4-30-2005

Pickering Brook Salt Marsh Restoration - Phase II

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Pickering Brook Salt Marsh Restoration – Phase II

A Final Report to

The New Hampshire Estuaries Project

Submitted by
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April 30, 2005

This project was funded by a grant from the New Hampshire Estuaries Project, as authorized by The U.S. Environmental Protection Agency pursuant to Section 320 of the Clean Water Act.

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Executive Summary

In the early 1900's, the majority of coastal salt marshes in New England were ditched as part of an aggressive mosquito control program. In an attempt to eradicate mosquito-breeding habitat, open water areas were drained by a series of ditches excavated in the thick peat soils. Elimination of open water and the unnatural drainage patterns led to degradation of healthy, functional saltmarsh systems and the disappearance of critical habitat for American black ducks, wading birds, shorebirds, shellfish, and fish species, including those that eat mosquito larvae.

The practice of mosquito ditching has since been found to have unintended consequences in salt marshes. The artificial ditch systems were found to hold shallow water just long enough for mosquitoes to successfully breed, while prohibiting access to predatory fish species that eat the larvae. Mosquito populations thrived. Ditching also lowered the water table and reduced soil salinities, thus increasing the potential for the invasion of non-native species, such as *Phragmites australis* (Daiber 1986). Overall, ditching decreased habitat for native species, disrupted the normal hydrologic functions of the salt marsh ecosystem and likely increased mosquito populations.

The 23-acre salt marsh addressed in Phase II of this project is part of the larger 42-acre Pickering Brook salt marsh restoration project area (Phase I: 19 acres, Phase II: 23 acres). The Phase II salt marsh is located on the north side of Pierce Point, along Pickering Brook, adjacent to Great Bay in Greenland, Rockingham County, New Hampshire. It is located within the Great Bay Estuary and is identified as a high priority habitat in the Habitat Protection Plan of the Great Bay Resource Protection Partnership.

The goal of the Pickering Brook Salt Marsh Restoration Project Phase I and Phase II was to restore a more natural hydrologic regime and provide permanent open water areas on the marsh surface. Restoration activities included the creation and enhancement of surface pools and reclamation of the man-made ditches, while imposing the least impact to the marsh surface. The restoration will also manage mosquito populations, expand recreational opportunities and improve water quality on the marsh

Phase II construction occurred under permit number 2002-02056 as amended. Ducks Unlimited contracted with SWAMP, Inc. to complete restoration activities with specialized low ground pressure equipment. Using a specialized wetland excavator, 13 man-made ditches were filled using marsh soils excavated during the enhancement of four permanent pools. To restore the marsh platform of the 23-acre Phase II salt marsh, approximately 470 CY of material was excavated for pool enhancement and then returned to the marsh through the filling or partial filling of existing ditches. Phase II earthmoving activities were completed by April 30, 2004.

A monitoring plan was established for Pickering Brook based on a combination of the GPAC and U.S. Fish and Wildlife Service, Coastal Program protocols. Monitoring will provide data necessary to evaluate both restoration approaches and their rate of success at accomplishing goals for this site through the sampling of chosen parameters or indicators.

Data analysis and conclusions are beyond the scope of this restoration project and will be conducted under a separate contract. Data was collected with the help of local landowners and volunteers from the Portsmouth Country Club, the Great Bay National Estuarine Research Reserve,

and Ducks Unlimited, Inc. Parameters used to assess the success of this restoration include fish use, bird use, mosquito larvae abundance, water levels and salinity, and native vegetation growth.

In the ever-evolving world of salt marsh restoration, it is important to incorporate an adaptive management plan into project design. For larger areas, a phased approach may also provide flexibility and benefit restoration efforts at a specific site under specific conditions. The completion of Phase I of the Pickering Brook restoration provided important information and feedback that were used to modify the Pickering Phase II restoration design.

The two approaches used to reclaim man-made ditches at Pickering Brook were meant to address the goals and objectives of the restoration plan. Monitoring data collected in subsequent years will be analyzed to comparatively evaluate marsh recovery. Using these two techniques side by side creates an opportunity for study and will provide researchers and land managers with great insight into the response of this salt marsh community to these practices.

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Introduction

Since colonial times, it has been estimated that humans have altered ninety percent of New England's salt marshes. The common practice of dredging ditches was performed in an effort to reduce mosquito populations that were produced in the marshes. Mosquitoes breed in shallow standing waters that remain on the marsh surface between tide cycles. In an attempt to eradicate mosquitoes at Pickering Brook salt marsh a series of parallel ditches and a perimeter ditch were excavated sometime during the 1930's and 1940's that affected disrupted salt marsh function.

The objective of mosquito-ditching was to drain existing permanent pools that held water throughout a tidal cycle that were thought to produce large populations of mosquito larvae. The practice has since been found to have unintended consequences in salt marshes. The artificial ditch systems were found to hold shallow water just long enough for mosquitoes to successfully breed, while prohibiting access to predatory fish species that eat the larvae. Mosquito populations thrived.

Prior to ditching, the soft-bottomed permanent marsh pools supported native fishes that preyed on mosquito larvae keeping mosquito populations in balance. Pools also provided many species of birds, fishes and invertebrates with foraging habitat. Ditching has lowered the water table and reduced soil salinities, thus increasing the potential for the invasion of non-native species, such as *Phragmites australis* (Daiber 1986). Overall, ditching decreased habitat for native species, disrupted the normal hydrologic functions of the salt marsh ecosystem and likely increased mosquito populations.

When found in large numbers salt marsh mosquitoes are considered pests by humans, and more recently, as vectors of disease, such as West Nile Virus and Eastern Equine Encephalitis. Since 1979, the Town of Greenland has contracted with Swamp, Inc. to provide chemical mosquito control to reduce mosquito populations in surrounding salt marshes. During the last 20 years, over 5,000 pounds of larvicide has been applied to Pickering Brook salt marsh at a cost to Greenland taxpayers of well over $19,000.

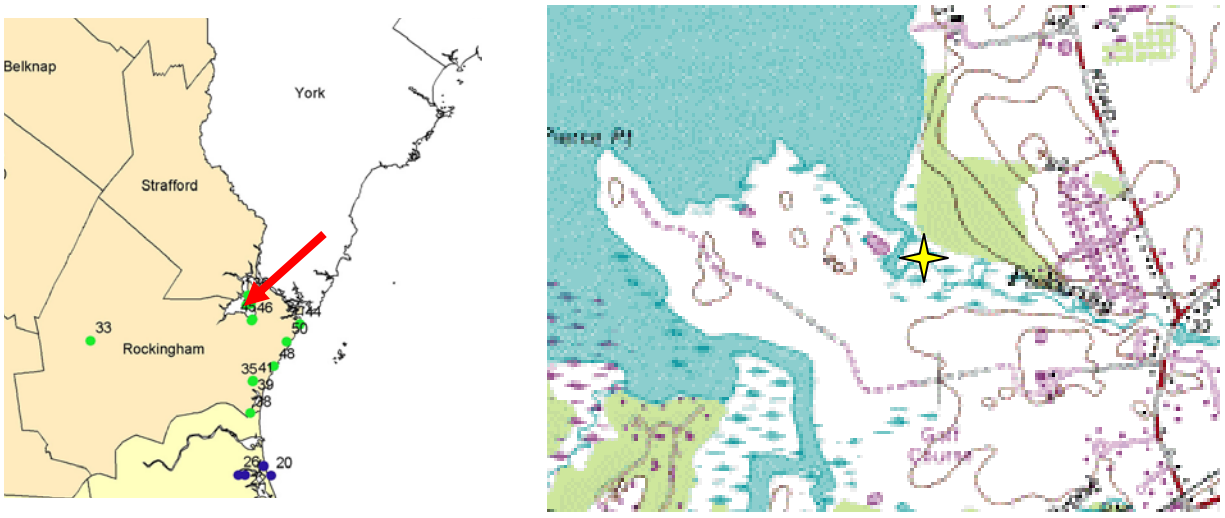
In the year 2000, SWAMP Inc. encouraged the Town of Greenland's Mosquito Commission to put aside town monies to restore Greenland's salt marshes. The town and its residents realized that a natural system for mosquito management was better than the continual application of pesticides. Restored marshes would also provide recreational, wildlife and water quality benefits for the town. To date, the town has spent over $40,000 to restore over 40 acres of salt marsh, including those at Pickering Brook.

States such as Delaware, New Jersey, Connecticut, Rhode Island and Massachusetts also had recognized the failure of ditched salt marshes and are now restoring more natural surface hydrology to create conditions that will naturally and inexpensively manage mosquito populations (Wolfe 1996). This awareness has now spread throughout New England

Project Location

The 23-acre salt marsh addressed in Phase II of this project is part of the larger 42-acre Pickering Brook project area (Phase I: 19 acres, Phase II: 23 acres). The Phase II salt marsh is located on the north side of Pierce Point, along Pickering Brook, adjacent to Great Bay in Greenland, Rockingham County, New Hampshire. It is located within the Great Bay Estuary and is identified as a high priority habitat in the Habitat Protection Plan of the Great Bay Resource Protection Partnership.
Latitude/Longitude: 43° 03' 02"N, 70° 49' 57"W; UTMS 19 350662E, 4768108N.

