Putnam Farm Conservation Area
Wetland Restoration Project Proposal
April 25, 2023

Restored vernal pool wetland
Mass Audubon Long Pasture Sanctuary

Thomas R. Biebighauser
Wetland Restoration and Training LLC

Ian Ives
Mass Audubon

Table of Contents

Introduction 3
Description of Project Work Areas 5
Goals and Objectives 10
Project Design 11
Recommended Actions 12
Removal of Soil and Trash Dumped in the Wetlands 12
Gradual Slopes and Bays Bordering Vegetated Wetlands 13
Creation of Vernal Pools in Sunlit Locations 13
Creating sandplain grassland habitat 13
Loosening compacted soils 15
Upland Native Plant Garden for Pollinators 16
Planting and seeding a diversity of native plants that will benefit pollinators. 16
Maps 20
Photos showing designed projects 23
Project Actions and Specifications 38
Removal of Soil and Trash Dumped in the Wetlands 38
Gradual Slopes and Bays Supporting Wet-meadow Wetlands 39
Creation of Vernal Pools in Sunlit Locations 40
Creating sandplain grassland habitat 41
Loosening compacted soils 41
Upland Native Plant Garden for Pollinators 41
Project Drawings 42
Heavy Equipment and Construction 44
Project Supervision 45
Estimated Budget 45
Mosquitoes and Wetlands 46
Invasive Species Control 47
Cattail and Phragmites 47
Climate Change 48
Sediment and Erosion Control 48
Educational Opportunities 49
Summary 50

References 51
About the authors 51
Appendix 1: Photos showing examples of wetlands restored by Tom Biebighauser and Ian Ives. 54
Appendix 2: Photos showing examples of wetlands restored by Tom Biebighauser 59

Introduction

This plan describes actions that may be taken to enhance and expand wetlands on the Putnam Farm Conservation Area owned by the town of Orleans, Massachusetts. The projects identified would increase plant and animal biodiversity on the conservation property and improve habitat for pollinators, benefitting community farming operations.

The Putnam Farm Conservation Area is located at 50 Bridge Road in Orleans, Massachusetts. Encompassing 13.86-acres, the land was purchased from Mr. Jay Putnam on December 29, 2010. The Putnam Farm is under the care and control of the Town of Orleans Conservation Commission and is used for open space conservation and passive recreational purposes (Town of Orleans, 2011).

The Putnam Farm was originally purchased by Joseph Henry Putnam in 1956 from Dick Nickerson for $10,000.00 (Putnam, 2023). At that time the property contained rolling hills and open fields that had been farmed for hundreds of years. In 1957 Joseph Putnam sold sand and gravel on the land to the Massachusetts Department of Public Works for $10,000.00. According to Jay Putnam, Joseph Putman's son, from 10-15-feet of sand and gravel was removed from the farm and used to construct the Eastham Rotary, which was built by filling a marsh (Putnam, 2023).

The Massachusetts Department of Public Works appears to have stopped removing soil from the Putnam Farm at an elevation approximately 24-inches above the water table. This was probably done so that the land would still be dry enough to farm. Topsoil was then spread over the ground following soil removal (Putnam, 2023).

One can tell that a large quantity of soil was removed from the Putnam Farm by walking along the northwest boundary of the property. A rim approximately 10-feet high can be seen bordering the backyards of homes located along the Goody Hallett Road in Eastham. One can see a large basin which is now the Putnam Farm Conservation Area when standing on the rim.

The Putnam family raised apples, asparagus, cucumbers, potatoes, squash, tomatoes, turnips, high bush blueberries, and grew Christmas trees on the farm. Jay Putnam remembers hiding in the turnip pits while playing army as a boy. The family erected greenhouses and installed a well to provide clean water for use in the greenhouses. Jay recalls the well producing over 100-gallons of water per minute, and the surface of the ground settling around the well. The farming ended in the 1960's. He recalled his father not wanting to pay workers 7-cents/pint for picking the high bush blueberries.

Jay Putnam remembered catching spotted salamanders and frogs in a pond along the Southern edge of the Putnam Farm property. This pond had been dug deeper by using a dragline in 1957. A pipe was installed so that overflow would drain into the salt marsh near the old railroad grade. Jay remembers hearing green frogs and spring peepers calling from the pond in the spring. His father stocked bluegill sunfish in the pond. He hunted rabbits on the farm and pheasants that had been stocked (Putnam, 2023).

Jay Putnam recalled the entire farm being open grassland with only a few planted Christmas trees 20-years ago (Putnam, 2023).

The Putnam Farm was carefully examined by the authors and a team of individuals representing the Orleans Conservation Commission, Agricultural Council, Putnam Farm Growers, Natural Resources Conservation Service, and community members from March 5-8, 2023 to identify what actions may be taken to improve the two existing wetlands, which are named the *Pond* and the *Shrub Swamp*. Three-day-long design charrettes involving individuals from these organizations were organized by Rick Francolini and John Jannell. The following individuals assisted with the design of the project outdoors for one or more days:

- Keely Ashe
- Karen Baker
- Alexander Bates
- Tom Biebighauser
- Judith Bruce
- Ginny Farber
- Rick Francolini
- Betsy Furtney
- Drusy Henson
- Ian Ives
- John Jannell
- Peter Jensen
- Krystle McMorrow
- Gretel Norgeot
- Maggie Payne

- Jay Putnam

These individuals visited the site during the week to learn more about the design process:

- Tom Fettig
- Joan Francolini
- Ken Johnson
- Walter North
- Hardie Truesdale
- Marcie Truesdale

Description of Project Work Areas

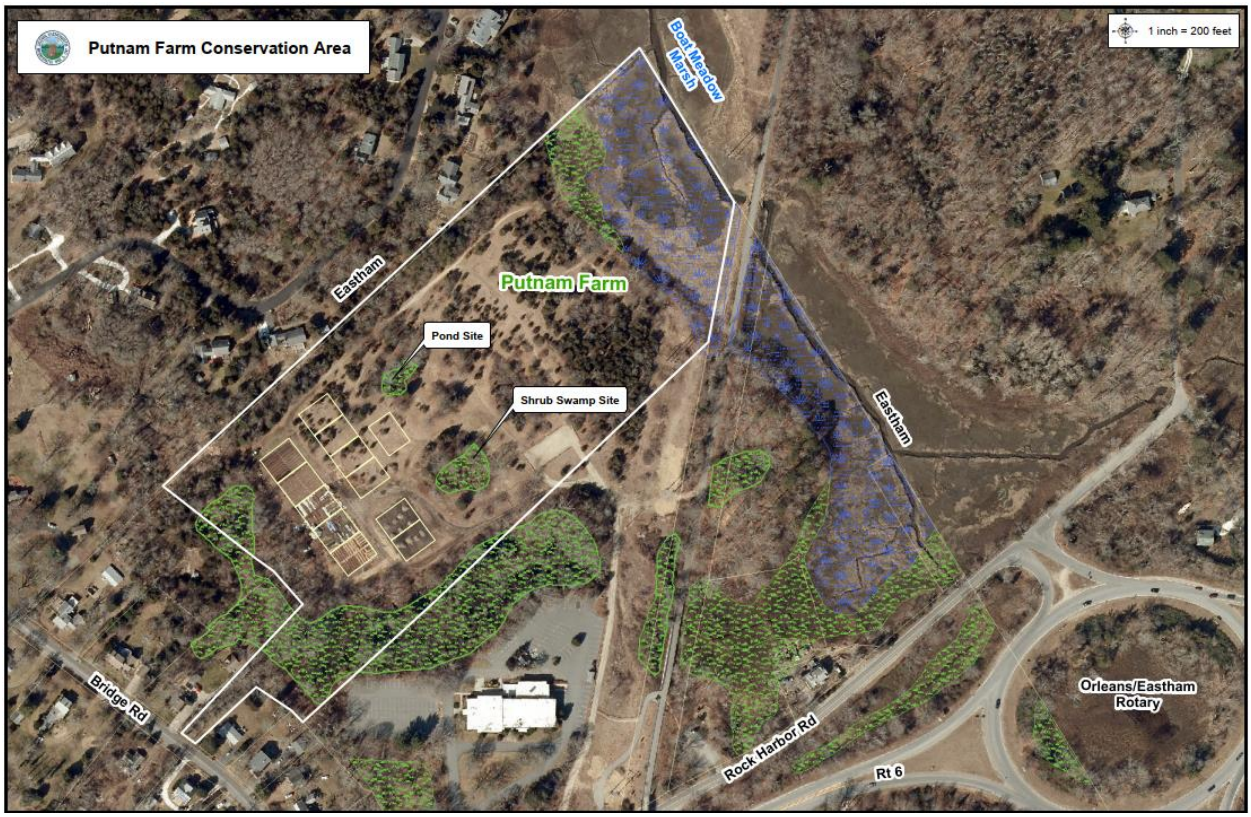
Actions were designed to improve biodiversity within two-small wetlands on the Putnam Farm. One wetland is named the *Pond*, the other the *Shrub Swamp*. The two wetlands are listed by the Town of Orleans as *Isolated Land Areas that are Subject to Flooding*.

The Pond is an Emergent Wetland containing water approximately 6-feet deep. It has steep banks that are crowded by trees and shrubs. A dragline was used to deepen the Pond years ago so its water could be used for irrigation (Putnam, 2023).

The trees and shrubs surrounding the Pond are shading the waters. The cold water can restrict the development of frog, toad, and salamander larvae. The lack of sunlight can impact turtle basking and nesting habitat. The dense shade also restricts the diversity and growth of flowering plants, affecting pollinator use of the area.

The dense tangle of tree and shrub branches over and around the water may be restricting bat and waterfowl use of the Pond. In addition, it would be very difficult for students and teachers to use the Pond for environmental education because of the dense vegetation blocking access and the drop-offs along the edge of deep water.

Wet-meadows that are important to frog and toad juveniles for feeding and hiding are not present along the edge of the Pond because of the steep slopes and high banks. Wildflowers were not found along the edge of the pond, most likely because of the shade from shrubs and trees.



Location of the Pond and Shrub Swamp Wetlands

The Pond is surrounded by a dense growth of trees and shrubs.

Aerial photo showing the Pond. Note how trees and shrub are covering the water (drone image by Alexander Bates)

List of plant species growing around the Pond Wetland.

Common Name	Scientific Name	Native	Non-Native	State Listed Invasive
Apple	Malus pumila	No	Yes	No
Arrowwood Virburnum	Viburnum dentatum	Yes	No	No
Bittersweet	Celastrus orbiculatus	No	No	Yes
Black Cherry	Prunus serotina	Yes	No	No
Black Oak	Quercus velutina	Yes	No	No
Black Willow	Salix nigra	Yes	No	No
Buckthorn	Rhammus sp.	No	No	Yes
Bush Honeysuckle	Lonicera taterica	No	No	Yes
Choke Cherry	Prunus virginiana	Yes	No	No
English Oak	Quercus robur	No	Yes	No
Grape (fox)	Vitis labrusca	Yes	No	No
Greenbrier	Smilax sp.	Yes	No	No

Common Name	Scientific Name	Native	Non-Native	State Listed Invasive
Highbush Blueberry	Vaccinium corymbosum	Yes	No	No
Multiflora rose	Rosa multiflora	No	Yes	Yes
Pear	Pyrus communis	No	Yes	No
Poison Ivy	Toxicodendron radicans	Yes	No	No
Serviceberry	Amelanchier sp.	Yes	No	No
Soft rush	Juncus effusus	Yes	No	No
Spruce	Picea glauca	Yes	No	No
Winterberry	Ilex verticillata	Yes	No	No

This Shrub Swamp is one of two wetlands on the Putnam Farm. The site is dominated by a dense growth of nonnative shrubs including multiflora rose and buckthorn.

