream of Stubb's Pond in Newington, NH that is the result of fresh water leaking through and around dam.

RESTORATION STRATEGY

The overall strategy has been to restore all of the potentially restorable salt marshes in New Hampshire impacted by restrictions to tidal flow. In 1994, the NRCS released a study on the potentially restorable salt marshes in New Hampshire. The study began with an initial field identification of approximately 100 potential marsh restrictions, primarily culverts and bridges. From this initial inventory, 84 sites were selected for further evaluation. For these marshes, an engineering survey

relating the size and shape of the opening(s) to the elevation of the marsh was conducted. All of the information obtained was entered into a database.

A simplified hydraulic modeling procedure was developed to analyze the degree of restriction of each opening. Restrictions and associated marsh segments (evaluation units) were analyzed as systems consisting of a tidal creek or river and all of its associated tributaries. Twenty systems were identified, with some containing only one evaluation unit and others, as many as 21. An example system would be Parson's Creek in Rye that has a total of nine restrictions and nine evaluation units.

A preliminary engineering cost estimate for corrective action at each restriction also was prepared. Corrective action was defined as enlarging the opening to the point at which the marsh surface would be covered with at least 10 cm of tidal water 7 days a month. Maps were produced using a geographic information system showing potentially restorable salt marshes. These maps, as well as a table listing restorable salt marshes and the cost of corrective action, were published in a document (USDA 1994) entitled "Evaluation of Restorable Salt Marshes in New Hampshire". This document has been distributed to all seacoast towns in the state.

Because of this inventory and evaluation, several projects have been completed restoring adequate tidal flow to approximately 350 acres of marsh. The largest replacement culverts installed to date have been a 24-foot concrete arch culvert and twin 6 x 12-foot concrete box culverts. These replaced much smaller culverts that had severely restricted tidal flow. Future projects in the planning stage involve the restoration of over 200 acres of marsh. In addition to enlarging road culverts, tidal creeks have been cleaned of sediment, and additional ditches dug to ensure adequate tidal flow to all parts of restored marshes. Funding for restoration has come from a number of sources including the New Hampshire Office of State Planning, the U.S. Fish and Wildlife Service, the U.S. Environmental Protection Agency, The Towns of Rye, Hampton, and North Hampton, New Hampshire, and the Natural Resources Conservation Service.

RESTORATION MEASURES

- Restoration of tidal flow
 - Replacement of restrictive culverts



Twin 6 x 12 foot replacement culverts at Wallace Road in Rye, NH. These culverts replace a 5 x 7 foot opening whose invert was approximately 1.5 feet higher than the replacement culvert. On this project the original culvert was left in place and the new culverts and new tidal creek were installed approximately 250 feet up the road.

□ Restoration of tidal creeks

Under natural conditions, the ebb and flow of tides as well as the toughness of the peat keep tidal creeks open. Many tidal creeks have vertical banks and yet remain stable for many years. In a deteriorated marsh, restoration of tidal creeks is necessary in many cases because the original tidal creeks have silted in during the time that tidal flow was restricted.

Deterioration of the peat also leads to sloughing of the creek banks. As a result the creeks in a deteriorated marsh tend to be wider and shallower than in a healthy marsh.



Excavation of a new tidal creek in a restored marsh, Rye, NH. The original tidal creek to this area of the marsh was destroyed by highway construction in the 1960's.

□ Removal of fill

Experience has shown that at least two feet of fill can be removed from filled salt marshes. Removal of fill must be accompanied with any other necessary measures to restore tidal flow.



0.5 - 1.5 feet of fill from the dredging of Rye Harbor in 1942 removed from the Awcomin marsh in 1993. This area has since naturally revegetated with *Spartina alterniflora*.

□ Reduction in excess nutrients

In New Hampshire the impacts of nutrient reduction through the application agricultural and other best management practices has not been documented. NRCS believes, however, that it is very likely that reducing nutrient inputs to salt marshes and other estuarine ecosystems will be beneficial.

□ Reduction of non-natural concentrations of fresh water

Measures to reduce concentrations of fresh water on salt marshes have been incorporated into several recent restorations in New Hampshire. In the past, when storm drains were directed into salt marshes there was no attempt the control the water once it reached the marsh. This led to ponding of fresh water near the culvert outlet and typically the degradation of a portion of the marsh around the outlet. In several such cases, stands of cattails and/or phragmites have developed at such outlets. This results in marsh subsidence that aggravates the ponding, creating a vicious cycle.

One approach to restoration has been to dig a ditch from a storm water outlet directly into a tidal creek. While it is still early to see dramatic results, it appears such ditching has two effects. First, fresh water discharge from storm drains is prevented from ponding and second saline tidal water is carried into the degraded portion of the marsh around the storm water outlet.

PLANNING CONSIDERATIONS

□ Potential for inducing flooding

Along the New Hampshire coast, there are two primary causes of flooding. One is storm water runoff and the other is storm tides. In many of the salt marshes restored by NRCS and its partners the primary flooding problems has been from storm water runoff ponding in the marsh because of inadequate culverts. Opening up these culverts not only restores tidal flow but also reduced the chance of flooding. Modeling by NRCS and the US Army Corps of Engineers indicates that enlarging the culverts does not increase the risk of flooding from storm tides.

Some areas of salt marsh simply cannot be restored because the expense of restoration would not justify the result. For example, there are small isolated marsh fragments in Hampton, NH, which cannot be restored because they are surrounded by residences at virtually the same elevation as the marsh surface.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, gender, religion, age, disability, political beliefs, sexual orientation, and marital or family status. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202)720-2600 (voice and TDD).

To file a complaint of discrimination, write USDA, Director, Office of Civil Rights, Room 326W, Whitten Bldg., 14th and Independence Avenue, SW, Washington, D.C. 20250-9410 or call (202)720-5964 (voice or TDD). USDA is an equal employment opportunity employer.