Figure 1. Location of Pickering Brook Salt Marsh Restoration, Greenland, New Hampshire, 2002 to 2004.



Purpose

Although degraded by grid-ditching, Pickering Brook salt marsh has continued to provide important habitat for fish and wildlife resources (as with all Greenland salt marshes). The remnants of these ditches can be observed in the aerial photographs included in Appendix I. The purpose of the Phase II project was to create permanent open water areas at selected locations on the marsh surface and to restore a more natural hydrologic regime by reclaiming the man-made drainage ditches. Both these activities are expected to increase fish and wildlife use of the marsh.

Restoration activities will also help to decrease salt marsh mosquito populations at Pickering. The primary mosquito predator of salt marshes, the mummichog (*Fundulus heteroclitus*), has been restricted by draining efforts to a few open water locations deep enough to sustain water during dry periods. The result of limiting access to this voracious predator was an exponential development of mosquito numbers over large areas of the high marsh. Restoration activities will provide access to mummichogs and other fishes, thereby naturally reducing mosquito populations at Pickering.

Studies specific to New England salt marshes found that grid-ditched marshes had lower bird species diversity. Preliminary pre-restoration monitoring at Pickering Brook revealed little wading bird and shorebird activity. The restoration of permanent open water pools will increase valuable habitat and foraging opportunities for birds (waterfowl, wading birds and shorebirds), as well as for other aquatic flora and fauna such as, aquatic invertebrates (coleopterans, hemipterans and dipterans), minnows (mummichogs and sticklebacks) and submerged aquatic plants (*i.e.*, widgeongrass - *Ruppia maritima*). Widgeongrass is a valuable food source for waterfowl and provides shade and shelter for aquatic invertebrates and minnows.

It is anticipated that water table heights will be elevated following restoration to approach pre-ditched levels. Wolfe (1996) states that the response of aquatic invertebrates, vegetation, and other biotic

components to any marsh alteration technique is more a function of water table height rather than water quality. The draining effects of ditching show a significant decrease in water table elevation in wells placed 1 meter, 5 meters, and 10 meters perpendicular to ditches with wells closest to the ditch subject to the greatest degree of drainage (Lesser, 1982).

It is expected that the Pickering Brook salt marsh will not require chemical treatments (larviciding) for mosquitoes following restoration. In past restoration projects, larval and pupal mosquito populations have been reduced by as much as 95 to 99% due to; 1) increased minnow predation, 2) decreased oviposition (egg laying) areas, and 3) by drowning from increased wave action in pools.

Ownership

The Phase II salt marsh at Pickering Brook is owned by, or is adjacent to, multiple private landowners. They are as follows: Mrs. Cynthia Smith/The Smith Great Bay Farm Ltd Partnership (conservation easement in progress with local land trust), Mr. and Mrs. John and Tracey Barry, Mr. and Mrs. Dale and Nicholas Genimatas, Mr. and Mrs. Rudy and Kathleen Burke, George Samuels and Anne Catell, Mr. and Mrs. Nelson and Joan Burbank, Mr. and Mrs. Cris and Gricel Goodman, and the Portsmouth Country Club. Landowners were informed by certified letter of the restoration plans and have given both their permission and support.

Partners

The restoration of both Phase I and II at Pickering Brook salt marsh was made possible through a partnership among the Town of Greenland, the New Hampshire Coastal Program (NHCP), Jackson Estuarine Laboratory, University of New Hampshire (UNH), the U.S. Fish and Wildlife Service Partners in Fish and Wildlife (USFWS), Great Bay National Estuarine Research Reserve, NH Department of Environmental Services, New Hampshire Estuaries Project (NHEP), the ME State Moose Plate Program and Ducks Unlimited, Inc. (DU).

Figure 2. Project Boundaries of Phase I and Phase II restorations at Pickering Brook Salt Marsh, Greenland, New Hampshire, 2002 to 2004.

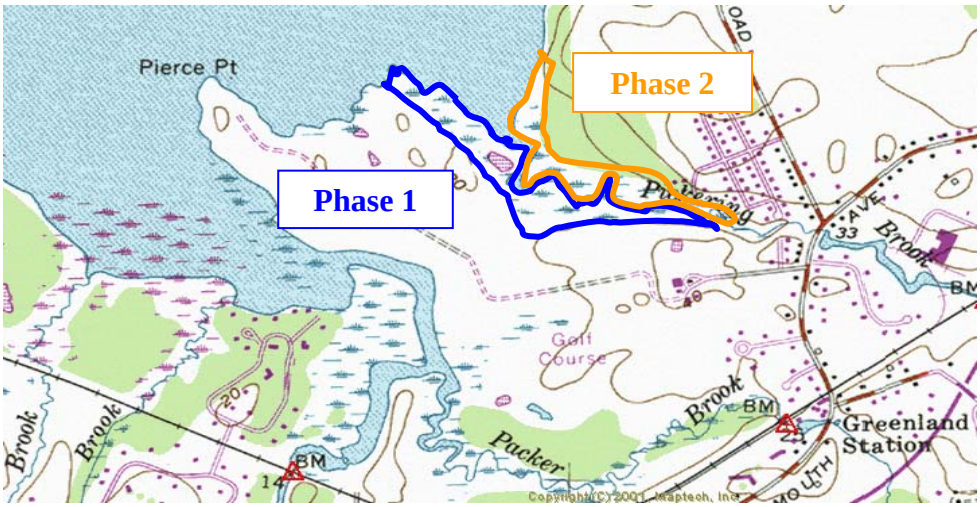
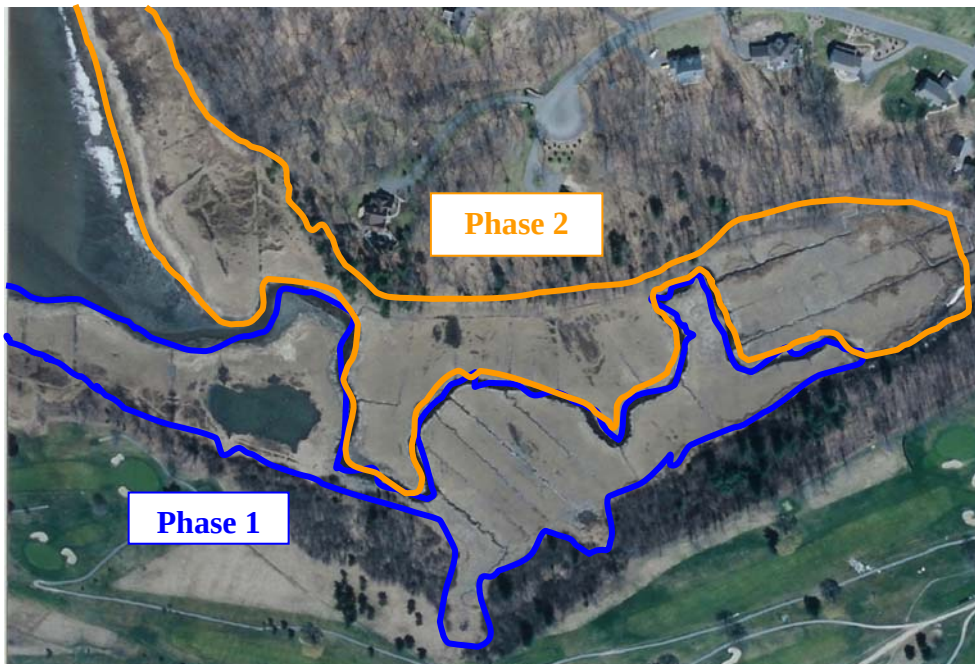


Figure 3. Aerial view of Phase I and Phase II project areas within Pickering Brook Salt Marsh Restoration, Greenland, New Hampshire, 2002 to 2004.



Goals and Objectives

Goals:
The goal of the Pickering Brook Salt Marsh Restoration Project Phase I and Phase II was to restore a more natural hydrologic regime and provide permanent open water areas on the marsh surface. Restoration activities included the creation and enhancement of surface pools and reclamation of the man-made ditches, while imposing the least impact to the marsh surface. The restoration will also manage mosquito populations, expand recreational opportunities, and improve water quality on the marsh.

Objectives:

1. Restore more natural hydrologic regime,
2. Raise the average water table of the marsh,
3. Decrease mosquito-breeding capabilities on the salt marsh,
4. Increase wildlife use of the salt marsh, primarily mummichogs, waterfowl and waterbirds.

