

Plan and Environmental Assessment

Little River Salt Marsh Restoration

North Hampton and Hampton, New Hampshire

USDA - Natural Resources Conservation Service

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Little River Marsh from Little Boar's Head (Circa 1902)



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Introduction

Salt marshes are one of the rarest native ecosystems in New Hampshire. Ammann *et al.* (1994) estimated that there are only 6,200 acres of salt marsh in the state. Of those 6,200 acres, current estimates indicate that approximately 700 acres have been severely impacted by restrictions to tidal flow. Since the 1994-Restoration Study, approximately 350 of these 700 acres have been restored through a multi-agency cooperative effort. The Little River Restoration Project aims to restore an additional 150-200 acres of salt marsh.

This project proposes to re-establish adequate tidal flow to the Little River Salt Marsh by a combination of measures. These include the installation of larger road culverts at strategic points and the restoration of 6,390 feet of tidal creeks and ditches by excavation. This project will also serve to reduce flood damages to homes around the marsh from storm water impounded in the marsh due to an inadequate outlet. The background of the project and a hydrologic and hydraulic analysis of alternatives are presented in the Little River Flood Analysis (US Army Corps of Engineers, 1999).

The Little River Salt Marsh has been impacted by human activity virtually since the founding of Hampton in 1638. Until the early decades of this century, the Little River Marsh and other salt marshes were an important part of the agricultural landscape. Salt marshes were used both for pasture and for the production of salt marsh hay.



Figure 1 - The Little River Marsh showing the Breach as it appeared in 1877 - US Coast and Geodetic Survey Coast Chart No. 108.

Over the last 350 years, local residents and others have manipulated the marsh for various purposes including agriculture, industry, mosquito control, sewage and garbage disposal, road construction, storm water management, and tourism. In spite of these manipulations and land use changes within the watershed, the Little River was able to maintain a relatively healthy back barrier marsh until relatively recently. Within the last sixty years, however, the cumulative effects of human activity and neglect have led to a significant deterioration of the marsh.

The primary cause of this deterioration has been the failure to maintain or to allow the river to naturally maintain an adequate connection with the ocean. An adequate outlet connecting a salt marsh to the sea is important for several reasons. First and most importantly, it allows twice daily flooding by tides. The ebb and flow of tidal water is vital to the health of a salt marsh. As ocean water flows into the marsh with each tide, it brings in nutrients and sediment, which sustain and replenish the marsh. Daily doses of salt water prevent freshwater marsh plants from competing with the salt marsh vegetation. An open outlet also prevents freshwater runoff from being impounded on the marsh.

Presently, the Little River Marsh has two connections with the ocean, neither of which allows adequate tidal flow to support the marsh. The southern connection, at the Hampton, North Hampton town line, historically called the "breach", is the naturally occurring outlet of the river. This outlet appears on several early maps (des Barres, 1779, Carrigan, 1805 and 1816, Thayer, 1841). In 1742, the outlet of the Little River was used to mark the eastern end of the boundary line between Hampton and North Hampton. Figure 1 shows the breach as it appeared in 1877. Since the late 1930's, the breach has been blocked by sediment more or less continuously. The other connection to the ocean is a 48-inch concrete culvert which runs through the gap between the second and third (from the north) fish houses at Little Boar's Head (Figure 2).

Portions of the marsh (particularly around the periphery and most of the marsh south of Appledore Road) have deteriorated to the point that they no longer support salt marsh vegetation. In these areas, salt marsh cordgrass (*Spartina patens*), black grass (*Juncus gerardii*) and other salt tolerant plants, have been replaced by the invasive species phragmites (*Phragmites australis*), narrow leaf cattail (*Typha angustifolia*), and purple loosestrife (*Lythrum salicaria*). These plants have very low value for wildlife.

Ammann et al. (1994) estimated the total area of the restorable marsh downstream of Huckleberry Lane to be 181 acres. This study also identified an additional 12 acres of restorable marsh above Huckleberry Lane, making the total marsh 193.5 acres. This estimate was based on digitized soils information from the National Cooperative Soil Survey. The present project is designed to allow the future restoration of these 12 acres by replacing the culvert under Huckleberry Lane.

A more recent delineation of restorable marsh within the town of North Hampton was done by Vera Associates. They used soils information (historic salt marsh soils), topography, and an existing salt marsh delineation (Michener, 1986). They estimated the restorable Little River Salt Marsh within the town of North Hampton at 138 acres.