Aerial photo showing the Shrub Swamp. The dense growth of nonnative trees and shrubs are affecting the growth of plants used by pollinators, restricting human access to water, and are draining the wetland (drone image by Alexander Bates)

The Shrub Swamp Wetland is a shallow depression that is dominated by a thick growth of shrubs and trees. Portions of the Shrub Swamp were found to have been filled with soil and trash. The Shrub Swamp contained a small area of water only 3-inches deep. The water level in this wetland fluctuates with rainfall and season, and has been reported to be several inches deeper than at the time of the visit and larger in diameter (Jannell, 2023).

The Shrub Swamp does not appear to contain water long enough for frog, toad, and salamander larvae to develop. However, it does appear to contain water long enough for mosquitoes to develop. Tom Biebighauser conducted a frog and toad survey (visual and audio) of the Shrub Swamp and the Pond on the evening of March 7, 2023 with no amphibians being detected.

The dense shade in and around the Shrub Swamp restricts the diversity and growth of flowering plants, affecting pollinator use of the area. The dense tangle of tree and shrub branches over and around the water may be affecting bat and waterfowl use of the wetland. It would be very difficult to use the Shrub Swamp for environmental education because of the dense growth of shrubs and thorns present on the greenbrier and multiflora rose.

List of plant species growing in and around the Shrub Swamp:

Common Name	Scientific Name	Native	Non-Native	State Listed Invasive
Apple	Malus pumila	No	Yes	No
Arrowwood Virburnum	Viburnum dentatum	Yes	No	No
Bittersweet	Celastrus orbiculatus	No	No	Yes
Black Cherry	Prunus serotina	Yes	No	No
Black Oak	Quercus velutina	Yes	No	No
Black Willow	Salix nigra	Yes	No	No
Buckthorn	Rhammus sp.	No	No	Yes
Bush Honeysuckle	Lonicera taterica	No	No	Yes
Choke Cherry	Prunus virginiana	Yes	No	No
English Oak	Quercus robur	No	Yes	No
Grape (fox)	Vitis labrusca	Yes	No	No
Greenbrier	Smilax sp.	Yes	No	No
Highbush Blueberry	Vaccinium corymbosum	Yes	No	No
Multiflora rose	Rosa multiflora	No	Yes	Yes
Pear	Pyrus communis	No	Yes	No
Poison Ivy	Toxicodendron radicans	Yes	No	No
Serviceberry	Amelanchier sp.	Yes	No	No
Soft rush	Juncus effusus	Yes	No	No
Spruce	Picea glauca	Yes	No	No
Winterberry	Ilex verticillata	Yes	No	No

Goals and Objectives

There is an unprecedented decline in insects, including critically important pollinator insects in the Northeast. Pollinators are essential to the environment. The ecological service they provide is necessary for the reproduction of over 85% of the world's flowering plants, including more than two-thirds of the world's crop species. The United States alone grows more than 100 crops that either need or benefit from pollinators. Pollinators are keystone species in terrestrial ecosystems. Fruits and seeds derived from insect pollination are a major part of the diet of approximately 25% of all birds, and of mammals ranging from red-backed voles to grizzly bears (Xerces Society, 2023). Establishing native pollinator plants, providing insect nest sites, avoiding pesticide use, and educating the public are widely accepted actions to reverse this trend.

The goal of this project is to restore a robust and healthy ecosystem on the Putnam Farm Conservation Area that will provide habitat to pollinators and a diversity of plant and animal species.

The objectives of this project are to:

1. Increase habitat for pollinators and beneficial insects that will support the agricultural efforts underway on the Putnam Farm. This includes the planting and seeding of pollinator plants.
2. Improve habitat for bats, frogs, toads, salamanders, turtles, and waterfowl.
3. Create educational opportunities to benefit all members of the community.
4. Increase wildlife viewing opportunities.
5. Remove trash and soil placed in wetlands.
6. Complete the project so that it will have a beneficial effect on agricultural land.
7. Restore the Pond and Shrub Swamp Wetland so they appear and function as natural wetlands that provide habitat for pollinators and require little or no maintenance.
8. Maintain sandplain grassland habitat.
9. Control erosion both during and after construction.
10. Control nonnative invasive plant species.

Project Design

Proposed actions were identified and designed to meet the objectives for the Putnam Farm Conservation Area. The design process began by examining historic aerial photos, current aerial photos, documents, and NRCS Soil Survey maps showing the property and surrounding land. An interview was conducted with previous landowner Mr. Jay Putnam on March 7, 2023. The farm area was carefully examined on the ground over a 4-day period to identify signs of filling and ditching that affect wetland areas.

Soil test holes were dug by Maggie Payne (Soil Scientist, NRCS) and Tom Biebighauser on March 6, 2023. The holes were dug using a 4-foot long-3-inch diameter open-face soil auger and a 10-foot long-3-inch diameter soil auger. The texture of soils at various depths was measured onsite using the ribbon test. The elevation of groundwater at various locations was determined by measuring how high water rose in each test hole.

A long-range laser-level and receiver were used to record elevations for each wetland project that was designed. The perimeter of each identified project was marked using colored plastic wire flags and ribbon tied to vegetation. Project areas were mapped using the Fields Area Measure App and an external Garmin GPS. Photographs were taken and notes were recorded for each wetland project that was identified and designed.

Actions were identified that would greatly improve habitat for a host of insect pollinators including but not limited to butterflies, moths, bees, as well as birds. Flowering wetland plants such as bidens, jewelweed, swamp milkweed, golden alexanders, monkey flower, cardinal flower, buttonbush, highbush blueberry, and trees including Eastern Red Cedar and willow may be established. These and other key native host plants may be established both around and in the restored wetlands. Exposed and saturated mineral soils may be created along wetland

margins where butterflies and moths could seek minerals and wasps obtain the mud needed for building nests. Shorebirds would also make use of the saturated and exposed soils.

Areas now growing nonnative and invasive plants such as buckthorn, honeysuckle, English oak, and multiflora rose may be controlled to restore a natural diversity of trees, shrubs, and wildflowers. The restoration of the two-wetlands would improve water quality, replenish groundwater, and reduce flooding in the community.

Wetland restoration for this project would involve shaping natural basins, creating gradual slopes, filling ditches, and loosening compacted soils – not building dams across streams. The recommended actions may be completed without further design. However, the Commission may choose to develop detailed engineering drawings showing exact locations of improvements, elevations, and cross sections. Tom Biebighauser is available to be onsite directing the completion of the project.

Recommended Actions

Seven main actions were identified for meeting the objectives listed for the two sites:

1. Removal of soil and trash dumped in the wetlands.
2. Creation of gradual slopes and bays supporting wet-meadow wetlands in sunlit locations.
3. Creation of vernal pools in sunlit locations.
4. Creating sand plain grassland habitat.
5. Loosening compacted soils.
6. Building an upland native plant garden for pollinators.
7. Planting and seeding a diversity of native plants that will benefit pollinators.

Removal of Soil and Trash Dumped in the Wetlands

Small trash items such as plant containers and plastic bags may be removed from the wetlands by hand. An excavator may be used to remove larger and heavier trash items, and soil that was dumped in the wetlands. The removal of trash and soil would expose saturated soils in sunlit locations that would grow a diversity of flowering wet-meadow plants important to pollinators.

Tom Biebighauser has found that the presence of trash on the surface of a wetland indicates that more trash has been buried in the ground, much like the tip of an iceberg. Wetlands have been convenient places for farmers to dump trash for hundreds of years. Municipal garbage collection in rural areas is a relatively new development, explaining why some farmers historically used wetlands as dumps.

Gradual Slopes and Bays Bordering Vegetated Wetlands

An excavator with a skilled operator may be used to make gradual slopes surrounding the wetlands, and to create areas bordering wetland communities with characteristics suited to pollinators. These areas can be planted with both wetland and upland pollinator plants, contain both deeper (longer hydroperiod) and shallower (shorter hydroperiod) bays, and receive high levels of sun exposure. To maximize sun exposure, trees existing on the south side of the Shrub Swamp would be removed. Keeping those on the north side if preferred by collaborators. These features will restore wet-meadow wetlands in sunlit locations, increasing plant diversity for pollinators, and providing safe access for students and adults to investigate the wetlands.

Buckthorn, honeysuckle, English oak, and multiflora rose may be removed as part of shaping gradual slopes around the wetlands and in creating wet-meadow wetland bays. Compacted soils may be loosened and a diversity of plants seeded and planted including cardinal flower, joe-pye weed, monkey flower, and sedges.

The steep slopes surrounding the Pond were created when the dragline deepened the site to store water for irrigation. The nearly vertical banks made it easier to pump water from the Pond, and helped control the growth of aquatic plants that can plug the pump inlet hose. The hooves of white-tailed deer drinking from the Pond have also sheared the banks, making them steeper.

Creation of Vernal Pools in Sunlit Locations

An excavator with a skilled operator may be used to restore vernal pools within and along the edges of the Pond and Shrub Swamp. A vernal pool is a wetland that fills with water in the spring and dries in the fall. Vernal pools in sunlit locations support a diversity of flowering plants important to pollinators such as bidens, button bush, cardinal flower, monkey flower, swamp milkweed, and joe-pye weed. Vernal Pools can also provide critical breeding habitat to a diversity of animal species including frogs, toads, salamanders, fairy shrimp, and clam shrimp.

The majority of vernal pools once present on Cape Cod have been drained and filled for farming, and building development. Vernal pools were relatively easy to destroy because of their small size and shallow depth. Farmers historically filled vernal pools using mule scoops and plows. They also drained vernal pools by burying structures made from wood, rock, clay tile, and plastic in the ground.

Creating sandplain grassland habitat

Sandplain grassland habitat may be created by spreading the sand texture soil removed from shaping vernal pools and wet-meadows on the surface of the ground surrounding the wetland. The Putnam Farm is well-suited for restoring sandplain grassland habitat because of the deep sand-texture soils combined with the removal of trees and shrubs that is taking place.

Creating sandplain habitat adjacent to the Pond and the Shrub Swamp will provide the Eastern painted turtle, snapping turtle, and Eastern box turtle with nesting habitat. Mass Audubon is willing to assist with the construction of areas suitable for use by the Eastern box turtle.

The following excerpt from Sandplain Grassland Network (Network, 2023) explains the importance of Sandplain Grasslands to maintaining biodiversity:

Sandplain grasslands of the northeastern U.S. are iconic hotspots for biodiversity and important conservation priorities because of their relative rarity, limited geographical range, and the diversity of uncommon plant and animal species that they support.