Indirect benefits:

- Decreased chemical/pesticide application,
- Improved water quality,
- Decreased opportunity for establishment of invasive non-native plant species,
- Increased breeding habitat for seaside and saltmarsh sharp-tailed sparrows,
- Increased community awareness/stewardship.

Methods

Project design

Prior to construction of Phase II, the permitted work plan was collaboratively altered by the New Hampshire Coastal Program, University of New Hampshire, Ducks Unlimited and SWAMP Inc. to reduce its' scope and potential negative effects from earthmoving activities on the marsh surface, but continue to address project goals. The NH Department of Environmental Services Wetlands Bureau approved the amended project design for Phase II on 02/26/04.

Through adaptive management planning it was decided that the reclamation of materials excavated from the marsh during pool enhancement would be used to fill the entire length of existing ditches (as material allowed) instead of using ditch plugs at single points. This modification would address the drainage of surface waters, avoid costly offsite disposal of materials and reclaim valuable marsh soils.

This design adaptation should promote a more natural hydrologic regime at Pickering. Receding waters from tidal flooding will be allowed to sheet flow across the surface of the marsh, as it did prior to ditching and approach a more natural water table, salinities, and saturation cycle of the peat, without providing shallow standing areas for mosquito production. The areas where the soil was excavated will become permanent open water that will enhance habitat for native species of fish, invertebrates, waterfowl, waterbirds, shorebirds, and wading birds.

Construction

Construction occurred under permit number 2002-02056, as amended. Ducks Unlimited contracted with SWAMP, Inc. to complete restoration activities with specialized low ground pressure equipment. Using a specialized wetland excavator, 13 man-made ditches were filled using marsh soils excavated during the enhancement of four permanent pools (Appendix II). To restore the 23-acre Phase II salt marsh, approximately 470 CY of material was excavated for pool enhancement and then returned to the marsh through the filling or partial filling of existing ditches. Phase II earthmoving activities were completed by April 30, 2004.

Specific construction activities included:

1. <u>The excavation of deeper areas in pannes and pools prone to desiccation for fish holdover areas.</u>
Four existing pools that were located in areas of the marsh that were prone to desiccation were enhanced through excavation. The creation of deep-water pools, or fish holdover areas, will provide permanent open water habitat for aquatic organisms and plant species during periods between flood cycles. The areas prone to desiccation were dry within seven to ten days following flooding tides and/or rain. Typically tidal flooding occurs only two to three days per month. Fish holdover areas will allow aquatic organisms to survive during these prolonged dry periods.

2. <u>Filled 13 man-made ditches with excavated marsh materials.</u>
Prior to completion of Phase I, it became evident that a large amount of dredged material was not needed for ditch plug construction and was scheduled to be exported offsite. Based on successful restoration activities in Connecticut and Massachusetts, DU and partners modified the design of Phase II resulting in "filled" instead of "plugged" ditches. Dredged salt marsh material from onsite pool enhancement activities was used to reclaim this area of salt marsh and no cost was incurred for offsite disposal.

Monitoring Plan

A monitoring plan was established for Pickering Brook based on a combination of the GPAC and U.S. Fish and Wildlife Service, Coastal Program protocols. Monitoring will provide data necessary to evaluate both restoration approaches and their rate of success at accomplishing set goals for this site through the sampling of chosen parameters or indicators.

Overall strategy

Selected parameters (indicators) were, and will continue to be sampled, and their values will be used to evaluate the results of the completed restoration (Ducks Unlimited and NH Coastal Program 2004). Indicators were selected to answer specific questions about the effects of restoration and the marsh's response to each type of restoration activity.

The restoration design and phased construction (Phase I and II) enabled simultaneous pre restoration monitoring of Phase I and Phase II that was conducted from April 2002 to October 2002. The Phase I area was restored during the winter of 2002/2003 and Phase II remained unaltered and was used as a reference area for Phase I. Subsequent restoration of Phase II was conducted during the winter of 2003/2004.

After the entire 42-acre marsh was restored, a second ditched marsh on Great Bay (Vol's Island Marsh, Newmarket) was chosen as a long-term reference site. Vol's Island Marsh will be used to maintain a dataset for "un-restored" marsh conditions. Monitoring of completed Phases I and II at Pickering and Vol's will continue for a minimum of one year after the Phase II restoration activities are completed.

Indicators and Sampling Effort (Appendix III)

Sampling of the parameters listed below occurred at Pickering Brook salt marsh in pre-restoration and post restoration years 1, 2 and 3. The off-site reference marsh at Vol's Island was sampled using the same protocols in years 2 and 3. Monitoring should continue for each phase of the restoration and reference area every two to five years. Dr. David Burdick, Jackson Estuarine Laboratory, University of New Hampshire will analyze the data under a separate contract.

- Soil salinity (*collected by DU and volunteers*): Soil salinity was sampled a minimum of six times each year from wells that were strategically placed in the marsh, with dates including spring and neap tide periods. Water was removed from a soil salinity well, mixed and read using a temperature corrected optical refractometer. Water temperature, salinity, and dissolved oxygen were measured in open water bodies in conjunction with fish sampling (see below). Sampling occurred at seven wells approximately every two weeks from May through October, 2002 to 2004.

- Ground water hydrology (*collected by DU and volunteers*): The height of the water table was measured a minimum of six times each year along four transects located perpendicular to parallel man-made ditches, with dates including spring and neap tide periods (two transects on each side of the brook) (n = 42). Sampling occurred approximately every two weeks from May through October, 2002 to 2004.

- Vegetative community (*collected by DU and volunteers*): Vegetation was sampled once each year in July or August using 0.5 m^2 quadrats placed on the marsh surface every 15m (50 feet) along a transect. All vegetation was identified to species and percent cover for each species was estimated. Vegetation, open water, wrack, and bare sediment were tallied to arrive at 100%

coverage for each sample. When species of concern were recorded in a quadrat (for Pickering Brook, this would include *Phragmites, Lythrum* and *Typha*), the shoot density and height of the three tallest plants were measured. Sampling occurred on seven transects once per year: July/August (2-3 days), 2002-2004.

- Nekton community (*collected by DU and volunteers*): Fish and invertebrates (shrimp, crabs) that live in the water column were sampled using ditch and lift nets in ditches and pools, respectively. After setting each net, the area of the net, the water depth of the fished area and the potential depth of the water body were measured. Salinity, dissolved oxygen and water temperature of these locations were also measured using a hand-held meter (YSI model 850).
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- Nets in pools and pannes were left for a minimum of 30 minutes; ditches were fished on falling tides once the water had left the marsh surface, but before the creek level dropped by half. All shrimp, crabs and fish were counted by species and the first 15 individuals of each sex (if they can be readily differentiated like mummichogs) are measured for length. Sampling occurred once in October 2002,twice in 2003, and twice in 2004. Nine ditches and nine "pools/pannes" were sampled. Three closed ditches (the water body created behind the ditch plug therefore not intertidal) were also sampled.

- Avian community (*collected by DU and volunteers*): Bird species were surveyed using four point-counts at each marsh. The counts lasted 10 minutes. All bird species heard or observed were recorded. Time, tidal stage and weather data are included in the surveys. Sampling occurred approximately every two weeks during the breeding season (May through September) and every three weeks during fall migration at high tide until the marsh was covered by lasting snow, 2002 to 2004.

- Photo stations (*collected by DU)*: In September through October, four photographs in cardinal directions (north, south, east and west) were taken from the center point of each of the four bird sampling point-count locations in each marsh.

- Mosquito populations (*collected by Town of Greenland/SWAMP Inc.*): SWAMP Inc. provided information on mosquito breeding since 1979 (Figure 3). The use of the marsh by mosquitoes will be evaluated by the amount of larvicide to be used on each management section (restored and un-restored). The amount of larvicide used to control mosquitoes is based on dip net counts. The total amount (weight) of larvicide is recorded for each area. Mosquito larvae were sampled in, 1) wet areas that are vegetated with the short-form of *Spartina alterniflora,* and 2) open water bodies without fish, using a standard dip net. A sample was taken every ten steps in these habitats. Sampling occurred approximately every two weeks after each spring tide (5 to 8 times per year) that covered the marsh surface during the mosquito-breeding season (May through October) each year, 2002 to 2004.

- Base map (*collected by NHCP*): Aerial photography was used to develop a digital base map of the two sites using GIS technology. Post-restoration photography will be taken and used to determine changes in open water occurring on the marsh surface. Aerial photographs were obtained in February 2002 and April 2003 and will be collected in years 2004, 2006 and 2008.

- Surface water hydrology (*collected by NHCP*): Automatic water level recorders were deployed at Pickering Brook salt marsh in both an unrestricted creek and upstream of a ditch plug, for two-week intervals. Data will be used to assess water retention on the marsh surface in ditched and plugged areas. Sampling occurred in October 2002 and December 2003 during a spring cycle event.