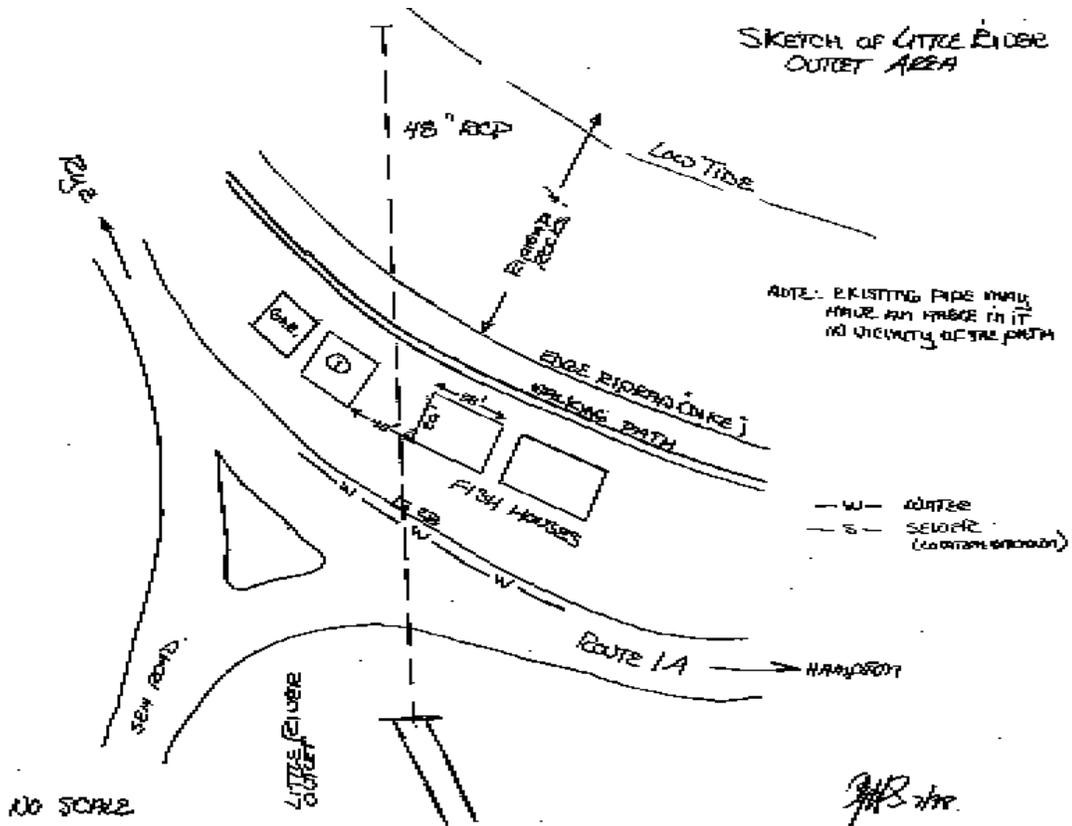


Figure 2 - Sketch of Existing Culvert (trunk) at the Little Boar's Head Fish Houses.

Participating Agencies and Non-Governmental Organizations

This project has been characterized by a high level of local involvement. Indeed, there is documentation of strong local involvement in the management of the marsh in general and in particular the maintenance of an adequate connection with the ocean as far back as 1780. In that year, the local people obtained permission from the New Hampshire Legislature to open the breach and maintain it for a period of ten years. During the early part of this century, the breach was regularly opened in the winter (see Figure 3).

Records of the Little Boars Head Improvement Association and later the Little Boars Head District beginning in the 1880's indicate a keen interest in maintaining tidal flow in the marsh. In 1888 the Little Boar's Head Improvement Association appointed a committee to request the Selectmen of North Hampton to open the mouth of the Little River and allow flooding of the marshes.

This active involvement in the restoration of the marsh has continued to the present day.



Figure 3 - Opening the Breach in 1937.

Participating Federal Agencies

- **Natural Resources Conservation Service**
 - Project Identification
 - Project Coordination
 - Project Planning
 - Local Liaison
 - Engineering
 - Ecological History of Marsh
 - Environmental Evaluation
 - Plan Preparation
 - Funding (Wetland Reserve Program)
- **US Fish and Wildlife Service**
 - Funding (Partners in Wildlife)
- **US Army Corps of Engineers**
 - Hydrology and Hydraulic Analysis of Alternatives

Participating State Agencies

- **Rockingham County Conservation District**
 - Local Liaison
 - Local Input
 - Historical Documentation
 - Project Coordination
- **New Hampshire Coastal Program**
 - Project Coordination
 - Monitoring
 - Funding (NH Coastal Grants Program)
 - Inter-Agency Liaison
- **New Hampshire Department of Transportation**
 - Traffic Control
 - Historical Documentation
 - Grading and Paving
- **New Hampshire Fish and Game Department**
 - Environmental Evaluation

Local Government Agencies

- **Town of North Hampton Conservation Commission and Board of Selectmen**
 - Local Input
 - Funding
 - Project Liaison
- **Town of Hampton Conservation Commission and Board of Selectmen**
 - Local Input
 - Funding
 - Project Liaison

Participating Non-Profit Organizations

- **Audubon Society of New Hampshire**
 - Acquisition of Conservation Easements in Marsh
 - Funding
- **Ducks Unlimited**

- Funding
- **Fuller Foundation**
- Funding

Participating Research and Academic Institutions

- **University of New Hampshire Jackson Estuarine Laboratory**
- Expert Opinion
- Monitoring
- **Wells Estuarine Research Reserve, Wells, Maine**
- Expert Opinion

Planned Project

The specific planned measures are:

- Replacement of the existing 48-inch culvert at Little Boar's Head with twin 6x12-foot concrete box culverts. Figure 4, shows the present 48-inch culvert being installed in 1948. This culvert replaced a 30-inch culvert installed in 1929, which in turn replaced a culvert installed about 1890. The size and type of the 1890 culvert is unknown.

The new twin culverts will be approximately 260 feet in length. They will be constructed of reinforced, salt tolerant concrete. Internal reinforcement bars will be epoxy treated. Provision will be made for the installation of stop logs.