Many widely-distributed plant species adapted to droughty, nutrient-poor soils attain their greatest abundance on open lands of the coastal sandplain. Examples of these species include little bluestem (Schizachyrium scoparium), Pennsylvania sedge (Carex pensylvanica), red fescue (Festuca rubra), poverty grass (Danthonia spicata), wild indigo (Baptisa tinctorum), stiff aster (Ionactis linariifolia), and bearberry (Arctostaphylos uva-ursi), intermixed with widespread shrubs such as black huckleberry (Gaylussacia baccata), lowbush blueberry (Vaccinium angustifolium) and small bayberry (Morella caroliniensis). Sandplain grasslands contain more than 20 plant species that are listed as endangered, threatened, of special concern, or exist on state watch lists because they may become threatened. These include sandplain gerardia (Agalinis acuta), Nantucket shadbush (Amalanchier nantucketensis), sandplain blue-eyed grass (Sisyrinchium fuscatum), eastern silvery aster (Symphyotrichum concolor), purple needlegrass (Aristida purpurascens), purple milkweed (Asclepias purpurascens), and butterfly weed (Asclepias tuberosa). Sandplain grasslands support regionally uncommon grassland birds such as grasshopper sparrows (Ammodramus savannarum), savanna sparrows (Passerculus sandwichensis), eastern meadowlarks (Sturnella magna), American kestrels (Falco sparverius), northern harriers (Circus hudsonius), short-eared owls (Asio flammeus) and barn owls (Tyto alba). All of these species are uncommon or declining in the northeast. Sandplain grasslands also support a variety of moth and butterfly species such as the chain dot geometer (Cingilla catenaria), tiger moths (Grammia oithona, G. phyllira) and the state listed frosted elfin (Callophrys irus).

Most sandplain grasslands owe their origin to land clearing and grazing that occurred in the northeast U.S. following European colonization. Smaller areas of land very near the coast probably formed a mosaic of shrubby or grassy vegetation patches, maintained in different stages of succession by the disturbances of wind, salt spray, and fires set by indigenous people, whose populations reached their greatest numbers near the coast. Grasslands expanded greatly during the expansion of agriculture and particularly animal grazing that followed European post-settlement and reached their greatest extent in the mid-1800s (Foster 2017). Frequent wildfires occurred during a period of abandonment of agriculture and subsequent forest

regrowth, lasting until roughly the time of World War II, when the residential development for vacation homes began to increase (Foster and Motzkin 1999b). These fires helped prolong the existence of grasslands and associated disturbance-dependent shrublands.

While never the dominant coastal vegetation before European colonization, sandplain grasslands and interspersed shrublands were important reservoirs of the region's biodiversity. Grasslands reached their greatest extent on Cape Cod, and on the islands of Martha's Vineyard, Nantucket, and Long Island. Today, the area covered by grasslands is declining sharply as a result of residential development, fire suppression, abandonment of agriculture and widespread regrowth of woody vegetation. More than 90% of the coastal grasslands and related heathlands that were widespread in the northeastern U.S during the mid-19th century have been lost and this ecosystem now ranks among the northeast U.S.'s most imperiled.

Loosening compacted soils

A penetrometer was used to measure soil compaction at various locations on the Putnam Farm. Soils were found to be compacted from 250-300 lbs./inch². Water is likely to runoff soils that are this compacted, and plants are slow to germinate and grow. In addition, animals like the Eastern spadefoot, Eastern painted turtle, Eastern box turtle, and snapping turtle may not be able to burrow in compacted soils.

Compacted soils may be loosened within and surrounding the wetlands to be restored. The sandy soils used to make sandplain grassland habitat may also be loosened. This involves using the bucket of an excavator to loosen all compacted soils to an average depth of 3-feet.

In the northeast, 70% of native bees are ground nesting, and 30% are cavity nesting. ground nesting bees require loose bare soil, and cavity nesters utilize cavities in dead wood, hollow stems, or brush piles. Bumble bees utilize brush piles. These features can be created with in the created loose soil alongside the restored wetland's edge. Ground bees utilize the shelter provided by little bluestem *(Schizachyrium scoparium),* Pennsylvania sedge *(Carex pensylvanica),* and other tufted native grasses. These species may be planted for this project.

Box Turtles, previously documented at the site, require sunny sandy soils for nesting. Sandy spoils from the wetland restoration can be spread in sunny spots adjacent to the restored wetlands to attract turtle nesting activity.

The loosening of compacted soils has been proven effective across North America for controlling erosion and for providing an excellent seedbed for growing pollinator plants. Precipitation and runoff rapidly soak into the ground on loosened soils instead of flowing across the surface and causing erosion. A diversity of native sandplain plants can be expected to

rapidly grow on soils loosened using this technique. However, the loosened soils would be shaped and smoothened so areas may be mowed to control woody vegetation.

In summary, loosening compacted soils will produce these benefits:

- Water soaks into the ground and does not runoff and cause erosion
- Trees, shrubs, and wildflowers rapidly germinate and grow
- Plant and animal diversity will be greatly increased
- Small mammals, turtles, crayfish, toads, and the Eastern spadefoot are able to burrow into the ground. Snakes, frogs, and toads often live in these burrows.
- Loosened soils retain moisture.

Upland Native Plant Garden for Pollinators

A contained wildflower garden/plot may be developed next to the parking lot for the Putnam Conservation Area. This demonstration garden would be highly visible to users and serve as an exhibit intended to promote native wildflower gardening in in the community. Volunteer garden stewards could be recruited to tend the garden, create interpretive information and create a sense of community pride. The Food Forest Initiative, Nauset Garden Club and the Pollinator Pathways Cape Cod may be utilized for their expertise and contributions to any proposed garden.

Planting and seeding a diversity of native plants that will benefit pollinators.

A diversity of native plants may be seeded and planted in the completed project areas to improve habitat for bees, butterflies, moths, bats, and waterfowl. An assortment of native plants may be seeded or planted the same day each portion of the project is completed to increase the probability of success.

Sedges and rushes can be expected to naturally colonize the wet-meadows and vernal pools that are built. However, native flowering plants that are important to pollinators should be seeded and planted as many of these plants are slow to seed in naturally.

Staff from the Xerces Society have been invited to visit the Putnam Farm Conservation Area to provide information on best management practices to use for establishing native plants that will benefit pollinators. They will also be asked to recommend species of plants to establish in uplands, wetlands, and hedgerow areas.

Recommended Sources for native plants:

For wild seed and plants: Prairie Moon Nursery www.prairiemoon.com

For potted plants:

- Sylvan nursery https://sylvannurseries.com/
- Weston Nursery https://www.facebook.com/WestonNurseries/
- Native Plant Trust https://www.nativeplanttrust.org/for-your-garden/buy-native-plants/
- New England Wetland Plants 14 Pearl Lane, South Hadley, MA 01075, 413-548-8000. *Minimum order = $250.*00. Wetland plants for large-scale installations and restoration projects, grown from locally collected seed. Trees and shrubs sold in gallon containers, herbaceous plants in 2" plugs sold in flats. Native seed mixes available.
- Grow Native Massachusetts website, a good source of native plant retailers: https://grownativemass.org/Great-Resources/nurseries-seed

The following table created by Dr. Robert J. Gegear lists plants supporting native bees and butterflies and other pollinator species at risk in Massachusetts. Seeding and planting a number of these plant species within and surrounding the designed wetland projects would greatly improve habitat for pollinators.

Research-based native plants to support MA bumblebee species at risk. Plants supporting butterfly and other bee species at risk are also indicated. List created by Dr. Robert J Gegear, UMASS Dartmouth (rgegear@umassd.edu).

Pollen Sources

LATIN NAME	COMMON NAME	PLANT TYPE	SUN	SOIL	BLOOM TIME							'At risk' species				
					Early		Mid		Late			BUMBLEBEES			BUTTER FLIES	OTHER BEES
					M	A	M	J	J	A	S	O	B. terricola	B. fervidus	B. vagans		
Hypericum ascyron	Great St. John's-wort	Herb. perenn.	Full-Part	Med												NA	
Hypericum majus	Greater St. John's-wort	Herb. perenn.	Full-Part	Med, Wet												NA	
Hypericum punctatum	Spotted St. John's-wort	Herb. perenn.	Full-Part	Med, Dry												NA	
Hypericum prolificum	Shrubby St. John's-wort	Shrub	Full-Part	Med, Dry												NA	
Rosa acicularis	Bristly rose	Shrub	Full-Shade	Med, Dry												NA	
Rosa blanda	Smooth rose	Shrub	Full-Part	Med, Dry												NA	
Rosa carolina	Carolina rose	Shrub	Full-Part	Wet, Med, Dry												NA	
Rosa nitida	Shining rose	Shrub	Full-Part	Wet, Med												NA	
Rosa palustris	Swamp rose	Shrub	Full-Part	Med												NA	
Rosa virginiana	Virginia rose	Shrub	Full-Part	Med												NA	
Rubus odoratus	Flowering raspberry	Shrub	Full-Part	Med												NA	
Salix discolor	Pussy willow (male)	Shrub	Full	Med												NA	
Salix humilis	Prairie willow (male)	Shrub	Full-Part	Med, Dry												NA	
Salix lucida	Shining willow (male)	Shrub	Full-Part	Med, wet												NA	
Salix occidentalis	Dwarf prairie willow (male)	Shrub	Full-Part	Med, Dry												NA	
Salix petiolaris	Meadow willow (male)	Shrub/sm tree	Full-Part	Med												NA	
Salix bebbiana	Bebb willow (male)	Shrub	Full-Part	Dry, Med, Wet												NA	
Spiraea alba	White meadowsweet	Shrub	Full-Part	Wet, Med												NA	
Spiraea tomentosa	Steeplebush	Shrub	Full-Part	Wet												NA	