Results and Discussion

Data collected during ongoing monitoring at Pickering Brook salt marsh restoration are summarized in Appendix III. Data analysis and conclusions are beyond the scope of this restoration project and will be conducted under a separate contract. Data was collected with the help of local landowners and volunteers from the Portsmouth Country Club, the Great Bay National Estuarine Research Reserve, and Ducks Unlimited, Inc. Parameters used to assess the success of this restoration include fish use, bird use, mosquito larvae abundance, water levels and salinity, and native vegetation growth.

Quantitative and qualitative pre-restoration monitoring (2003) and post-restoration monitoring (2003 and 2004) were conducted. Monitoring activities included:

- cover-type mapping, - descriptive information on pools and community types,
- photo documentation at established permanent photo stations,
- annual vegetation sampling along transects,
- bird surveys using point counts,
- mosquito breeding sampling using dip nets,
- groundwater and surface water level and salinity measurements at identified stations,
- tidal signal measurements, and
- vegetative sampling at permanent quadrats.

Monitoring data are to be shared with all partners and additional restoration activities may be recommended and implemented as part of the adaptive management strategy used for this restoration. The University of New Hampshire has been contracted by the NH Department of Environmental Studies to conduct the data analyses.

Predictions

It was predicted based on similar studies (Adamowicz and Roman unpublished) that in ditches where plugs were installed (Phase I), water will drain at a slower rate creating ponding behind the plugs. Deeper more slowly drained water will raise the water table, increase fish populations, promote increased bird use and vegetation change in the marsh. Filled ditches will result in different drainage patterns.

Data will be collected through a monitoring program that will be used to evaluate how the enhanced pools and filled ditches of Phase II influence tidal hydrology across the marsh. The two restoration approaches will be taken into consideration when evaluating the following parameters.

Surface water hydrology: Flooding during the highest of spring tides should be similar across the entire marsh. The ditch plugs will retain water in the linear ditches behind the plugs during low tide and neap high tides when the floodwaters may not reach the pools and pannes in Phase I. More standing water will be held on the marsh. Filled ditches will promote an even tidal drainage in Phase II, and allow for a more uniform hydration of the peat. Water will remain only in the enhanced pools to create open water habitat.

Ground water hydrology: Both techniques will raise the water table in the marsh. Amplitude of the water table in wells extending from one parallel ditch to the next will be reduced in areas where ditches are plugged. We expect at least 5 cm greater water table elevation (Adamowicz and Roman 2002). Filled ditches should also result in higher water tables as well.

Surface water and soil salinity: Ditch plugging may stabilize the salinity in pools, and increase and stabilize salinity of marsh soils during neap tides. Increased salinity would likely have the greatest effect on vegetation (including invasive species). We expect an increase of at least 2 ppt in soil salinity of plugged areas compared with reference areas averaged over the early growing season. Areas where ditches are filled should show more uniform salinity readings throughout the root zone and peat.

Vegetation community: With more open water on the marsh, *Spartina alterniflora* would be expected to increase in cover at the expense of *S. patens* (Warren and Niering 1993). The change in hydrology will increase and stabilize root zone salinity, produce more diverse plant assemblages, and decrease the opportunity for establishment of invasive plant species (common Reed (*Phragmites australis* Type M), purple loosestrife (*Lythrum salicaria*), narrow-leaved cattail (*Typha angustifolia*) and perennial pepperweed (*Lepidium latifolium*). Stabilized water conditions in pools may promote the establishment of widgeongrass (*Ruppia maritima*) populations.

Nekton community: Enhanced and created pools will improve and stabilize dissolved oxygen, water temperatures (cooler) and water salinities making these areas more suitable for fish species. Following restoration it is anticipated that there will be more fish per area, or more importantly, the number fish on the marsh surface during low tide will increase.

Fish, and shellfish benefiting from the restoration of Pickering Brook salt marsh

1	Mummichog	*Fundulus heteroclitus*
2.	Threespine Stickleback	*Gasterosteus aculeauts*
3.	Atlantic Silverside	*Menidia menidia*
4.	Fourspine Stickleback	*Apeltes quadracus*
5.	American Shad	*Alosa sapidissima*
6.	Ninespine Stickleback	*Pungitius pungitius*
7.	Striped Killifish	*Fundulus majalis*
8.	Atlantic Herring	*Clupea harengus*
9.	American Eel	*Anguilla rosterata*
10.	Sheepshead Minnow	*Cyprinodon variagatus*
11.	Bluefish	*Pomatomus saltatrix*
12.	Striped bass	*Morone saxatilis*
13.	Sand Shrimp	*Crangon septemspinosa*
14.	Periwinkle	*Littorina littorina*

Avian community: Brush et al. 1986, observed that grid-ditched marshes had lower bird diversity. The elimination of open water at Pickering Brook has resulted in the disappearance of critical habitat necessary for American black ducks, wading birds and shorebirds. Bird use of the restored marsh will increase (both number of species and abundance of some species) due to the increase in open water, food resources and suitable habitat.

Mosquitoes: Mosquito breeding habitat will decrease with the creation of permanent water on the marsh (pools and plugged ditches) almost immediately after restoration activities are complete. As other

studies have demonstrated, an increase in semi-permanent non-tidal water on the marsh surface promotes increased fish use, including insectivorous fish (such as mummichogs) that eat mosquito larvae. The increase of mosquito-eating fish will manage mosquito populations, thus eliminating the need to chemically treat the marsh throughout the summer. In past restoration projects, larval and pupal mosquito populations have been reduced by as much as 95-99% after restoration (Wolfe 1996).

Figure 4. Mosquito breeding locations as documented since 1979 by Swamp, Inc. at Pickering Brook Salt Marsh Restoration, Greenland, New Hampshire, 2002 to 2004.

Community Involvement
Volunteers were used to assist in the collection of nekton, vegetation, avian and water quality monitoring data. Participation provided citizens with a hands-on opportunity to learn about salt marshes.

Table 1. Number of volunteer hours spent conducting monitoring for the Pickering Brook Salt Marsh Restoration, Greenland, New Hampshire, 2002 through 2004.

Volunteer Monitoring hours 2002 - 2004					
Monitoring site	**# Volunteers**	**Salinity & Groundwater**	**Bird**	**Nekton**	**Vegetation**
Vol's Island 2004	16	13.8	0.00	35.00	9.00
Vol's Island 2003	9	11.75	15.00	57.75	10.00
Pickering 2004	41	97.5	13.80	214.57	41.00
Pickering 2003	12	11.00	23.00	180.50	46.75
Pickering 2002	4	0.00	16.00	8.00	4.00
Total	**82**	**134.05**	**67.8**	**563.62**	**110.75**

Conclusions and Recommendations

In the ever-evolving world of salt marsh restoration, it is important to incorporate an adaptive management plan into project design. For larger areas, a phased approach may also provide flexibility and benefit restoration efforts at a specific site under specific conditions. The completion of Phase I of the Pickering Brook restoration provided important information and feedback that were used to modify the Pickering Phase II restoration design.

In Phase I a portion of the dredged material excavated during surface pool and runnel creation was used to create ditch plugs. Prior to project completion it became evident that the large amount of high quality dredged marsh soils obtained were not needed for ditch plug construction and were scheduled to be exported offsite. Based on successful restoration activities in Connecticut and Massachusetts, DU requested to fill one man-made ditch (2' x 3' x 110') with approximately 24 CY of dredged material instead of the proposed smaller ditch plug. The request was permitted and the reclamation of the salt marsh platform was performed using the peat as instead of creating a plug. This technique was then applied to Phase II ditch restoration activities.

The two approaches used to reclaim man-made ditches at Pickering Brook were meant to address the goals and objectives of the restoration plan. Monitoring data collected in subsequent years will be analyzed to comparatively evaluate marsh recovery. Using these two techniques were used side by side creates an opportunity for study and will provide researchers and land managers with great insight into the response of this salt marsh community to these practices.

References

Adamowicz, S.C. 2002. New England salt marsh pools: analysis of geomorphic and geographic parameters, macrophyte distribution, and nekton use. Ph.D. Dissertation, University of Rhode Island, Graduate School of Oceanography, Narragansett, RI.

Adamowicz S.C. and C.T. Roman. 2002. Final Report: Initial Ecosystem Response of Salt Marshes to Ditch Plugging and Pool Creation: Experiments at Rachel Carson National Wildlife Refuge (Maine).

Brush, T., R.A. Lent, T. Hruby, B.A. Harrington, R.M. Marshall, and W.G. Montgomery. 1986. Habitat use by salt marsh birds and response to Open Marsh Water Management. *Colonial Waterbirds.* 9: 189-195.

Burdick, D. 2004. Adaptive Management for Pickering Brook Marsh: Year One of Post-Restoration, South Side (*in progress*).