One of the fish houses will be temporarily moved to allow installation of the new culverts. Construction will occur during the winter when this structure is unoccupied and traffic flow is low. The existing waste disposal system of this structure will be replaced by a holding tank. A forced-main sewer and waterline in Route 1A will be relocated as needed.

Excavation will be in earth and loose boulders, no rock excavation is expected (see Figure 4). The existing 48-inch pipe will be used to carry the flow of the Little River during construction, then removed.

The outlet of the existing 48-inch pipe is on rocks. The alignment may have a slight angle near the fish houses. The outlet is a section of pipe with boulders placed around it. There is no head wall or wingwalls. It appears stable and there has reportedly been relatively little maintenance at this location. The new alignment of the new culvert will parallel the old culvert.

Culvert replacement will require the installation of temporary sheet-pile cofferdams. This will temporarily disturb approximately 50 square feet of marsh.

- Lowering the inverts of the new culverts to 0.0 feet NGVD (National Geodetic Vertical Datum of 1929). The seaward and landward inverts of the existing culvert are set at 0.6 and 0.8 feet respectively. Placing the invert of the new culvert at 0.0 feet has been concurred in by Dionne (1999) and Burdick (1999). This invert elevation will provide

adequate tidal flows to the marsh for restoration purposes. The normal flow of the river will prevent the river channel and great ditch from completely emptying during low tide.

- Dredging of 6,390 feet of existing ditches and tidal river channel. Approximately 7,300 cubic yards of earth will be excavated. All excavated side slopes will be 1:1 (1-foot horizontal to 1-foot vertical).

The two right angle jogs in the channel between stations 4+75 and 7+00 will be rounded. The right angle curves will be replaced with circular curves that have a centerline radius of 100 feet. The channel width from the culvert under Route 1A to the junction (station 19+25) will be dredged to a bottom width of 24 feet. The bottom elevation will be lowered to 0.0 feet from stations 0+00 to 13+25 and gradually increased to elevation 1.0 from station 13+25 to station 18+50. The bottom elevation from station 18+50 to station 19+25 will be dredged to a constant depth of 1.0 feet. The dredging will increase the top widths measured in feet from 18 to 32, 19 to 34, and 22 to 31 respectively for stations 2+25, 13+25, and 18+50. In addition, the respective cross sectional areas measured in squared feet will be increased from 49 to 133, 54 to 126, and 62 to 96. Cross sections before and after dredging are trapezoidal. The amount of earth dredged between stations 0+00 and 19+25 will be 5,003 cubic yards.

The southern branch of the Little River starting at station 19+25 to Appledore Road (station 46+75) will be dredged to a bottom width of 8 feet with a constant bottom elevation of 1.0 foot. The shape of the channel before dredging is triangular and will have a trapezoidal shape after dredging. There will be 1,429 cubic yards of earth dredged from this section of the river.

The bottom width of the Little River on the south side of Appledore Road will be dredged and tapered from a width of 8 feet to 4 feet. The length of the tapered section will be 20 feet. The river will be dredged to a bottom width of 4 feet from the tapered section of the river to where it intersects Huckleberry Lane (station 63+90).

The shape of the cross section before dredging is triangular and will have a trapezoidal shape after dredging. The amount of earth excavated from this section of the river, which starts at station 46+75 and ends at 63+90, will be 897 cubic yards.

The total marsh area that will be affected by dredging is 39,560 square feet. The affected areas are:

- from station 0+00 to station 19+25 - 25,400 square feet
 - station 19+25 to station 46+75 will be 9,350 square feet
 - station 46+75 to station 63+90 will be 4,810 square feet
- Replacement of the existing 42-inch diameter culvert at Appledore Road. This culvert has a seaward invert elevation of 3.2 feet NGVD and a landward invert of 2.6 feet. It will be replaced by a 4x8-foot salt resistant concrete box culvert. Both the seaward and landward inverts of the new culvert will be 1.5 feet.



Figure 4 - Installation of the present 48-inch culvert under Route 1A at the Fish Houses. This is the approximate location for the new culverts.



Figure 5 - Twin 6x12 foot culverts under Wallis Road in Rye, New Hampshire. These culverts were installed as part of the Parsons Creek Salt Marsh Restoration Project and illustrate the type of concrete box culvert that is planned for the Little River Restoration.