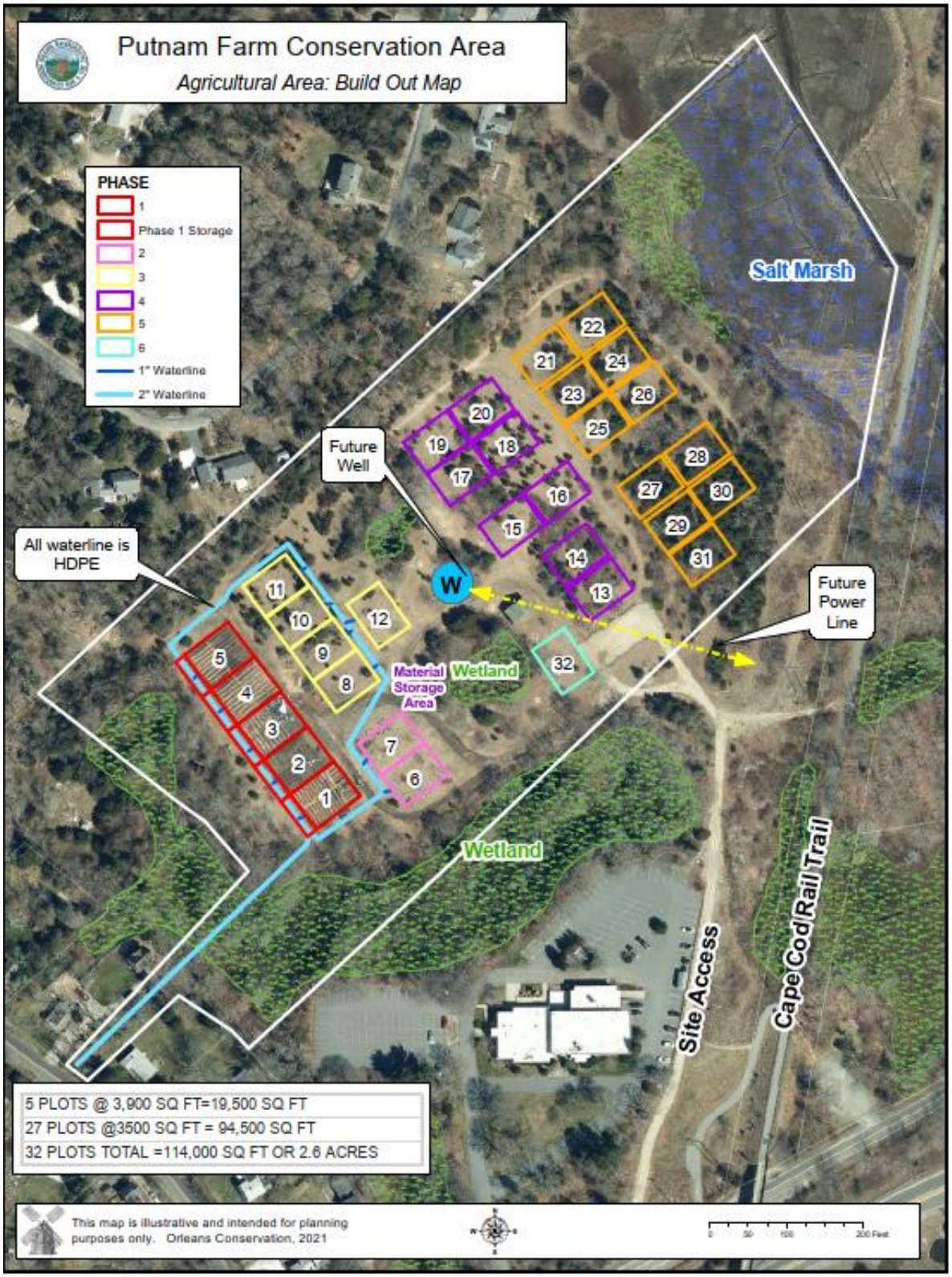
Nectar sources

LATIN NAME	COMMON NAME	PLANT TYPE	SUN	SOIL	BLOOM TIME							BUMBLEBEES			BUTTER FLIES	OTHER BEES
					Early		Mid		Late							
					M	A	M	J	J	A	S	O	B. terricola	B. fervidus	B. vagans		
Eupatorium perfoliatum	Boneset Thoroughwort	Herb. perenn.	Full, part	Wet, Med													
Asclepias amplexicaulis	Clasping milkweed	Herb. perenn.	Full-Part	Dry													
Asclepias exaltata	Poke milkweed	Herb. perenn.	Part, Shade	Med, Dry													
Asclepias incarnata	Swamp milkweed	Herb. perenn.	Full-Part	Med, Dry													
Asclepias purpurascens	Purple milkweed	Herb. perenn.	Full-Part	Wet, Med,Dry													
Asclepias quadrifolia	Four-leaved milkweed	Herb. perenn.	Full-Part	Med, Dry													
Asclepias syriaca	Common milkweed	Herb. perenn.	Full	Wet, Med, Dry													
Asclepias tuberosa	Butterfly milkweed	Herb. perenn.	Full-Part	Dry													
Asclepias verticillata	Whorled milkweed	Herb. perenn.	Full-Part	Med, Dry													
Cercis canadensis	Eastern Redbud	Tree	Part	Med, Dry													
Eutrochium dubium	Coastal Plain Joe-Pye weed	Herb. perenn.	Full-Part	Wet, Med													
Eutrochium fistulosum	Hollow Joe-Pye weed	Herb. perenn.	Full-Part	Wet, Med													
Eutrochium maculatum	Spotted Joe-Pye weed	Herb. perenn.	Full-Part	Wet, Med													
Eutrochium purpureum	Purple Joe-Pye weed	Herb. perenn.	Part	Wet,Med, Dry													
Ilex opaca	American holly	Tree	Full-Shade	Med, Dry													
Symphyotrichum lateriflorum	Calico aster	Herb. perenn.	Full-Part	Med Wet, Med dry													
Salix discolor	Pussy willow (female)	Shrub	Full	Med													
Salix humilis	Prairie willow (female)	Shrub	Full-Part	Med, Dry													
Salix lucida	Shining willow (female)	Shrub	Full-Part	Med, wet													
Salix occidentalis	Dwarf prairie willow (female)	Shrub	Full-Part	Med, Dry													
Salix petiolaris	Meadow willow (female)	Shrub/sm tree	Full-Part	Med													
Salix bebbiana	Bebb willow (female)	Shrub	Full-Part	Wet, Med, Dry													
Solidago speciosa	Showy goldenrod	Herb. perenn.	Part	Med													
Baptisia tinctoria	Yellow wild indigo	Herb. perenn.	Full-Part	Wet, Med, Dry													
Cephalanthus occidentalis	Common buttonbush	Shrub	Full-Part	Wet, Med													
Chamerion angustifolium	Narrow-leaved fireweed	Herb. perenn.	Full	Med, Dry													
Chelone glabra	White turtlehead	Herb. perenn.	Full-Part	Wet, Med													
Cirsium discolor	Field thistle	Herb. perenn.	Full-Part	Med, Dry													
Cirsium horridulum	Yellow thistle	Herb. perenn.	Full	Med, Dry													
Cirsium muticum	Swamp thistle	Herb. perenn.	Full-Part	Wet, Med													
Cirsium pumilum	Pasture thistle	Herb. perenn.	Full	Med, Dry													
Diervilla lonicera	Northern bush honeysuckle	Shrub	Full-Shade	Dry, Med													
Desmodium canadense	Showy tick trefoil	Herb. perenn.	Full-Part	Med, Dry													
Agastache scrophulariaefolia	Purple giant hyssop	Herb. perenn.	Sun, Shade	Dry, Med, Wet													
Gentiana clausa	Closed gentian	Herb. perenn.	Full-Part	Med													
Impatiens capensis	Spotted touch me not	Annual	Full-Part	Wet, Med													
Lobelia siphilitica	Blue lobelia	Herb. perenn.	Full-Part	Wet, Med													
Lupinus perennis	Wild lupine	Herb. perenn.	Full-Part	Med, Dry													
Mimulus alatus	Winged monkey-flower	Herb. perenn.	Full-Part	Wet- Med													
Mimulus ringens	Allegheny monkey-flower	Herb. perenn.	Full-Part	Wet, Med wet													
Monarda fistulosa	Wild bergamot	Herb. perenn.	Full-Part	Wet, Med, Dry													
Monarda didyma	Scarlet bee balm	Herb. perenn.	Full-Part	Wet, Med													
Pedicularis canadensis	Wood betony	Herb. perenn.	Full-Part	Wet, Med, Dry													

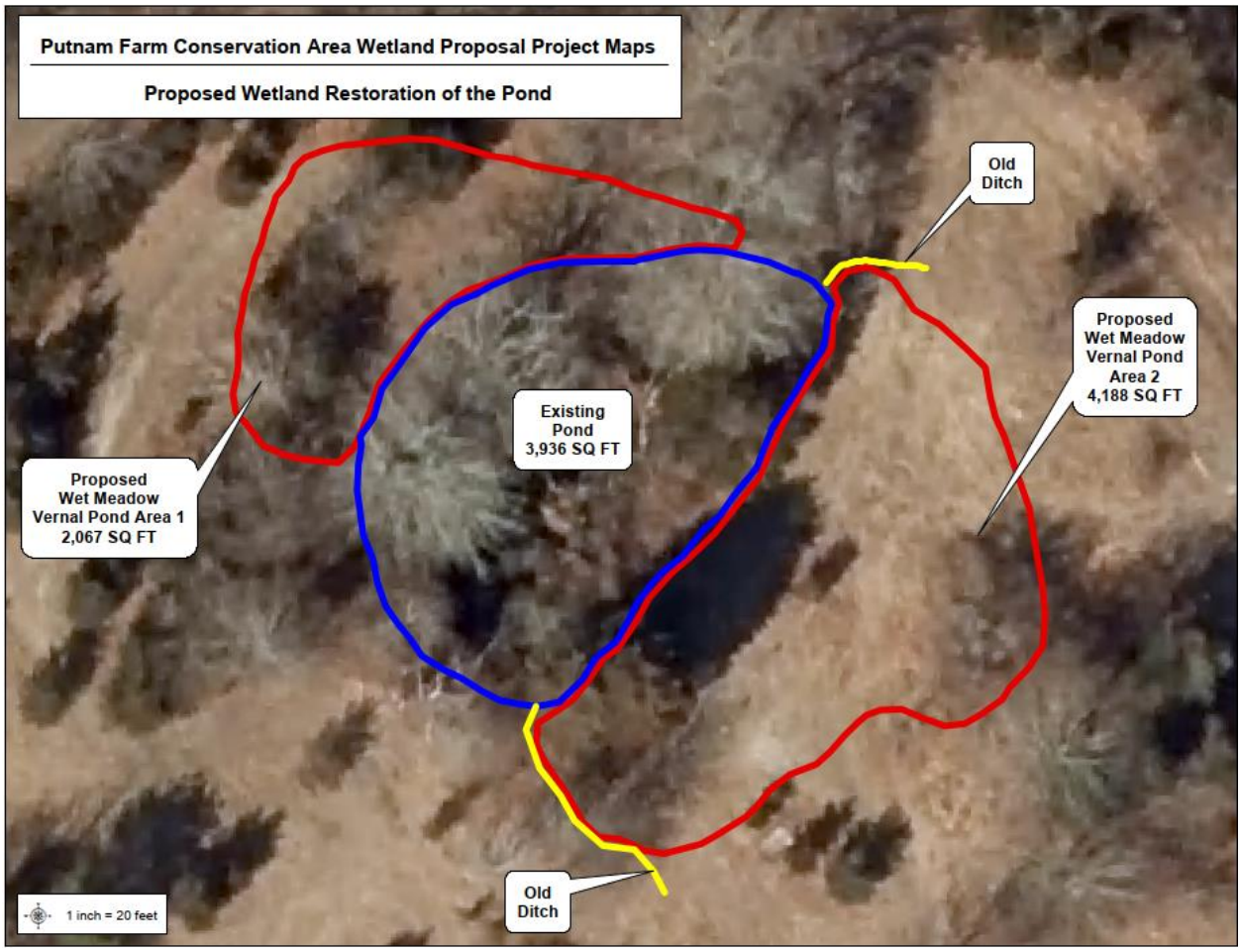
Penstemon digitalis	Foxglove beardtongue	Herb. perenn.	Full-Part	Wet, Med, Dry													
Penstemon hirsutus	Northeastern beardtongue	Herb. perenn.	Full-Shade	Wet, Med, Dry													
Pontederia cordata	Pickerelweed	Herb. perenn.	Full-Part	Aquatic													
Physostegia virginiana	Obedient plant	Herb. perenn.	Full-Part	Wet, Med													
Prunella vulgaris	Common selfheal	Herb. perenn.	Full-Part	Med													
Scutellaria galericulata	Hooded skullcap	Herb. perenn.	Full-Part	Wet, Med													
Scutellaria lateriflora	Mad dog skullcap	Herb. perenn.	Full-Part	Wet, Med													
Stachys pilosa	Hairy hedge-nettle	Herb. perenn.	Full-Part	Med													
Vaccinium angustifolium	Lowbush blueberry	Shrub	Full-Part	Med, Dry													
Vaccinium corymbosum	Highbush blueberry	Shrub	Full-Shade	Wet, Med, Dry													
Vaccinium fuscatum	Black highbush blueberry	Shrub	Full-Part	Med, wet													
Vaccinium myrtilloides	Velvet-leaved blueberry	Shrub	Full-Shade	Med													
Vaccinium oxycoccos	Small cranberry	Shrub	Full-Shade	Med, wet													
Vaccinium pallidum	Hillside blueberry	shrub	Full-Shade	Wet, Med, Dry													
Host plants (all regions)					**BLOOM TIME**							**BUMBLEBEES**			**BUTTER FLIES**	**OTHER BEES**	
LATIN NAME	**COMMON NAME**	**PLANT TYPE**	**SUN**	**SOIL**	**Early**		**Mid**		**Late**			**B. terricola**	**B. fervidus**	**B. vagans**			
					M	**A**	**M**	**J**	**A**	**S**	**O**						
Viola sororia	Common violet	Herb. perenn.	Full-Shade	Wet, Med, Dry											See accompanying table for species present in your region		
Viola pedata	Bird's foot violet	Herb. perenn.	Full-Part	Med, Dry													
Viola pedatifida	Prairie violet	Herb. perenn.	Full-Part	Med, Dry													
Viola sororia	Common Blue Violet	Herb. perenn.	Full-Shade	Wet, Med, Dry													
Viola pubescens	Smooth Yellow Violet	Herb. perenn.	Part	Wet, Med, Dry													
Viola striata	Cream Violet	Herb. perenn.	Part, Shade	Wet, Med, Dry													
Baptisia tinctoria	Small Yellow Wild Indigo	Herb. perenn.	Full-Part	Wet, Med, Dry													
Doellingeria umbellate	Flat topped aster	Herb. perenn.	Full-Part	Wet, Med													
Rumex spp.	Water dock	Herb. perenn.															
Vaccinium macrocarpon	Cranberry	trailing shrub	Part	Wet													
Quercus spp.	Oak	Tree															
Juniperus virginiana	Eastern red cedar	Tree	Full-Shade	Dry													
Ribes spp.	Gooseberry	Herb. perenn.	Full-Shade	Wet, Med, Dry													
Cardamine spp.	Bitter-cress	Herb. perenn.															
Fagus grandifolia	American Beech	Tree	Shade, Part	Med													
Carex stricta	Tussock sedge	Grass	Part-Full	Wet, Med													
Andropogon gerardii	Big bluestem	Grass	Full	Med, Dry													
Schizachyrium scoparium	Little bluestem	Grass	Part-Full	Med, Dry													
Panicum virgatum	Switch grass	Grass	Part-Full	Wet, Med													
Poa pratensis	Kentucky bluegrass	Grass	Full	Wet, Med													
Sorghastrum nutans	Indiangrass	Grass	Full-Shade	Wet, Med													
Chasmanthium latifolia	Indian woodoats grass	Grass	Full-Part	Wet, Med													
Eragrostis spp.	Lovegrass	Grass	Full	Med, Dry													
Agrostis perennans	Bentgrass	Grass	Part	Wet													
Danthonia spicata	Poverty grass	Grass	Full-Part	Dry													
Calamagrostis canadensis	Reed grass	Grass	Full-Shade	Wet, Med													
Bromus spp.	Brome	Grass	Full	Med													
Nectar/pollen - butterflies and other bees at risk					**BLOOM TIME**							**BUMBLEBEES**			**BUTTER FLIES**	**OTHER BEES**	
LATIN NAME	**COMMON NAME**	**PLANT TYPE**	**SUN**	**SOIL**	**Early**		**Mid**		**Late**			**B. terricola**	**B. fervidus**	**B. vagans**			
					M	**A**	**M**	**J**	**A**	**S**	**O**						
Zizia aurea	Golden alexander	Herb. perenn.	Full-Part	Med													
Zizia aptera	Meadow zizia	Herb. perenn.	Full-Part	Med													
Geranium maculatum	Wild geranium	Herb. perenn.	Full-Part	Med													
Lysimachia spp.	Loosestrife	Herb. perenn.	Part-Shade	Wet- Med													
Cardamine spp.	Bitter-cress	Herb. perenn.	Part	Wet- Med													
Solidago altissima	Tall goldenrod	Herb. perenn.	Full-Part	Med, Dry													
Solidago arguta	Forest goldenrod	Herb. perenn.	Part	Med, Dry													
Solidago gigantea	Smooth goldenrod	Herb. perenn.	Full-Part	Wet, Med													
Solidago juncea	Early goldenrod	Herb. perenn.	Full-Part	Med, Dry													
Solidago odora	Sweet goldenrod	Herb. perenn.	Full-Part	Med, Dry													
Solidago rugosa	Rough-stemmed goldenrod	Herb. perenn.	Full-Part	Med													
Rubus allegheniensis	Common blackberry	Shrub	Full-Part	Med													
Rubus canadensis	Smooth blackberry	Shrub	Full-Part	Med, Dry													
Rubus flagellaris	Northern blackberry	Shrub	Full-Part	Med, Dry													
Rubus pensilvanicus	Pennsylvania blackberry	Shrub	Full-Part	Med, Dry													
Hydrophyllum virginianum	Virginia waterleaf	Herb. perenn.	Part-Shade	Med													