Burdick, D., Bottitta, G. and Diers, T. 2004. Adaptive Management Plan for Pickering Brook Marsh (*in progress*).

Daiber, F.C. 1986. Conservation of Tidal Marshes. Van Nostrand Reinhold Co., New York.

Ducks Unlimited, Inc. and the New Hampshire Coastal Program. 2003. A Volunteer's Handbook for Monitoring New Hampshire Salt Marshes.

Erwin, R.M., J.S. Hatfield, M.A. Howe, and S.S. Klugman. 1994. Waterbird use of saltmarsh ponds created for Open Marsh Water Management. *Journal of Wildlife Management.* 58: 516-524.

Ferrigno, F., P. Slavin, and D.M. Jobbins. 1975. Saltmarsh water management for mosquito control. *Proceedings of the NJ Mosquito Extermators Association.* 62: 30-38.

Neckles, H.A., M. Dionne, D.M. Burdick, C.T. Roman, R. Buchsbaum, and E. Hutchins. 2002. A monitoring protocol to assess tidal restoration of salt marshes on local and regional scales., *Restoration Ecology.* 10(3):556-563.

Warren, R.S. and W.A. Niering. 1993. Vegetation changes on a northeast tidal marsh: Interaction of sea-level rise and marsh accretion. *Ecology.* 74:96-103.

Wolfe, R.J. 1996. Effects of open marsh water management on selected tidal marsh resources: A review .*Journal of the American Mosquito Control Association.* 12: 701-712..

Appendices

Appendix I. Aerial views of Pickering Brook Salt Marsh, Greenland, New Hampshire.

Appendix II. Construction activities performed at Pickering Brook Salt Marsh Restoration, Greenland, New Hampshire, 2004.

Version 1

Red lines indicate filled ditches

White areas are enhanced pools and pannes

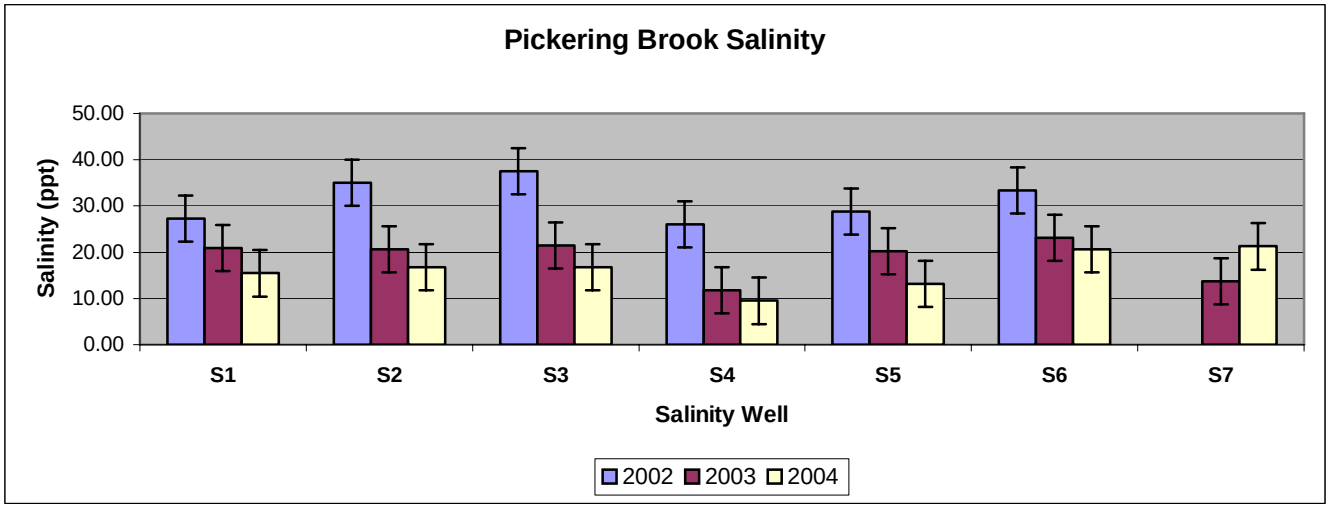
Appendix III. Summary of data collected during the Pickering Brook Salt Marsh Restoration project, Greenland, New Hampshire, 2002 to 2004.

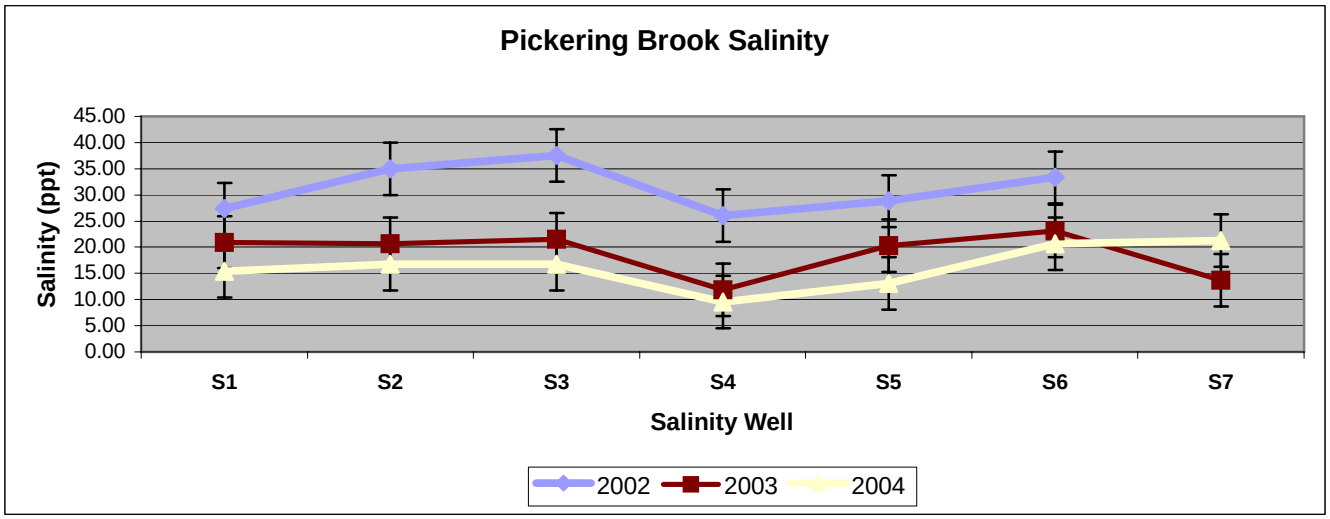
Data analysis is beyond the scope of this restoration project. Data collected will be analyzed and formal conclusions developed by Dr. David Burdick, Jackson Estuarine Laboratory, University of New Hampshire under a separate contract.

Salinity

Sampled 2002: 4 days; August through October
2003: 11 days; June through October
2004: 6 days; June through September

Figure 5. Overall trends in salinity readings over the three years of monitoring at Pickering Brook Salt Marsh Restoration, Greenland, New Hampshire, 2002 to 2004.





Groundwater wells

Sampled 2002: 4 days; August through October
2003: 11 days; June through October
2004: 6 days; June through September

Tidal influence/ surface water level

Sampled 2002: October 4 through 10
2003: November 18 through 24
2004:November 19 through December 2

Avian use

Sampled: 2002: September through November; 6 days
2003: May through November; 11 days
2004: April through June; 3 days

Table 2. Bird species recorded during monitoring surveys at Pickering Brook salt marsh restoration, Greenland, New Hampshire, 2002 to 2004.

American Black Duck	***Anas rubripes***	Herring Gull	*Larus argentatus*
American Crow	*Corvus caurinus*	**Least Sandpiper**	***Calridris minutilla***
American Goldfinch	*Carduelis tristis*	**Lesser Yellowlegs**	***Tringa flavipes***
American Robin	*Turdus migratorius*	**Mallard**	***Anas platyrhynochos***
Barn Swallow	***Hirundo rustica***	Mourning Dove	*Zenaida macroura*
Belted Kingfisher	***Ceryle alcyon***	Northern Cardinal	*Cardinalis cardinalis*
Blue Jay	*Cyanocitta cristata*	Northern Flicker	*Colaptes auratus*
Blue-wing Teal	*Anas discors*	**Northern Harrier**	*Cricus cianeus*
Canada Goose	*Branta canadensis*	Northern Mockingbird	*Mimus polyglottos*
Cedar Waxwing	*Bombycilla cedrorum*	**Purple Martin**	***Progne subis***
Common Grackle	*Quiscalus quiscula*	Red-tailed Hawk	*Buteo jamaicensis*
Common Tern	***Sterna hirundo***	Red-Winged Blackbird	*Agelaius phoeniceus*
Double-crested Cormorant	*Phalacrocorax auritas*	Savannah Sparrow	*Passerculus sandwhichensis*
Eastern Bluebird	*Sialia sialis*	**Semipalmated Sandpiper**	***Calidris pusilla***
Eastern Kingbird	*Tyrannus tyrannus*	**Snowy Egret**	*Egretta thula*
European Starling	*Sturnus vulgaris*	Song Sparrow	*Melospiza melodia*
Great Black-backed Gull	*Larus marinus*	Sharp-shinned Hawk	*Accipiter striatus*
Great Blue Heron	***Aredea herodias***	**Saltmarsh Sharp-tailed Sparrow**	***Ammodramus n. subvirgatus***
Gray Catbird	*Dumetella carolinensis*	**Tree Swallow**	***Tachycinets bicolor***
Greater Yellowlegs	***Tringa melanoleuca***	Turkey Vulture	*Cathartes aura*
Total – 42 species			

***species in bold** indicate species that frequent salt marsh habitats, non-bolded species are casual visitors

Nekton use

Sampled: 2002: Oct 14 and 15t
2003: June 14 and 15; September 22 and 23
2004: July 9 and 10; September 10

Table 3. Fish and Invertebrates species recorded from the water column during monitoring of Pickering Brook Salt Marsh Restoration, Greenland, New Hampshire, 2002 to 2004.