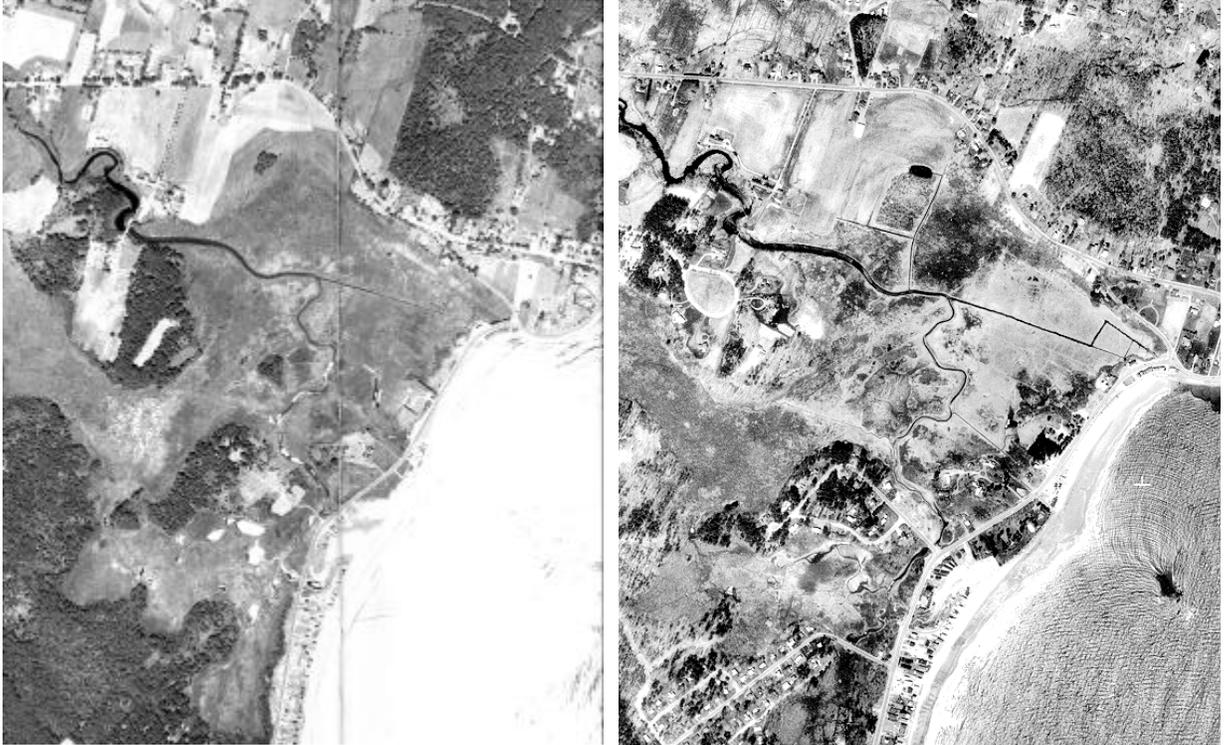


Figure 6 - Aerial photographs of the Little River Marsh in 1942 (left) and 1992 (right). Note the development around the marsh in 1992 as well as the construction on Huckleberry Lane shown in the lower portion of the 1992 photograph.

Effects of the Project on Wetland Functions and Values

Land use changes as well as the blocking of the breach over the last 50-plus years can be seen in Figure 6. In addition, much development has occurred in the watershed of the Little River.

A functional assessment was conducted using the procedures described in the documents "The Highway Methodology Workbook" (U.S. Army Corps of Engineers, Undated). This evaluation was supplemented by procedures described in the "Method for the Evaluation and Inventory of Vegetated Tidal Marshes in New Hampshire" (Cook et al., 1993). The best professional judgment of local experts was incorporated into these assessments. The Little River Marsh was assessed under present conditions; future without project, and future with project. Seven important wetland functions were assessed; flood flow alteration, fish and shellfish habitat, production export, wildlife habitat, educational/scientific value, uniqueness/heritage, and visual quality/aesthetics.

The Army Corps Functional Assessment Method was completed for current conditions and future with project. A separate evaluation for future without project was not run because it believed that conditions in the marsh will be at least as deteriorated as current conditions and may even worsen. The data sheet for present conditions is shown in Figure 7 and in the restored marsh in Figure 8.

Wetland Function-Value Evaluation Form **EXISTING CONDITIONS**

FUNCTIONING SALT MARSH
 Total area of ~~10~~ ~10 Human made? NO Is wetland part of a wildlife corridor? YES or a "habitat island"? _____
 Adjacent land use RESIDENTIAL Distance to nearest roadway or other development 0'
 Dominant wetland systems present DEGRADED SALT MARSH Contiguous undeveloped buffer zone present NO
 Is the wetland a separate hydraulic system? NO If not, where does the wetland lie in the drainage basin? OUTLET
 How many tributaries contribute to the wetland? 1 Wildlife & vegetation diversity/abundance (see attached list)

Wetland I.D. LITTLE RIVER SALT MARSH
 Latitude 42° 57' 0" Longitude 70° 42' 50"
 Prepared by: AMMANN Date _____
 Wetland Impact:
 Type RESTORATION Area 150+ ACRES
 Evaluation based on:
 Office X Field X
 Corps manual wetland delineation completed? Y X N _____

Function/Value	Occurrence		Rationale (Reference #)*	Principal Function(s)/Value(s)	Comments
	Y	N			
Groundwater Recharge/Discharge					
* Floodflow Alteration	✓		7, 9, 12, 13, 15	✓	RESTRICTED OUTLET CAUSES FLOODING
* Fish and Shellfish Habitat	✓		18		RESTRICTED OUTLET LIMITS FISH HABITAT
Sediment/Toxicant Retention					
Nutrient Removal					
* Production Export	✓				RESTRICTED OUTLET REDUCES EXPORT
Sediment/Shoreline Stabilization					
* Wildlife Habitat	✓				INVASIVE PLANTS REDUCE HABITAT VALUE
Recreation					
* Educational Scientific Value	✓				DEGRADED MARSH LOWERS VALUE
* Uniqueness/Heritage	✓			✓	" " " "
* Visual Quality/Aesthetics	✓				" " " "
ES Endangered Species Habitat					
Other					

Notes: * EVALUATED FUNCTIONS * Refer to back up list of numbered considerations.