Thank you to Amy Meltzer for help with compiling plant information!

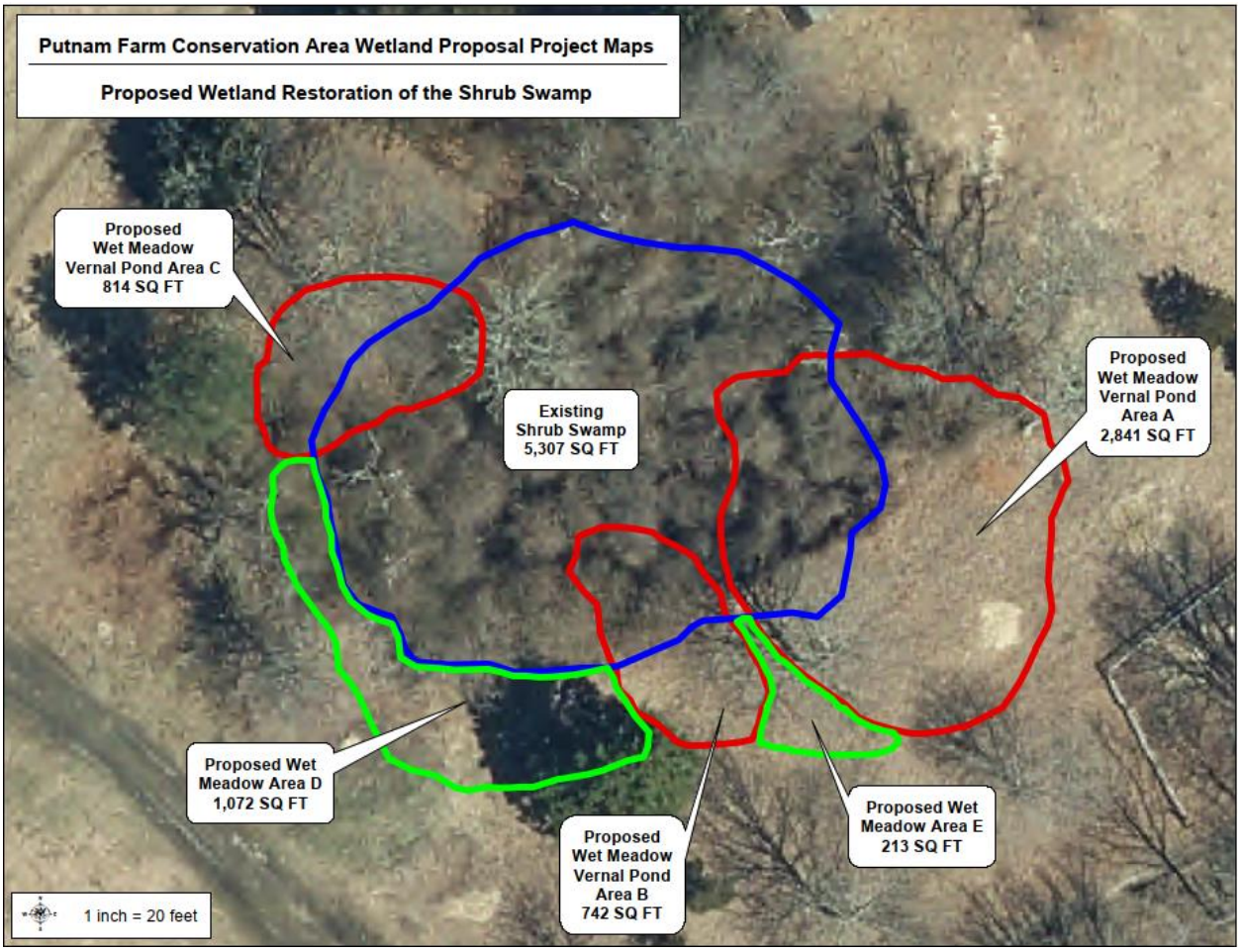
Maps



Build-out map for the Putnam Farm Conservation Area



Map showing management actions designed to restore the Pond Wetland



Map showing management actions designed to restore the Shrub Swamp Wetland

Photos showing designed projects

The Putnam Farm Conservation Area encompasses 13.86-acres in the Town of Orleans, Massachusetts.

Mr. Jay Putnam (holding red container) describes the history of the Putnam Farm to the group. From 10-15-feet of soil was removed in 1957 from the entire farm to build the rotary.

The person is standing on a ridge surrounding the Putnam Farm. The rim is the original elevation of ground before 15-feet of soil was mined from the 10-acre property.

This frame made from old power poles is where Jay Putnam tried to make salt when he was a boy.

Jay Putnam points out a high bush blueberry that is the right size for producing fruit. He recommends aggressive trimming of the large high bush blueberries on the farm.

Soil test holes were dug to determine where wetlands had been filled. They were also useful in determining groundwater elevations, and soil texture by layer.

The thickness of the “A” soil horizon (topsoil) was recorded for each soil test hole that was dug.

One can see groundwater in this dug hole located near the Pond. The elevation of groundwater is within 24-inches of the surface over the Putnam Farm Conservation Area. The presence of the water table near the surface offers excellent opportunities to build wetlands.

The wetlands may be restored so that they provide habitat for a diversity of pollinators and bats, helping to improve crop productivity.

Here Ian Ives with Mass Audubon is sampling aquatic life in the Shrub Swamp. Only leaches were found.

Dense patches of shrubs would be removed to restore sunlit wet-meadow and vernal pond wetlands in the Shrub Swamp.

Elevations were taken to in and surrounding the wetlands on the Putnam Farm.

John Jannell places a wooden stake in the Shrub Swamp that will be used to monitor water levels and to serve as a benchmark for the elevations that were recorded.

Ian Ives samples aquatic life in the Pond wetland. Note the large high bush blueberry growing along the edge of the water.

It is recommended that tall high bush blueberries like the one shown that are growing along the edge of the wetlands be cut at ground level and then transplanted to help restore areas of wet-meadow wetlands and vernal pools in sunlit locations.

Ian Ives counts growth rings on this cut stump from an English Oak, a nonnative species. The tree was 17-years old when it was cut. There were only a few trees on the Putnam Farm 20-years ago.

This photo shows Area 1 near the Pond wetland where steep banks may be sloped and a bay containing wet-meadow wetland restored.

The steep bank may be sloped and a wet-meadow wetland restored within Area A of the Pond wetland.

Large native tree species including this red maple would not be removed. This red maple is located within Area 1 of the Pond wetland where the steep banks may be sloped and a wet-meadow bays developed.

Area 2 near the Pond wetland may be changed from upland to vernal pond and wet-meadow wetland habitat.

Area 2 near the Pond wetland may be changed to vernal pond and wet-meadow wetland habitat that would greatly improve habitat for pollinators.

Here is where a vernal pond was designed in Area A of the Shrub Swamp.

This photo shows Area A in the Shrub Swamp where a vernal pool may be built.

This photo shows Area B in the Shrub Swamp where a vernal pool was designed.