Mummichog	*Fundulus heteroclitus*
Atlantic Silverside	*Menidia menidia*
Three-Spine & Four-Spine Stickleback	*Gasterosteus spp.*
Herring	*Alosa spp.*
Green Crab	*Carcinus maeneus*
Sand Shrimp	*Crangon septemspinosa*
Shore/Grass Shrimp	*Palaemonetes spp.*
Nine-Spine Stickleback	*Pungigitus pungititus*
Horseshoe Crab	*Limulus polyphemus*
Total = 9 species	

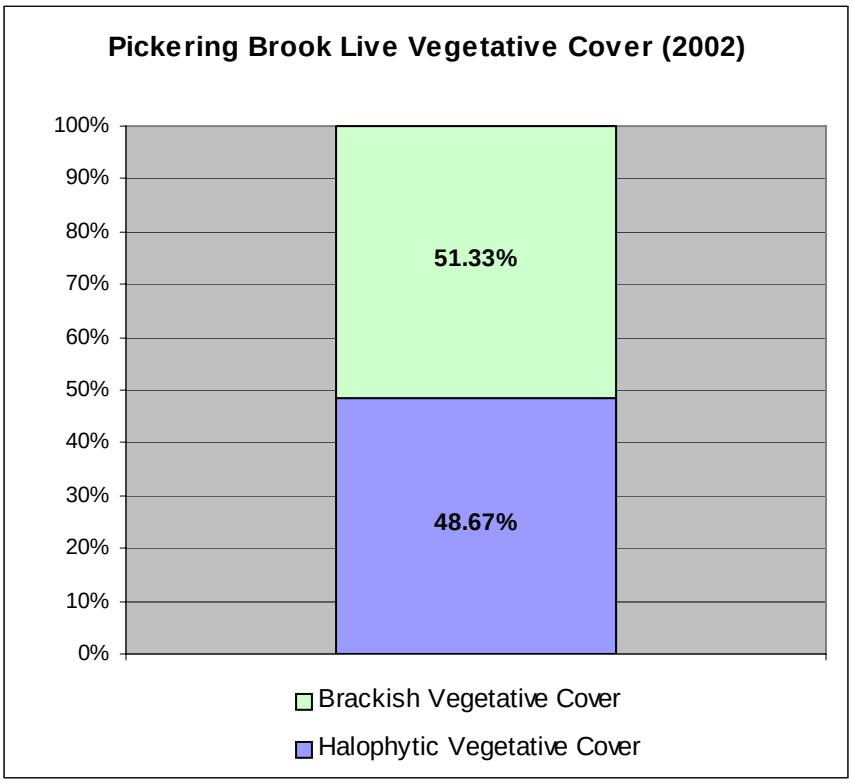
Vegetation

Sampled: 2002: August 9t
2003: July 25
2004: August 6 and 7

Table 4. Plant species recorded during monitoring activities at Pickering Brook Salt Marsh Restoration, Greenland, New Hampshire, 2002 to 2004.

Marsh Orach	*Atriplex patula*	Bushy Knotweed	*Polygonum ramoissium*
Saltmarsh Aster	*Aster tenufolius*	Switchgrass	*Panicum virgatum*
Spike Grass	*Distichlis spicata*	Saltwater Cordgrass	*Spartina alterniflora*
Red Fescue	*Festuca rubra*	Common Glasswort	*Salicornia europaea*
Overlooked Hedge Hyssop	*Gratiola neglecta*	Saltmarsh Bulrush	*Scirpus maritimus*
Jewelweed	*Impatiens capensis*	Saltmeadow Grass	*Spartina patens*
Black Grass	*Juncus gerardi*	Saltmarsh Bulrush	*Scirpus robustus*
Sea Lavender	*Limonium nashii*	Seaside Goldenrod	*Solidago sempervirens*
Sweet Gale	*Myrica gale*	Narrow-Leaf Cattail	*Typha angustifolia*
Northern Bayberry	*Myrica pensylvanica*	Seaside Arrow Grass	*Triglochin maritimum*
Halberd-Leaved Tearthumb	*Polygonum arifolium*	Tall Meadow Rue	*Thalictrum pubescens*
Reed Canary Grass	*Phalaris arundinacea*	Poison Ivy	*Toxicodendron radicans*
Seaside Plantain	*Plantago maritima*	**Total** = 25 species	

Figure 6. Percent change in salt marsh vegetation during restoration at Pickering Brook Salt Marsh, Greenland, New Hampshire, 2002 to 2004.



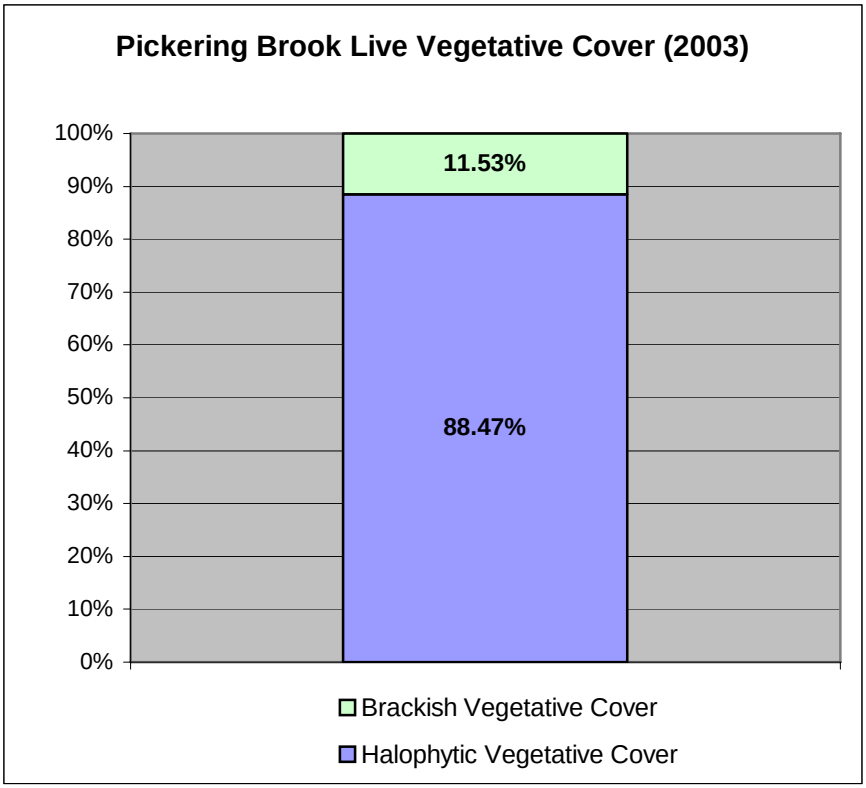
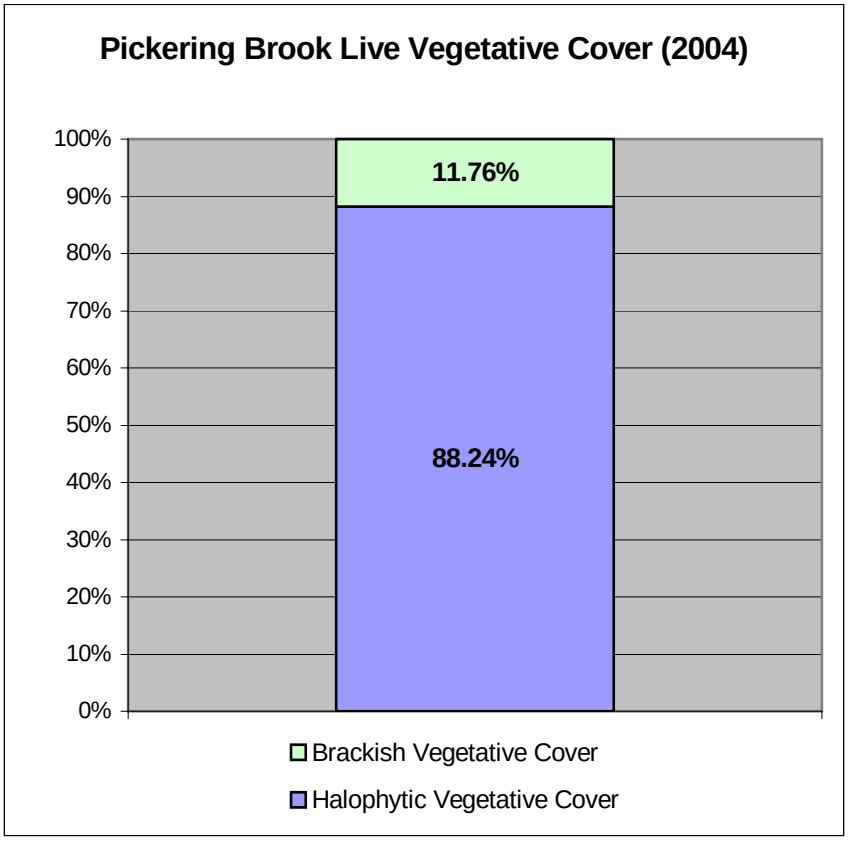