Figure 7 - US Army Corps of Engineers "Highway Method" data sheet for future without project conditions.

Wetland Function-Value Evaluation Form **FUTURE WITH PROJECT**

FUNCTIONING SALT MARSH
 Total area of wetland 150+ ACRES Human made? NO Is wetland part of a wildlife corridor? YES or a "habitat island"? _____

Adjacent land use RESIDENTIAL Distance to nearest roadway or other development 0

Dominant wetland systems present FUNCTIONAL SALT MARSH Contiguous undeveloped buffer zone present 0

Is the wetland a separate hydraulic system? NO If not, where does the wetland lie in the drainage basin? OUTLET

How many tributaries contribute to the wetland? 1 Wildlife & vegetation diversity/abundance (see attached list)

Wetland I.D. LITTLE RIVER SALT MARSH
 Latitude 42° 57' 50" Longitude 70° 42' 50"
 Prepared by AMMMMM Date 6/2/99
 Wetland Impact:
 Type RESTORATION Area 150+ ACRES
 Evaluation based on:
 Office Field
 Corps manual wetland delineation completed? Y N

Function/Value	Occurrence		Rationale (Reference #)*	Principal Function(s)/Value(s)	Comments
	Y	N			
<input type="checkbox"/> Groundwater Recharge/Discharge					
* <input checked="" type="checkbox"/> Floodflow Alteration	<input checked="" type="checkbox"/>		4, 12		ENLARGED CULVERT WILL REDUCE FLOODING
* <input checked="" type="checkbox"/> Fish and Shellfish Habitat	<input checked="" type="checkbox"/>		3, 4, 5, 6, 9, 10, 11, 14, 17	<input checked="" type="checkbox"/>	NET INCREASE IN FISH HABITAT PREDICTED
<input type="checkbox"/> Sediment/Toxicant Retention					
<input type="checkbox"/> Nutrient Removal					
* <input checked="" type="checkbox"/> Production Export	<input checked="" type="checkbox"/>		1, 2, 4, 6, 7, 9, 10, 11, 12, 23	<input checked="" type="checkbox"/>	NET INCREASE PREDICTED
<input type="checkbox"/> Sediment/Shoreline Stabilization					
* <input checked="" type="checkbox"/> Wildlife Habitat	<input checked="" type="checkbox"/>		2, 6, 7, 8, 9, 14, 17, 18, 21, 23	<input checked="" type="checkbox"/>	NET INCREASE IN SALT MARSH SPECIES
<input type="checkbox"/> Recreation					
* <input checked="" type="checkbox"/> Educational Scientific Value	<input checked="" type="checkbox"/>		12, 13, 14, 16, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11		NET INCREASE PREDICTED
* <input checked="" type="checkbox"/> Uniqueness/Heritage	<input checked="" type="checkbox"/>		13, 14, 16, 17, 18, 19, 22, 25, 27, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12	<input checked="" type="checkbox"/>	" " "
* <input checked="" type="checkbox"/> Visual Quality/Aesthetics	<input checked="" type="checkbox"/>		NACOSTAL METHOD		" " "
ES Endangered Species Habitat					
Other					

Notes: * EVALUATED FUNCTIONS * Refer to back up list of numbered considerations.

Figure 8 - US Army Corps of Engineers "Highway Method" data sheet for future with project conditions.

Restoration of the marsh will restore normal function for all of the functions assessed. In addition, restoration will reverse the trend toward marsh surface subsidence. Research indicates (Wood et al., 1989) that back-barrier marshes in Maine have the highest sediment accumulation rates of the four types of marshes studied. Four-fifths of the back-barrier marshes they studied were accumulating sediment at a rate that outpaced current sea level rise.

Below is a discussion of these assessments for each of the seven functions evaluated.

Fish and Shellfish Habitat

Fish Habitat Under Existing Conditions

The present 48-inch culvert (the trunk) provides access for some fish species. However, the small size of this culvert severely restricts the total area of fully functioning salt marsh to an estimated 30 acres. This reduction in total area of salt marsh from its historical extent of nearly 200 acres reduces two critical salt marsh habitats for fish, tidal creeks and rivers and salt marsh pannes. Tidal creek habitat is presently restricted by tidal flow restrictions at Little Boar's Head, Appledore Road, and Huckleberry Lane. In addition, there is up to 2.2 feet of sediment in the Little River Channel and the "Great Ditch." Several factors have likely contributed to this sedimentation. First, the restrictions to tidal flow greatly reduce the flushing action that would normally occur with each tidal cycle. Second, the origin of much of the sediment is probably "rotten" peat which has sloughed from the degraded portions of the marsh and tidal creeks.

Roman et al. (1994) discussed water quality problems that can affect fish habitat in salt marshes degraded by restrictions to tidal flow. These problems are primarily due to changes in hydrology, which lead to an anaerobic decomposition of marsh peat. This in turn causes marsh subsidence and an increase in organic matter to tidal streams. The decay of additional organic matter in the streams reduces dissolved oxygen levels. The oxidation of salt marsh peat under these conditions may also result in the release of acidic leachate caused by the oxidation of pyrites.