Vernal ponds may be built in dry portions of the Shrub Swamp. This photo shows the dense shrubs growing on Area B where a vernal pond was designed.

The pink colored wire flags mark the boundary of a vernal pond that may be built within Area C of the Shrub Swamp.

Location of a designed vernal pond within Area C of the Shrub Swamp.

Shrub Swamp Vernal Pond Area C showing some of the trash that would be removed as part of the project.

Shrub Swamp Vernal Pond Area C

The trash disposed of in wetlands over the years would be removed by this project.

This groundwater monitoring well identified on the Putnam Farm will not be disturbed by the project.

Project Actions and Specifications

The following section describes the actions recommended for completing this project. Detailed specifications are included to help those implementing the project to be successful in meeting objectives:

Removal of Soil and Trash Dumped in the Wetlands

Trash and litter that can be picked up by hand will be placed in garbage bags and disposed of in a large trash container provided for the project. Individuals observing construction being done by the excavator may also pick up and dispose of small trash items as they are exposed.

The excavator will be used to remove any larger trash items from the wetlands uncovered during construction. The excavator can place these items in a large trash container provided for the project.

Gradual Slopes and Bays Supporting Wet-meadow Wetlands

1. The perimeter of each project work area is marked with colored wire flags placed in the ground and colored plastic ribbons tied to trees and shrubs. Project work areas are also shown on the maps prepared for the project. John Jannell with the Town of Orleans has GPS shapefiles showing each possible work area.
2. An excavator may be used to shape gradual slopes and bays along the edge of the Pond and the Shrub Swamp to restore wet-meadow wetlands. A survey and detailed engineering drawings that show planned depths and percent slopes may be ordered by the Commission.
3. To increase the success of transplanting high bush blueberry the plants should first be trimmed at ground level during the dormant season. High bush blueberry with roots attached may then be transplanted using the excavator as part of wet-meadow and vernal pool construction.
4. Plants to be protected within and bordering work areas should be marked in advance of construction by using a unique color of plastic flagging unlike the colors used to mark the perimeter of work areas.
5. The excavator is used to remove plant species that are marked to be transplanted.
6. The excavator is used to remove trees, shrubs, grasses, and topsoil from within the flagged area. The topsoil is saved and placed in piles for use in community food gardens.
7. Trees and shrubs that are removed are placed in a large trash container for disposal.
8. The operator uses the bucket of the excavator to remove trees and shrubs that are shading the water.
9. The excavator shapes gradual slopes and shallow water bays along the edge of the site. Elevations are taken during construction using the laser level to make certain that saturated soils are present to form wet-meadow wetlands. Digging depths are adjusted as needed to maintain saturated soils. The elevations of groundwater that has been recorded from nearby groundwater monitoring wells will be used to identify depths prior to construction.
10. Pits, small diameter basins, low mounds, ridges, and hummocks are created to provide conditions for a diversity of plants to grow. These features are not compacted. Mounds are made of different heights and sizes. The height of the mounds is measured in relation to the elevation of the low edge of the marked perimeter of the wetland being built. Mounds should average 6-inches high, 3-feet in diameter, and be naturally spaced approximately 5-feet apart. Higher mounds will grow shrubs and trees.
11. Sand texture soils that are removed are spread adjacent to the site to create sandplain grassland habitat.
12. Soils are loosened and shaped so they may be mowed.
13. Saved shrubs and trees are replanted.
14. A diversity of native plants is planted and seeded when excavation is complete.

Creation of Vernal Pools in Sunlit Locations

1. The perimeter of each project work area is marked with colored wire flags placed in the ground and colored plastic ribbons tied to trees and shrubs. Project work areas are also shown on the maps prepared for the project. John Jannell with the Town of Orleans has GPS shapefiles showing each possible work area.
2. An excavator may be used to shape naturally appearing and functioning vernal pools within the Pond and the Shrub Swamp.
3. To increase the success of transplanting high bush blueberry the plants should first be trimmed near ground level during the dormant season. High bush blueberry with roots attached may then be transplanted using the excavator as part of wet-meadow and vernal pool construction.
4. Plants to be protected within and bordering work areas should be marked in advance of construction by using a unique color of plastic flagging unlike the colors used to mark the perimeter of work areas.
5. The excavator is used to remove plant species that are marked to be transplanted.
6. The excavator is used to remove trees, shrubs, grasses, and topsoil from within the flagged area. The topsoil is saved and placed in piles for use in community food gardens. Large branches and tree trunks are saved for placement in and around the vernal pools being built.
7. Trees and shrubs that are removed are placed in a large trash container for disposal.
8. The operator uses the bucket of the excavator to remove trees and shrubs that are shading the vernal pool being built.
9. Ditches that are present are disabled and filled so they will not drain the vernal pool.
10. A basin is dug that it is deepest in the center in relation to the low edge of the marked perimeter. Basins are dug to vary in depth from 14-36-inches and are generally shaped like large satellite dishes. The exact depth of basins to be dug will be based on groundwater elevations recorded by nearby groundwater monitoring wells.
11. No dams, dikes, or berms should be built from the soil removed from digging the vernal pools.
12. The excavator shapes gradual slopes and shallow water bays along the edge of each vernal pool being built.
13. Elevations are taken during construction using the laser level to make certain that saturated soils are present to form wet-meadow wetlands surrounding the vernal pools being built. Digging depths are adjusted as needed to maintain saturated soils and the desired final depth of water in the vernal pool.
14. Pits, small diameter basins, low mounds, ridges, and hummocks are created to provide conditions for a diversity of plants to grow. These features are not compacted. Mounds are made of different heights and sizes. The height of the mounds is measured in relation to the elevation of the low edge of the marked perimeter of the wetland being

built. Mounds should average 6-inches high, 3-feet in diameter, and be naturally spaced approximately 5-feet apart. Shrubs and trees may grow on mounds that are higher than 6-inches.
15. Large and small woody debris are placed in and around the finished vernal pool.
16. Sand texture soils that are removed are spread adjacent to the site to create sandplain grassland habitat.
17. Compacted soils are loosened.
18. Saved shrubs and trees are replanted.
19. A diversity of native plants is planted and seeded where excavation is complete.

Creating sandplain grassland habitat

1. Areas where sand-texture soil may be spread from the excavation of wetland projects will be identified and marked in advance of construction.
2. The excavator is used to spread sandy soils generated from digging the wetland projects. Soils are shaped to create naturally appearing ridges and mounds.
3. The surface of the ground is shaped so that the sandplains may be mowed to control trees and shrubs.
4. A diversity of native plants is seeded and planted.

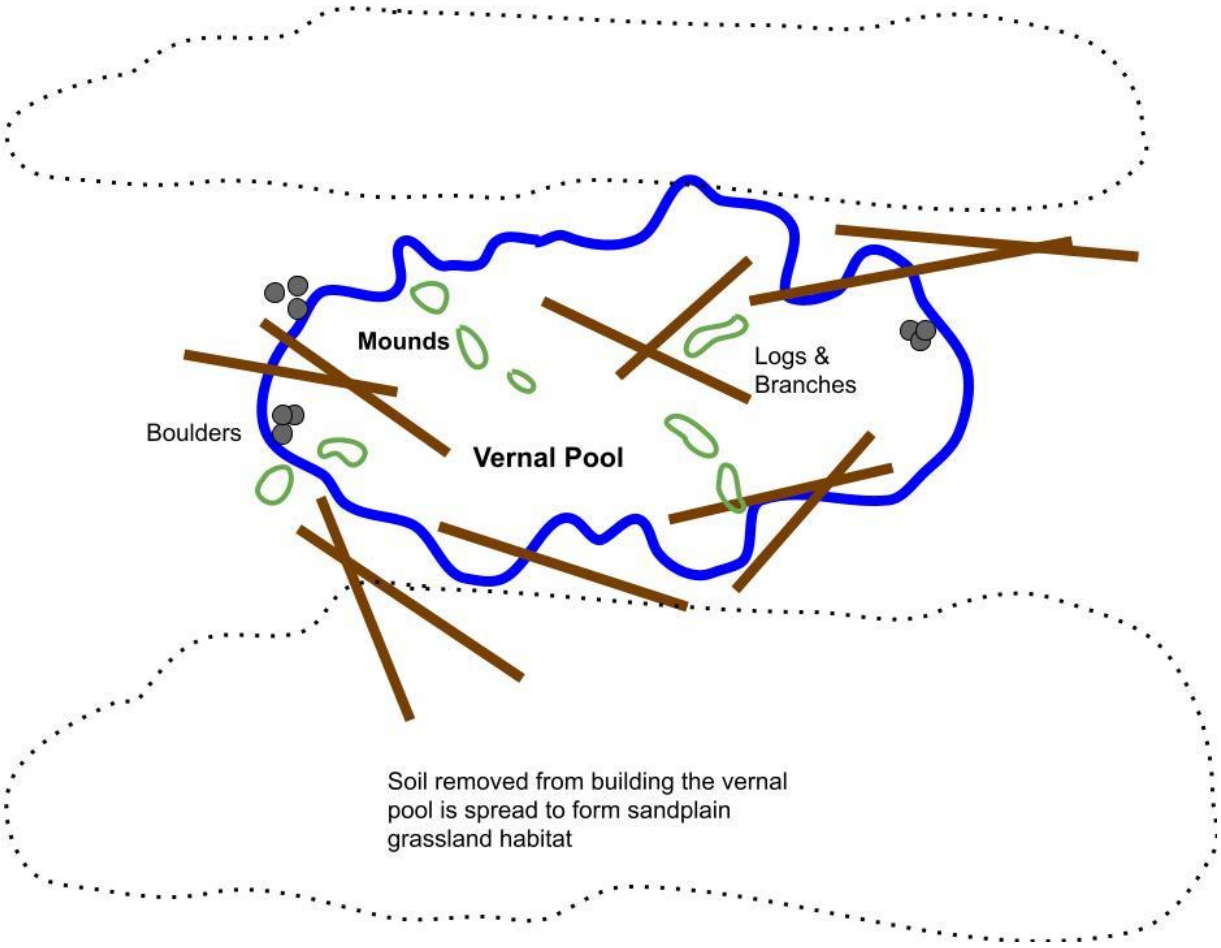
Loosening compacted soils

1. Compacted soils will be loosened within and surrounding the wetlands to be restored, and on the sandplain grassland that is created.
2. The bucket of an excavator is used to loosen compacted soils
3. The excavator operator uses a digging bucket with teeth to loosen the soils.
4. A penetrometer is used to measure soil compaction after loosening, which should be less than 50lbs./in^2.
5. Loosened areas may be planted and seeded to a diversity of native plants used by pollinators.