Figure 6. continued.



Mosquito use and management at Pickering Brook (1979- 2003)

- Larviciding costs (labor, insecticide, etc.): $65/ hour.
- Each larviciding application (18 hours @ $65/hour): $1,170.00
- Average annual cost (5 applications @ $1,170.00): $5,850.00

Larvicide application at both phases – 42 acres

Year sampled	Acres	Personnel hours	Amount of larvicide (lbs.)	Cost of hrs and larvicide ($)
1982	44	93	795	1,340
1992	44	97	1079	4,029
2002	44	86	865	5,590
***2003**	44	179	1072	4,886

Larvicide application at each phase

*2003 (7 trips to site)	Acres	Personnel hours	Amount of larvicide (lbs.)	Cost of hrs and larvicide ($)
Phase I	20	21	43	415
Phase II	24	158	1029	3,399

Sediment samples

The four sediment samples collected from the marsh analyzed by NH DES were found to below the detection levels for Dichlovos, Simizine, Chlorothalonil, Metalachlor, Glyphossate, PCNB, Atrazine, Metalaxyl and Chlorpyrifos.

Photo points of marsh surface

2002: October
2003: November
2004 October

Aerial photographs

2002: February
2003: April
2004 April

Appendix IV. Raw data on separate disk and electronic copy to Project Manager.

Appendix V. Supporting documentation.

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WETLANDS AND NON-SITE SPECIFIC PERMIT 2002-02056

Permittee: **Town of Greenland, Mosquito Control Commission**
575 Portsmouth Ave Greenland, NH 03840
Project Location: **Pickering Brook Dr, Greenland**
Greenland Tax Map/Lot No. VARVIOUS /
Waterbody: **Pickering Creek salt marsh**

APPROVAL DATE: 02/26/2004 EXPIRATION DATE: 10/24/2007

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Based upon review of the above referenced application, in accordance with RSA 482-A and RSA 485-A:17, a Wetlands Permit and Non-Site Specific Permit was issued. This permit shall not be considered valid unless signed as specified below.

AMENDMENT

PERMIT DESCRIPTION: Dredge and fill approximately 17,238 square feet of tidal wetland to restore the hydrology of a 42 acre degraded salt marsh along Pickering Creek and adjacent to Great Bay. Work will include ditch sloping and maintenance, installing 12 ditch plugs within existing drainage ditches, creating 6 constructed pools to enhance habitat for fish, invertebrates, wading birds and submerged aquatic vegetation. Short connecting channels (runnels) will be constructed between pools. Dredged materials will be utilized to fill mosquito breeding depressions, and to partially fill 14 man-made drainage ditches.

THIS APPROVAL IS SUBJECT TO THE FOLLOWING PROJECT SPECIFIC CONDITIONS:

1. All work shall be in accordance with plans by Swamp Inc, as received by the Department on 9/16/02; and by revised plans by Ducks Unlimited Inc, as received by the Department on 2/18/03 and 2/20/04.
2. Work on the salt marsh shall occur during the months of August through the following April. No work on the marsh shall occur after April 30 unless a waiver of this condition is issued from the DES Wetlands Bureau.
3. Any further alteration of areas on this property that are within the jurisdiction of the DES Wetlands Bureau will require a new application and further permitting by the Bureau.
4. DES coastal restoration staff shall be notified in writing prior to commencement of work and upon completion of restoration activities.
5. Construction equipment shall have specialized low ground pressure tracks, which impact less than four (4) pounds per square inch when loaded, or the permittee shall utilize timber or plywood mats beneath machines when driving over wetland areas.
6. Timber or plywood mats shall be utilized in all areas of the marsh where construction equipment is required to travel or turn multiple times over the same area.
7. All weight distribution mats shall be removed from the marsh within a minimum practicable time period.
8. Dredged material shall be stockpiled outside of any area that is within the jurisdiction of the DES Wetlands Bureau.
9. The applicant shall re-use sod mats that are removed for panne/pool creation areas to cover the fill material that is placed in man-made ditches, as depicted on the revised plans.
10. Appropriate siltation/erosion controls shall be in place prior to construction, shall be maintained

during construction, and shall remain until the area is stabilized.
11. The permittee shall submit monitoring reports to the DES Wetlands Bureau according to the specifications stated in the "Monitoring Requirements for Salt Marsh Restoration Projects", NH Coastal Program, September 1998.

GENERAL CONDITIONS WHICH APPLY TO ALL DES WETLANDS PERMITS:
1. A copy of this permit shall be posted on site during construction in a prominent location visible to inspecting personnel;
2. This permit does not convey a property right, nor authorize any injury to property of others, nor invasion of rights of others;
3. The Wetlands Bureau shall be notified upon completion of work;
4. This permit does not relieve the applicant from the obligation to obtain other local, state or federal permits that may be required (see attached form for status of federal wetlands permit);
5. Transfer of this permit to a new owner shall require notification to and approval by the Department;
6. This permit shall not be extended beyond the current expiration date.
7. This project has been screened for potential impacts to **known** occurrences of rare species and exemplary natural communities in the immediate area. Since many areas have never been surveyed, or have received only cursory inventories, unidentified sensitive species or communities may be present. This permit does not absolve the permittee from due diligence in regard to state, local or federal laws regarding such communities or species.

APPROVED: _____
DES Wetlands Bureau

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BY SIGNING BELOW I HEREBY CERTIFY THAT I HAVE FULLY READ THIS PERMIT AND AGREE TO ABIDE BY ALL PERMIT CONDITIONS.

_____ _____
OWNER'S SIGNATURE (required) CONTRACTOR'S SIGNATURE (required)

Appendix V continued.

■ Surprise pledge at national convention helps restore Pickering Brook salt marsh

Restoration undoing 1930s efforts to drain marsh

By DU Program Biologist Grace E. Bottitta

This aerial view photo of Pickering Brook salt marsh was taken in April 2002, prior to restoration

At the 2002 DU Convention in New Orleans, Susie Konkel (Portland, Maine) surprised her brother with a $150,000 pledge in his honor to deliver habitat in the Atlantic Coast Ecosystem Initiative in New England.

The restoration of the Pickering Brook salt marsh, in Greenland, N.H. is the first of many projects to benefit from Susie's gift. This salt marsh was ditched and drained in the 1930s in an attempt to eradicate mosquito-breeding habitat.

What resulted was the loss of open water on the marsh surface, critical for black ducks, wading birds, shorebirds, and fish.

Prior to construction, the local DU biologist, DU conservation volunteers, the University of New Hampshire and the N.H. Coastal Program documented the degraded condition of the marsh; including fish and bird usage, mosquito larvae abundance, and groundwater levels.

In December 2002, the first phase of restoration began. The frozen marsh surface made it easier for the specialized wetland equipment to fill in sections of the ditches and create deep pools and shallow pannes. By increasing the amount of water available on the marsh surface, we will re-create essential open water habitat that will allow native salt marsh dependant species - waterfowl, fish, shorebirds, etc., to return and increase in number. This restoration will also naturally manage the mosquito population and improve water quality.

The funds received from Susie Konkel, the Fuller Foundation and the Town of Greenland, combined with volunteer time will match federal funds from the N.H. Coastal Program/ NOAA partnership and the U. S. Fish Wildlife to restore the Pickering Brook salt marsh to its former beauty and function.

Appendix V continued.