A site visit by Doug Grout (Grout, 1999) of NH Fish and Game, indicated the following about current conditions in the marsh:

- Winter flounder are unlikely due to the small culvert. They may be more likely with a larger culvert.
- River herring are not likely in the river due to the small size and long length of the trunk (existing 48 inch culvert).
- A fish kill of freshwater fish such as bass and catfish occurred during the October 96 storm as these fish were washed down the river to the North Hampton Beach.
- The weir across the Little River at the upstream end of the marsh is an impediment to fish passage except during very high tides.
- There is presently very little cobble bottom for spawning in the river (approximately 150 feet near the trunk).

- Salinities on the upstream of the trunk were measured at 13 ppt (low tide) and 30 ppt (high tide).

Diers et al. (1999) sampled fish populations June 30, 1999, at three stations on the Little River using a seine. The results were as follows.

- Station 1 located near the trunk - Stickleback, banded killifish, mummichog, sand shrimp, and green crab
- Station 2 located at the intersection of Little River and the "great ditch" - mummichog, banded killifish, stickleback, American eel, and green crab
- Station 3 located just below the weir - stickleback, mummichog, banded killifish, sand shrimp, American eel and green crab

Fish Habitat in Restored Marsh

Channel dredging/excavation will be on one side only except in rare cases where this is impractical. This will protect existing overhanging channel banks that provide shade and contribute to the diversity of fish habitat. Enlarging the opening to a more natural size for a salt marsh of this size would greatly increase the total habitat for anadromous, catadromous and amphidromous fish. One of the most important functions of salt marshes is to provide food chain support for the coastal fisheries in the Gulf of Maine. Much of the nutrients exported to coastal fisheries is in the form of forage fish such as Atlantic silversides (*Menidia menidia*) and mummichogs (*Fundulus heteroclitus*). These amphidromous fish move between salt and brackish water feeding on detritus and invertebrates.

Little (1995) indicates that Striped Bass (*Morone saxatilis*) once spawned in the larger tidal rivers in New Hampshire including the Piscataqua. They are also known to have moved in and out of smaller tidal streams around the Gulf of Maine with the tide. Many populations were eliminated in the 17th and 18th Centuries by over fishing. Early fishermen placed nets across tidal creeks effectively trapping large portions of a population on the outgoing tide. While it is not known if striped bass once used the Little River, it is certainly possible that they did. This important game fish might utilize a restored marsh at least for feeding.

Another important habitat function is to serve as nurseries/refuges for important fish such as winter flounder (*Pseudopleuronectes americanus*) and alewife (*Alosa pseudoharengus*).

Specific habitat types that would be increased include:

- **Tidal Creeks and Rivers** - Removal of sediment from the "great ditch" and Little River Channel will improve this habitat type. The sediment to be removed is primarily degraded peat and other sediments deposited due to the present restriction of tidal flow. The restriction to tidal flow has contributed to sedimentation in two ways. First, much of the peat in the upper portion of the marsh has lost its integrity due to the replacement of spartina by phragmites, narrow leaf cattail, and other invasive species. Second, rotten peat and other sediments have accumulated in the channel and "great ditch" because there is presently inadequate tidal flow to keep the channels flushed.

This habitat will also improve because of an increase in cobble beds for spawning. These beds are formed by the inwash of rocks from the beach. Now these beds are limited

about 150 feet upstream of the trunk. Increasing the culvert size will allow greater amounts of bed material to be washed into the Little River within the marsh.

- **Salt Marsh Pannes** - At the present time pannes in most of the marsh, especially above Appledore road, are in a highly degraded condition due to lack of tidal flow. Peat degradation and the replacement of spartina and other typical salt marsh plants with invasive plants have reduced their function as habitat for salt marsh fish to zero in many places.

Published literature on range and habits of fish indicates that restoration of the marsh could reasonably be expected to increase potential habitat for the fish listed below. This does not mean that any, or all, of the listed fish will necessarily use the improved habitat or that the improved habitat is of high quality for all species. Grout (1999) for instance, believes that a smelt fishery is possible but not likely because of probable salinity ranges and lack of gravel for spawning. In addition, the actual use of the marsh by a particular species depends on non-habitat factors including the actual presence or a given species along this section of the coast. The list then should be viewed as simply an indication of the presence of potential habitat in the restored marsh.

- Rainbow Smelt *Osmerus mordax* (Mitchill) - Anadromous
- Alewife *Alosa pseudoharengus* (Wilson) - Anadromous
- Blueback Herring *Alosa Aestivalis* (Mitchill) - Anadromous
- Winter Flounder *Pseudopleuronectes americanus* (Walbaum) - Amphidromous
- Mummichog *Fundulus heroclitus* (Linnaeus) - Amphidromous
- Banded Killifish *Fundulus diaphanus* (Lesueur) - Amphidromous
- Threespine Stickleback *Gasterosteus aculeatus* (Linnaeus) - Amphidromous
- Fourspine Stickleback *Apeltes quadracus* (Mitchill) - Amphidromous
- Ninespine Stickleback *Pungitius pungitius* (Linnaeus) - Amphidromous
- American Eel *Anguilla rostrata* (Lesueur) - Catadromous

Wildlife Habitat

Wildlife Habitat Under Existing Conditions

Existing wildlife habitat in the marsh is threatened by the invasion of phragmites, purple loosestrife, and narrow leaf cattail, plants that generally lower the wildlife habitat value of tidally restricted salt marshes. This phenomenon has been widely observed in salt marshes with restricted tidal flow (Roman *et al.*, 1984, and Ammann, 1999). These species, especially phragmites and purple loosestrife, tend to create a monoculture with low habitat value. Short (1984) learned from talks with knowledgeable residents, that purple loosestrife was first noticed on the marsh in the mid-1960's.