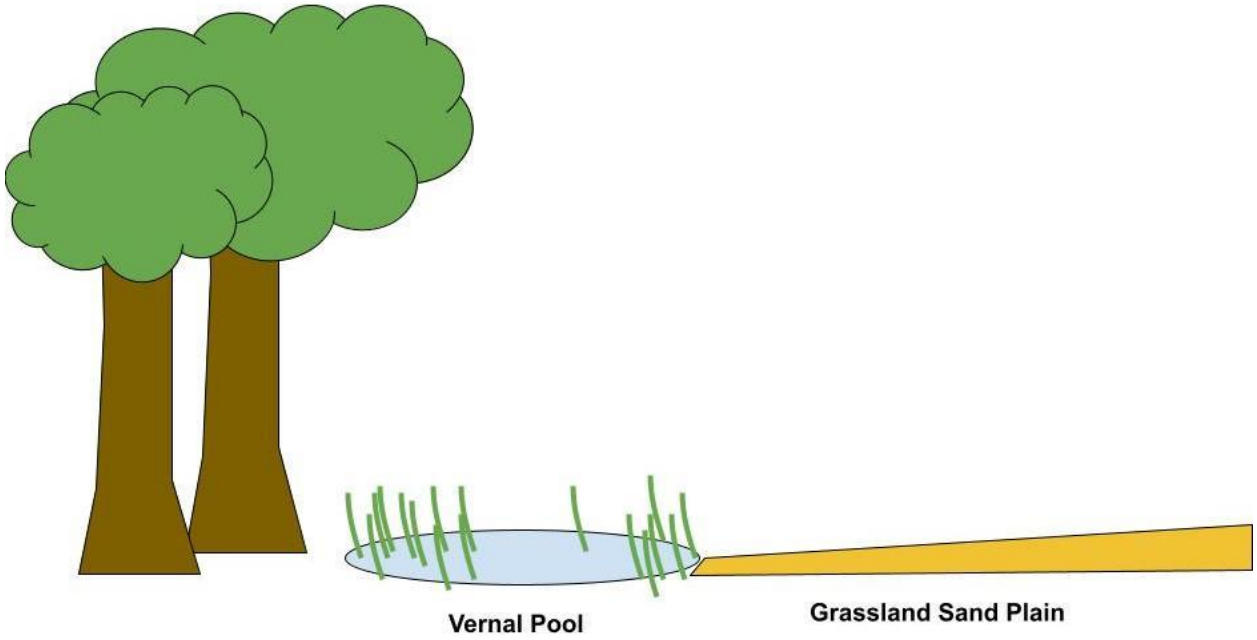
Upland Native Plant Garden for Pollinators

1. The perimeter of the planned native plant garden is marked on the ground.
2. Trees and shrubs shading the native plant garden are removed.
3. Some of the soil that is removed from completing the wetland projects may be placed near the parking lot to create a naturally appearing mound for the native plant garden.
4. Compacted soils may be loosened using the bucket on the excavator.
5. A diversity of native flowering plants may be seeded and planted to establish the native plant garden for pollinators.

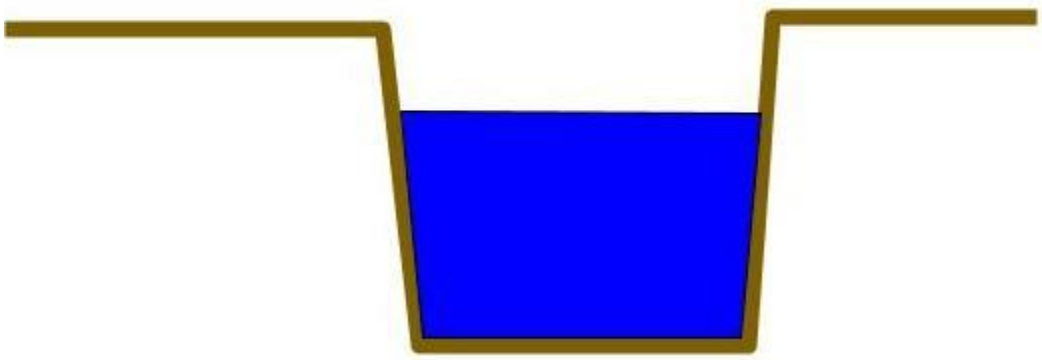
Project Drawings



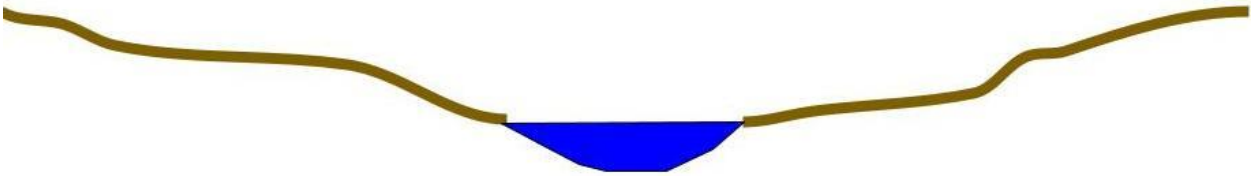
Vernal pool restoration (typical plan view, not to scale). Please note there is no buffer of trees or shrubs between the wetland and the sandplain. The spread soils may be used by ground nesting bees and the Eastern box turtle.



Vernal pool restoration (typical profile view, not to scale). Please note there is no buffer of trees or shrubs between the wetland and the sandplain.



Wetland bank before sloping (Typical profile view, not to scale)



Wetland bank after sloping (Typical profile view, not to scale)

Heavy Equipment and Construction

An excavator is needed to build the wetland designed for this project. The machine should be operated by a skilled professional.

A Request for Price (RFP) for a Service Contract may be prepared and advertised for providing the heavy equipment and operator needed to complete this project. The award of this Service Contract may be based on 3-factors:

a. Type, size, and condition of heavy equipment that the contractor has available for use on the project.
b. Individuals experience and skill operating heavy equipment and restoring wetlands.
c. Price per hour and cost for mobilization and demobilization.

The heavy equipment to be used should be equivalent to the following[1]:

Cat 335F
273 HP
77,000lbs operating weight
Digging bucket with teeth (60-inches wide)
Thumb attachment

The excavator should be less than 10-years old and in excellent condition without oil leaks. Each piece of heavy equipment should have two-rolls of paper towels, 4-absorbent pads, rubber gloves, and three-garbage bags for a spill-kit.

[1] Using smaller or older heavy equipment will lengthen the time it takes to complete the project, and significantly increase costs. The larger excavator has a greater reach, and allows for moving larger quantities of soil in less time.

Project Supervision

A person who is familiar with wetland construction techniques should be on the site at all times serving as a Contract Inspector/Representative to monitor the completion of the designed project. This person should have great knowledge of wetland construction, be dedicated, and communicate effectively with the contractor and heavy equipment operators. This person would also be able to visit with agency personnel and neighboring landowners who stop by to ask questions during construction.

The onsite Contract Inspector/Representative should monitor soil texture, groundwater elevations, surface elevations, slopes, and compaction during construction. This person would make sure that heavy equipment operators do not disturb existing wetlands, cultural resource sites, and neighboring property. This person's judgment would be critical in deciding if and how to modify the design based on what is found when heavy equipment begins to dig. Having the best Engineering Design and Construction Contract in the world does not excuse the critical need of having a person who knows how to build wetlands on site monitoring the construction of the wetland project. The rewards of having a highly experienced Contract Inspector/Representative onsite supervising the wetland project are great. Not only is a significant amount of money saved, but a much higher quality project is built.

Thomas R. Biebighauser is available to be on site onsite every day while heavy equipment is operating to provide training to personnel, mark and stake project areas, monitor elevations with tripod and heavy equipment mounted lasers, monitor wetland size and shape, guard against disturbing or flooding neighboring properties, monitor compaction using a penetrometer, maintain worksite safety, direct heavy equipment operations, disable drainage systems, shape wetlands, record hours worked by heavy equipment operators, photograph construction, prepare maps of completed wetlands, keep a daily work diary, respond to public and agency concerns, and lead tours of the project area. Tom would also provide training to heavy equipment operators and agency personnel in the use of techniques he has developed over the past 44-years to restore wetlands and streams to provide habitat for rare animal and plant species.

Estimated Budget

A detailed estimated budget was prepared for implementing the Putnam Farm Conservation Area Wetland Restoration Project. This budget was provided to Mr. John Jannell with the Town of Orleans.

Mosquitoes and Wetlands

The wetlands to be built can be expected to lower mosquito populations in the community. The larvae of dragonflies, damselflies, water boatman, water striders, and salamanders living in the wetlands can be expected to control mosquito larvae in less than one year. Swallows, bats, and adult dragonflies flying near the wetlands will consume adult mosquitos. The wetlands can be expected to become population "sinks" for mosquitoes.

Dragonfly larvae living in the restored wetlands can be expected to control mosquito larvae

Salamander larvae generally control mosquitoes in restored wetlands.

Invasive Species Control

Minimizing the spread of invasive species is a key concern during implementation of the designed projects because of the areas of soil that are exposed may create conditions for non-native species to become established. The following measures are recommended to control invasive species:

1. Nonnative plants should be controlled prior to construction where possible.
2. Heavy equipment operators must clean machines to prevent the introduction of non-native species to the site.
3. Non-native grasses and associated soil/seedbank growing in and near the wetland restoration areas would be scraped off and buried onsite. Although this takes extra time during the restoration project, it would greatly decrease the establishment of non-native plants.
4. Thick layers of weed-free mulch (1 bale of barley or wheat straw/10 m^2) may be used to suppress weeds and retain moisture for new plantings.
5. Native plants would be seeded and planted in and around the restored wetlands and on areas where soil is spread to help control non-native plants.

Cattail and Phragmites

Actions are recommended to prevent cattails, reed canary grass, and phragmites from dominating the restored wetlands. These techniques may be used to prevent any one plant from taking over restored areas:

1. Any Phragmites on site should be controlled prior to construction of the wetlands.
2. Heavy equipment can be used to remove nonnative plants as part of construction.
3. Nonnative plants may be buried onsite or removed so they do not spread.
4. Wetland basins may be restored to contain uneven elevations with mounds, hummocks, ridges, pits, and depressions.
5. Compacted soils may be loosened within and around the restored wetlands.
6. Ridges, mounds, tufts, and scrapes may be created within the wetlands.
7. Exposed soils may be seeded to a diversity of sedges, rushes, and wheat, generally the same day the wetland is built.
8. Exposed soils that are above the water level may be mulched using wheat straw, oat straw, or barley straw, and not hay that often contains weeds.
9. Some of the vernal pools may be built shallow so they may dry in late summer or early fall. These dry basins may be mowed to help control unwanted plants.

The restored wetlands may be monitored for nonnative plant colonization following construction. Nonnative plants that begin growing in and near the wetlands may be controlled each month following construction as it can be difficult to control cattails and phragmites once they are established. This action would facilitate the establishment of an attractive diversity of native aquatic plants in the new wetlands. The diversity of native aquatic plants that colonize the wetlands can also be expected to remove nutrients from the water.

Climate Change

The wetlands to be restored will sequester carbon by tying up large quantities of organic material in inundated and saturated soils. Restoration of the wetlands will restore historic groundwater elevations, halting the decomposition of the organic soils and release of carbon into the atmosphere. Nonnative plants and roots may also be buried in the soil that would become saturated, sequestering their carbon indefinitely. This newly saturated soil would also capture and hold phosphorus.

The proposed project would restore a diversity of native flowing plants that would benefit pollinators such as bees, butterflies, hummingbirds, and moths. These pollinators would help ensure the survival of a diversity of plants that convert carbon dioxide into oxygen.

The wetlands to be restored can be expected to replenish groundwater. This groundwater would provide cool water to nearby streams under low flow conditions. The projects would naturally capture runoff and inject this water into the ground.

Sediment and Erosion Control

The installation of silt fence is not needed to control erosion for this project. Erosion would be effectively controlled by the construction of numerous vernal pool depressions, and by the loosening of compacted soils.

Close monitoring of wetland restoration sites by the Tom Biebighauser near Hudson, New York in 2022 following torrential rains while construction was taking place showed that the miles of silt fence that was installed did nothing to control erosion. All of the erosion on the site was being controlled by the construction of numerous wetland basins that collected and held runoff, and by the loosening of compacted soils using the rough and loosen technique. The act of installing the silt fence actually caused erosion to occur because soils were exposed in areas growing dense vegetation. People who have used silt fence for years are amazed by how the rough and loosen technique is far more effective for controlling erosion.