Restoration of Pickering Brook Salt Marsh

By Grace E. Bottitta, Biologist, Ducks Unlimited

The specialized low ground pressure excavator and dump carrier used to implement this restoration work exerts about two-pounds/square inch of pressure on the surface of the marsh (less than a human footprint).

Pickering Brook, Greenland, NH
In the early 1900s, the majority of coastal saltmarshes in New England were ditched as part of an aggressive mosquito control program. In an attempt to eradicate mosquito-breeding habitat, the ditches drained the open water necessary for a healthy saltmarsh. What resulted was the loss of open water on the marsh surface, critical for black ducks, wading birds, shorebirds, and fish, including those that eat mosquito larvae. The absence of mosquito-eating fish on the salt marsh surface allows high numbers of mosquitoes to breed and hatch, which necessitates spraying throughout the summer to control mosquito populations.

Throughout last summer Ducks Unlimited, the University of New Hampshire, SWAMP Inc. the NH Coastal Program and local volunteers, documented the degraded condition of the marsh; including fish and bird usage, mosquito larvae abundance, and groundwater levels.

In December 2002, the first phase of restoration began. The frozen marsh surface made it easier for the specialized wetland equipment to fill in sections of the ditches and create deep pools and shallow pannes. Phase 2 of the restoration will be completed by Winter 2003-2004. By increasing the amount of water available on the marsh surface, we will re-create essential open water habitat that will allow native salt marsh dependent species - waterfowl, fish, and shorebirds to return and increase in number. This restoration will also naturally manage the mosquito population and improve water quality. Monitoring will continue until Fall 2004.

Ducks Unlimited in partnership with the Town of Greenland, the New Hampshire Coastal Program, University of New Hampshire, Great Bay National Estuarine Research Reserve, U. S. Fish and Wildlife Service, National Oceanic and Atmospheric Administration and the Portsmouth Country Club - will restore the Pickering Brook Saltmarsh to its former natural beauty and function.

To find out more about this project or other Ducks Unlimited projects throughout New England or would like to volunteer on this or, for any questions please contact Grace Bottitta at (603) 778-0704 or e-mail gbottitta@ducks.org.

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Numerous reports on Pickering were included in Ducks Unlimited Newsletters, Standard Reports and Updates distributed to the public, our members and employees.

Pickering Brook also appears on the Ducks Unlimited National and Regional web pages:

http://www.ducks.org/conservation/Projects/GreatLakesAtlantic/AtlanticCoast/PickeringBrook.asp

Pickering Brook appears as part of the volunteers monitoring effort, The New Hampshire Marsh Monitors, posted on the New Hampshire Department of Environmental Services, Coastal Program web page.

http://www.des.state.nh.us/Coastal/

News Release

Contact: Grace Bottitta
Biologist, Ducks Unlimited
603-778-0704 or gbottitta@ducks.org

FOR IMMEDIATE RELEASE

Pickering Brook Salt Marsh Restoration Project Starts Phase Two

Greenland, New Hampshire—March 10, 2004 — The 40-acre Pickering Brook salt marsh in Greenland, New Hampshire was one of many marshes on the Atlantic Coast that was ditched and drained in the 1930's in an attempt to control mosquitoes. The result was the loss of semi-permanent open water on the marsh surface, critical for black ducks, wading birds, shorebirds and fish. Ducks Unlimited, the University of New Hampshire, the NH Coastal Program, NH Fish and Game and Great Bay National Estuarine Research Reserve and volunteers examined and documented the degraded "health" of the Pickering Brook salt marsh, and found it was evident that restoration was needed. Funds and in-kind services received from Ducks Unlimited donors, the Fuller Foundation, the Town of Greenland, NH Coastal Conservation Association, the Portsmouth Country Club, NH Department of Environmental Services and from the sale of the Conservation License Plate (Moose Plate) under the NH State Conservation Committee grant program combined with volunteer time, will match federal funds from the NH Coastal Program/NOAA partnership, the NH Estuaries Project/Environmental Protection Agency partnership and the U.S. Fish and Wildlife Service Partners in Fish and Wildlife, to restore the Pickering Brook salt marsh to its former beauty and function. By increasing the amount of water available on the marsh surface will re-create essential open water habitat that will allow native salt marsh dependent species for instance, waterfowl (such as black ducks and green-winged teal), fish, songbirds and shorebirds, etc. to return and increase in number. This restoration will also naturally manage the mosquito population and improve water quality.

The first phase of Pickering Brook restoration activities were completed in Winter 2002/2003. *"The partnership's goal was to design a plan that corrected the damaged hydrology to one that more accurately paralleled and depicted a natural system, while imposing the least impact to achieve this*," states Ducks Unlimited Biologist, Grace Bottitta.

The second phase of the restoration project began on Wednesday, March 10, 2004. The objective for the restoration is to increase the occurrences of permanent and semi-permanent saltwater (pools and pannes) on the salt marsh, which will provide more quality habitat for salt marsh - related species, such as mummichogs, black ducks and egrets, as well as increase overall waterfowl and water bird use of the salt marsh. As studies have demonstrated, where there is an increase in pool habitat in appropriate places, the insectivorous fish have access to eat the mosquito larva, decreasing the need to apply larvicide to manage mosquitoes.

Restoration activities on the salt marsh will continue for the next few weeks. Post restoration monitoring will occur for the next 2-3 years. For more information please contact Grace Bottitta, the project's manager and Biologist for Ducks Unlimited, Inc. at 603 778-0704 or gbottitta@ducks.org.

With more than one million supporters, Ducks Unlimited is the world's largest wetland and waterfowl conservation organization. Since it's founding in 1937, DU has raised more than $1.5 billion and conserved nearly 11 million acres of critical wildlife habitat across North America. Wetlands are nature's most productive ecosystems, but the United States has lost more than half of its original wetlands and continues to lose more than 100,000 wetland acres every year

Appendix V continued.

An article was published in Portsmouth Herald Newspaper article on March 13, 2004 (see attached website)
http://www.seacoastonline.com/news/03132004/news/5120.htm

Excavators molding Greenland salt marsh

By Jack Loftus
jloftus@seacoastonline.com

GREENLAND - Since it was ditched and drained as part of an attempt to control mosquito populations in the 1930s, the 40-acre Pickering Brook salt marsh has been unable to sustain much of the wildlife that needs that environment to survive.

Numbers have declined in species like the black duck, various wading birds, shorebirds and fish as their natural habitats are drained or filled, said Ducks Unlimited biologist Grace Bottitta.

In response to the decline, Bottitta and 16 volunteers have been working to restore the Pickering Brook salt marsh, and others like it across the Seacoast, for the last three years.

Joined by the University of New Hampshire, the N.H. Coastal Program, N.H. Fish and Game and the Great Bay National Estuarine Research Reserve, Bottitta and her group of volunteers are already on their way to restoring the brook to functioning as it did more than 70 years ago.

"The partnership's goal was to design a plan that corrected the damaged hydrology to one that more accurately paralleled and depicted a natural system, while imposing the least impact to achieve this," Bottitta said.

Currently, the site is home of excavators that are in the process of manipulating the environment to increase the occurrences of permanent and semi-permanent saltwater pools and reservoirs on the salt marsh, Bottitta said.

According to Bottitta, these features will provide more quality habitats for salt marsh species like mummichogs, black ducks and egrets, in addition to other waterfowl that make use of the marsh.

"The excavators employ large tracks that apply very low pressure to the salt marsh, resulting in very little impact to the environment," Bottitta said.

Funding and donations have been received from but not limited to Duck Unlimited donors, the Fuller Foundation, the town of Greenland, the N.H. Coastal Conservation Association, the Portsmouth Country Club (owner of the salt marsh land) and the sale of the Conservation "Moose" License Plates totaling $100,000, Bottitta said.

"The town of Greenland has been great," Bottitta said, adding that the town can expect lower mosquito insecticide bills, as the insectivorous fish who make the marsh their home will feed on the mosquito larva.

Bottitta, who has been involved with the Pickering Brook project for the past three years, said 16 volunteers were responsible for logging 175 volunteer hours in 2003.

"We wouldn't be able to do it without our volunteers," she said.

The active construction process that began at Pickering Brook represents Phase 2 of the restoration project. Bottitta said that the first phase involved monitoring the site for animal behavior and vegetation, including the bird-monitoring efforts of Greenland resident Dennis O'Neil.

O'Neil volunteered his time every two weeks during the months between May and October for the past two years, and will continue to monitor the site after the major construction is completed within the next few weeks.

Post-restoration monitoring will then continue for the next two to three years, Bottitta said.

"It's an intensive process," Bottitta said. "It's not difficult; it just takes a while, but it's fun going out there."

According to the Web site, Ducks Unlimited has become the world's largest wetland and waterfowl conservation organization since its founding in 1937. To date, DU has raised $1.5 billion and has conserved 11 million acres of wildlife habitats across North America.