Short (*ibid.*), found a 70 percent reduction in the area dominated by the salt marsh grass *Spartina patens*. This was most likely related to the greatly reduced soil salinities he found in most of the marsh. Only a small portion of the marsh had soil salinities above 10 parts per

thousand (ppt) even at high tide. This was especially true for the portion of the marsh upstream of Appledore Road. Except for a narrow band along the river most of this area has a soil salinity of less than 5 ppt.

Salinity measurements on three replicate transects in areas being invaded by purple loosestrife (Dzierzeski, 1991) indicate that this plant is rarely found in areas where soil pore water salinities exceed 6 ppt. The presence of soil salinities of 6 ppt in areas with *Spartina patens* is itself an indication of marsh degradation. *Spartina patens* tends to grow on the more saline portions of a salt marsh and soil pore salinities in the range of 18 ppt would be more usual. The soil salinity of her transects ranged from 3.3ppt to 25.3 ppt. *S. patens* grew through this salinity range indicating that the area had once been functioning high marsh. Purple loosestrife, on the other hand, only grew at salinity range between 3.3 and 7.7 ppt.

Additional loss of salt marsh habitat has occurred by the invasion of shrubs and freshwater marsh plants around the edge of the marsh. While these plants have value for wildlife, they are nevertheless encroaching on areas of historic salt marsh, one of the rarest habitats in New Hampshire. The project will not eliminate the shrub habitat and other brackish and fresh habitats associated with the marsh. Rather these habitats will be restricted to the periphery of the marsh where they normally occur under natural conditions.

Wildlife Habitat in a Restored Marsh

Sinicrope (1990) found that the reintroduction of tidal flow to a salt marsh generally increased salt marsh plants and decreased fresh and brackish species. Live coverage of *typha angustifolia* declined from 74% to 16% and surviving stands were stressed. *Spartina alterniflora* expanded from 1% to 45% and high marsh species became established covering 20% of the marsh. Live coverage of phragmites increased from 6% to 17% primarily around the edge of the marsh. It most likely moved into areas from which typha had been eliminated by increased salinity. Nine percent of phragmites encountered on transects was dead.

Salt marshes have been identified as having high habitat value by the New Hampshire Resources Protection Project (Ueland, *et al.*, 1995). Obviously, increasing the area of sustainable functioning salt marsh associated with the Little River from approximately 30 acres to 150+ acres plus will significantly increase the amount of salt marsh habitat available along the New Hampshire seacoast.

Wildlife that will specifically benefit from the restoration of the marsh include:

- Shore Birds (e.g. least sandpiper, willet, greater and lesser yellowlegs)
- Waterfowl (e.g. black duck, mallard)
- Song Birds (e.g. sharp-tailed sparrow, seaside sparrow)
- Birds of Prey (e.g. harrier)
- Wading Birds (e.g. green heron, great blue heron, snowy egret)
- Small Mammals (e.g. muskrat)
- Large Mammals (e.g. white-tailed deer)

Flood Flow Alteration

Flooding Under Present Conditions

Under present conditions the restriction caused by the 48 inch culvert impounds storm water in the marsh causing flooding of some local residences. This flooding and its causes are modeled and discussed in US Army Corps of Engineers (1999) report. This flooding has been exacerbated by the development around the natural outlet of the marsh near the Hampton - North Hampton town line. This outlet, known historically as the breach, is closed except during certain storms when it has been opened up by the NH Department of Transportation to release impounded storm water in the marsh. Flood damage has occurred from water flowing over Route 1A and from erosion of the breach during times of water outflow. Civil litigation over the responsibility for some of this damage is currently underway. The outcome of this litigation is not known. The present level of development around the breach as well as the current litigation precludes permanently opening the breach for either tidal flow or outflow of storm water. It is likely that in a future without project, flood damage would continue.

Flooding in a Restored Marsh

Installation of the project would prevent flooding of Route 1A and reduce flooding of residences around the marsh from a rainfall event similar to the October 1996 storm. Reduction of flood damages to some basements and yards from smaller storm events will also be realized from the proposed project.

Educational/Scientific Value

Educational potential under present conditions

Presently the marsh is in a seriously degraded condition. Its educational/scientific potential is limited to showing what a degraded salt marsh looks like. This condition is predicted to worsen due to a lag between the restriction of tidal flow and all of the degenerative effects of that restriction. Loss of peat integrity and subsidence are expected to continue. Also expected to continue and perhaps accelerate is the spread of invasive plants. Without restoration, the viable salt marsh will likely shrink to 5-10 acres near the trunk and a narrow fringe of low marsh along the river channel.