Erosion and sediment would be controlled by the excavation of shallow wetland basins that would collect and hold runoff from precipitation and snowmelt. The wetland basins would be placed in shallow drainages that collect and contain runoff during storm events.

The land located immediately adjacent and downhill from the wetland basins to be restored would not be disturbed by this project. These areas would serve as natural fully vegetated buffers that would also help prevent water or soil from leaving the site.

Compacted soils would be loosened within and surrounding the wetlands to be restored. The practice has been proven across North America to control erosion. Precipitation and runoff rapidly soak into the ground instead of flowing across the surface. A diversity of native plants would rapidly grow on soils loosened by using this technique.

No roads would be constructed that can cause erosion. Heavy equipment would not expose soils when traveling between wetland restoration sites.

The actual restoration of the wetlands should be considered as an erosion control measure. This project would stop erosion by filling and blocking ditches, restoring shallow basins, and by loosening compacted soils. *These actions would significantly reduce runoff and erosion from the property.*

A diversity of native plants would be planted and seeded within and surrounding the restored wetlands, and on the soil spread from building the wetlands. The seed mixtures used would contain many species of wildflowers to improve habitat for pollinators. There are also seeds and roots of many species of native plants that are present in the topsoil to be spread within and surrounding the restored wetlands that would sprout and grow within days of construction.

Educational Opportunities

The wetlands and sandplain grassland habitat may be restored as part of a Hands-on Wetland Workshop instructed by Tom Biebighauser and Ian Ives. The training may be designed to help and encourage agency personnel, nonprofit organizations, and private landowners to build and manage wetlands to increase habitat for pollinators and enhance agricultural operations.

Tom Biebighauser began instructing Hands-on Wetland Restoration Workshops in 2003, and has now taught these practical sessions in 28-States, Puerto Rico, 3-Canadian Provinces, New Zealand, and Taiwan. Hands-on Wetland Restoration Workshops are well received and very effective. On a scale from 1 to 10, course evaluations consistently rate Hands-on Wetland Restoration Workshops from 9.8 to 10.0. Senior natural resource managers have written … “It’s the best training I’ve ever received, and “I was amazed by how much I learned.”

The Putnam Farm Conservation Area may also serve as an outdoor classroom where children and adults can learn how wetlands, rare species, and farming practices complement each other.

Summary

Actions are identified to enhance and potentially expand two-wetlands on the Putnam Farm Conservation Area that have been overgrown by nonnative trees and shrubs. The project would increase plant and animal biodiversity on the conservation property and improve habitat for pollinators. Wet-meadow wetlands may be restored to provide habitat for a diversity of flowering plants that benefit pollinators and farming operations. Vernal ponds containing open water may be restored to provide habitat for bats, frogs, toads, salamanders, swallows, Purple Martins, and waterfowl. The steep banks surrounding the dugout Pond may be made gradual, restoring wet-meadow wetlands teaming with wildflowers. Organic soils removed from restoring the wetlands may be used to improve community agricultural plots. Sand obtained from restoring the wetlands may be used to form sandplain habitat to support a unique assemblage of plant and animal species. The project may be accomplished to provide environmental education opportunities for people of all ages.

This plan was prepared for the Town of Orleans by:

Thomas R. Biebighauser
Wildlife Biologist and Wetland Ecologist
Wetland Restoration and Training LLC
3415 Sugar Loaf Mountain Road
Morehead, KY 40351

Cell phone: 606-356-4569
Email: tombiebighauser@gmail.com
Website: https://www.wetlandrestorationandtraining.com

and

Ian Ives
Sanctuary Director
Mass Audubon's Long Pasture Wildlife Sanctuary
345 Bone Hill Rd
P.O. Box 235
Cummaquid, MA 02637

Telephone: 508-362-7475 Ext 9350
E-mail: iives@massaudubon.org

References

Gosselink, M. a. (1993). Wetlands. In M. a. Gosselink, *Wetlands 2nd Edition.* Van Nostrand Reinhold.

Jannell, J. (2023, March 6). (I. Ives, Interviewer)

Network, S. G. (2023, March 12). *Sandplain Grassland Network*. Retrieved from Sandplain Grassland Network: https://sandplaingrassland.net/management/management-overview/

Putnam, J. (2023, March 7). Former Landowner. (T. R. Biebighauser, Interviewer)

Town of Orleans. (2011). *Baseline Documentation Report and Land Management Plan for the Putnam Farm Conservation Area.* Orleans: Town of Orleans.

Xerces Society. (2023, March 26). *Pollinator Conservation*. Retrieved from https://xerces.org/pollinator-conservation

About the authors

Thomas R. Biebighauser has been restoring wetlands, streams, and rivers since 1979. He has designed over 10,000 wetland and stream projects and has successfully supervised the construction of over 2,850 wetlands in 27-states, 3-Canadian provinces, New Zealand, Puerto Rico, and Taiwan. He carries a deep and long-standing concern for the environment and finds it rewarding to assist individuals who are interested in restoring wetlands and streams. Tom's passion for restoring wetlands has been recognized by his receiving 44-awards, including the National Wetlands Award for Conservation and Restoration in 2015.

Tom teaches that when building a wetland, it is necessary to identify and disable historic drainage features to be successful. He methodically researched the literature from the 1600's to the present to learn how wetlands were changed into farmland. Tom has interviewed and worked alongside numerous seniors who spent their lives draining wetlands and moving streams, documenting their practices so others can be successful in restoring these ecosystems. This knowledge has allowed him to identify over 50-signs showing where wetlands once occurred on the landscape.

Tom enjoys leading workshops where participants can learn about wetland restoration by designing and constructing wetlands from start to finish in one-day. He has instructed hands-on wetland workshops since 2003. These practical training sessions are responsible for empowering hundreds of individuals to build wetlands around the world.

Tom has developed highly successful and inexpensive techniques for restoring wetlands and streams that should last forever without maintenance. He cautions against using berms, dams, dikes, levees, weirs, diversions, pipes, pumps, water control structures, or wells that all require

frequent and expensive maintenance. Having built over 1,400-dams he has since decommissioned over 300-dams and impoundments, restoring natural valleys in the process.

He specializes in restoring wetlands, streams, and rivers that provide habitat for endangered and threatened species. Tom has developed techniques for building wetlands that improve habitat for rare species including the Blandings turtle, burbot, California red-legged frog, Chiricahua leopard frog, grizzly bear, Eastern spadefoot, Great Basin spadefoot, Indiana bat, marbled salamander, mole salamander, Northern bat, Northern leopard frog, Sandhill Crane, Trumpeter Swan, Virginia big-eared bat, Western painted turtle, white sturgeon, and the wood frog.

Tom has built over 250-wetlands at universities, high schools, middle schools, and elementary schools across North America. He involves students in the design, construction, planting, and monitoring of these wetland habitats. Tom instructs a graduate-level online Wetland Design Class at the University of Louisville Speed School of Engineering where individuals learn how to build naturally appearing and functioning wetlands.

Tom has developed highly effective techniques for restoring wetlands in deserts, having built over 600-wetlands in arid regions of Arizona, British Columbia, California, Nevada, New Mexico, and Utah. He has discovered how to successfully restore wetlands, lakes, and streams so they would contain water forever in response to the long-term drought wrought by climate change.

Tom worked as a Wildlife Biologist for the U.S. Forest Service for 34-years, helping personnel from federal, state, and county agencies initiate wetland and stream restoration programs across the United States. He took the lead in completing hundreds of partnership projects for building emergent, ephemeral, forested, peatland, shrub, and wet-meadow wetlands on public and private lands during his career with the Forest Service.

In 2003, Tom wrote and published the book *A Guide to Creating Vernal Ponds*, distributing over 30,000 copies. His second book, *Wetland Drainage, Restoration, and Repair* was well received after its release in 2007. The three-editions of this book *Wetland Restoration and Construction, A Technical Guide* has been used by wetland and watershed professionals throughout the world in the years since its printing in 2011. Ellen Eubanks and Tom published the book *Restoration of Forests, Grasslands, and Wetlands Damaged by Off-Highway Vehicle* in 2014.

Ian Ives is the Director of Mass Audubon's Long Pasture Wildlife Sanctuary. He has a strong background in local wetland conservation and vernal pool protection. Ian is currently leading the pioneering Eastern Spadefoot Toad Restoration Project at Mass Audubon Sanctuaries and other protected lands in Massachusetts, and has overseen 12-wetland restoration projects in Massachusetts. The Projects involve rare species management, outreach and education and citizen science.

Appendix 1: Photos showing examples of wetlands restored by Tom Biebighauser and Ian Ives.

Vernal pond wetland restored at the Mass Audubon Long Pasture Sanctuary. Large boulders may be added to the wetlands on the Putnam Farm Conservation Area if desired.

Vernal pond wetland restored at the Mass Audubon Long Pasture Sanctuary

Vernal pond wetland restored at the Mass Audubon Long Pasture Sanctuary

Vernal pond wetland restored at the Mass Audubon Long Pasture Sanctuary (Winter)

Vernal pond wetland restored at the Mass Audubon Long Pasture Sanctuary (Early Spring)

Vernal pond wetland restored at the Mass Audubon Long Pasture Sanctuary (Late Summer)

Vernal pond wetland restored at the Mass Audubon Long Pasture Sanctuary (Early Fall)

Vernal pond wetland restored at the Mass Audubon Long Pasture Sanctuary (Fall)

Vernal pond wetland restored at the Mass Audubon Long Pasture Sanctuary (Winter)

Two-year old wet-meadow & shallow water emergent wetland (vernal pond) built using an aquatic-safe liner Mass Audubon Ashumet Holly Sanctuary

Appendix 2: Photos showing examples of wetlands restored by Tom Biebighauser

Emergent wetland and wet-meadow wetland. Sparwood, British Columbia, Canada

Queens Wetland Restoration Project, Monongahela National Forest, West Virginia. Emergent wetland and Wet-meadow wetland.

Emergent wetland near Elkins, West Virginia.

Vernal pond. Monongahela National Forest, West Virginia

Wet-meadow wetland, Creston, BC

Emergent palustrine wetland, 1-year old, Salmo, British Columbia

Emergent palustrine wetland, 1-year old, Salmo, British Columbia

Emergent wetland on the Wayne National Forest, Ohio.

Emergent wetland restored in field. Photo taken 10-years following construction. Menifee County, Kentucky

Emergent wetland in Menifee County, Kentucky

Wet-meadow wetland, Rowan County, Kentucky

Vernal Pond, Rowan County, Kentucky

Vernal pond, Rowan County, Kentucky

Emergent and Shrub Swamp Wetlands, Wayne National Forest, Ohio

Emergent wetland on the Wayne National Forest, Ohio

Wet-meadow, Portal, Arizona

Wet-meadow wetland. Menifee County, Kentucky

Emergent wetland. Menifee County, Kentucky

Wet-meadow with wildflowers. Rowan County, Kentucky

Wet-meadow wetland with burweed. Menifee County, Kentucky

Wet-meadow wetland in Menifee County, Kentucky

Wet-meadow and ephemeral wetland in Rowan County, Kentucky

Emergent wetland, Menifee County, Kentucky

Wet-meadow wetland, Creston, British Columbia

Wet-meadow wetland, Creston, BC.

Vernal Pond and wet-meadow wetlands, Creston, BC.

Wet-meadow wetland and vernal pond, Creston, BC