Little River has been the site of several scientific investigations Richardson (1983), Short (1984), Waterman (1991), Dzierzeski (1985). The first study was done before the marsh had deteriorated to its present state. Its author (Richardson, 1999) advocates that the marsh be restored even if it means losing some of the existing beds of widgeon grass discussed below. The last two studies were done in the Little River Marsh specifically because tidal flow had been restricted. Their aim was to investigate negative impacts of tidal flow restriction on salt marshes. All of these studies contribute to the baseline understanding of the marsh and will provide needed data to understand the changes that will occur after restoration.

Beds of widgeon grass (*Ruppia maritima*) exist in pannes and the Little River channel upstream of Appledore Road. Richardson (1983) indicated that the primary habitat for this plant is areas of still or slow moving water such as deep pools and shallow pools (pannes). *Ruppia* also occurs in ditches and tidal creeks. Under present conditions most of the high marsh pools and pannes in this area that would support *Ruppia* has been lost to invasive plants. This has greatly restricted potential habitat for this important plant. The Little River channel has become more

pool like because of the restrictions to tidal flow and possibly better ruppia habitat than under natural conditions.

Educational/Scientific Potential in a Restored Marsh

Restoration of the marsh will provide an opportunity to document the return to health of the second largest back barrier marsh on the New Hampshire Coast. This is in addition to the obvious educational and scientific value of having a large fully functioning salt marsh under conservation easement.

Some but certainly all or even most beds of ruppia south of Appledore Road may be lost due to the planned dredging of the river channel. These losses are expected due to the enlargement of the Appledore culvert and the resultant lessening of ponding in the river channel. The extent of this loss cannot be predicted precisely. For one thing, the pools in which the ruppia now grows have been in existence for well over 100 years (see Figure 1). They existed even when there was an unrestricted opening at the breach. It is likely that most of the ponds visible on the 1877 Coastal Chart will remain even after restoration. In addition, the restoration of high marsh in this area will create opportunities for the development of new ponds and pannes.

To minimize negative impacts ruppia beds will be avoided where possible. Sumps will be excavated in some ponds and pannes to prevent complete drying. Sills will be left where possible to retain some intertidal water in existing ruppia ponds. In addition new pannes and pools will be dug in the former high marsh to provide future habitat. Richardson (1999) believes that there is a good possibility that such areas will become populated with ruppia. He is the acknowledged expert on ruppia in New Hampshire and very supportive of the planned project.

The unavoidable loss of some ruppia beds must be weighed against the greatly increased habitat that will be provided by restoring the high marsh and its associated pannes and pools above Appledore as well as the rest of the marsh.

Production and Export

Production and Export Under Present Conditions

Nutrient export from the marsh is limited by the restriction to tidal flow. Nutrients leave a salt marsh as dissolved material, detritus and forage fish. Waterman (1991) studied the nutrient fluxes of three New Hampshire salt marshes, Little River, Bass Beach, and Wallis Sands. He found that Bass Beach and Little River marshes, which had restricted tidal flow, had decreased exports of dissolved nutrients compared to the unrestricted Wallis Sands Marsh. There was also greater removal of NH_4 and PO_4 . The increased NH_4 retention in the marsh may be accelerating the growth of purple loosestrife. Dzierzeski (1991) found that purple loosestrife responded to increases in nitrogen fertilization.

Production and Export in a Restored Marsh

Increased tidal flow will probably increase the export of usable nutrients to Coastal fisheries. This increase will be due to the increase of dissolved nutrients, detritus and forage fish.

Uniqueness/Heritage

Uniqueness/Heritage Under Present Conditions

The Little River marsh is the second largest back barrier marsh in New Hampshire. It has a long history of human use, including strong local and state concern for its ecological health. Local citizens have known for several hundred years, at least, that the key to keeping the marsh healthy is to maintain tidal flow. Under present conditions, this unique and important marsh has deteriorated and will continue to deteriorate.

Uniqueness/Heritage in Restored Marsh

The overall concept of this project is to reduce the most damaging human stressor to this marsh, namely restriction of tidal flow. This will restore this important native ecosystem. The aim of this project is not to return the marsh to its pristine state that is not realistic. Rather, the goal is to reestablish to the greatest practical degree the physical, chemical, and biological conditions that existed before the marsh was stressed by human activity.

Visual Quality/Aesthetics

Visual Quality/Aesthetics Under Present Conditions

Under present conditions, views of the marsh are marred by stands of phragmites and purple loosestrife. The open grassland look of a functioning salt marsh which contributes so much aesthetic appeal to the seacoast is disappearing.

The south of Appledore Road is almost completely overgrown by invasive plants. Local residents recognize that while purple loosestrife is attractive in bloom, its floral display is a clear warning of a degrading salt marsh. Long time residents have recounted impressions of the marsh in the 1940's when the area south of Appledore was predominantly salt marsh. At that time, residents could boat from a pool at the river mouth up to the weir. Subsequent installation of smaller culverts at Appledore and the breach stopped these scenic trips.

Visual Quality/Aesthetics in Restored Marsh

Over a long period, the marsh should recover most of its original vegetation. Areas of subsided high marsh may cycle through a phase of low marsh. The overall effect will be a return to the open vistas, which characterized the marsh in years past.

Conclusions

Under existing conditions of severely restricted tidal flow, the marsh has seriously deteriorated and will continue to do so until very little of the original marsh remains. This project represents an opportunity to restore this marsh to a reasonable level of ecological health.

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