Great Bay Nitrogen Nonpoint Source Study Implementation Phase I - Sagamore-Hampton Golf Club BMPs

A Final Report to
The New Hampshire Department of Environmental Services

Submitted by

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TABLE OF CONTENTS

Executive Summary

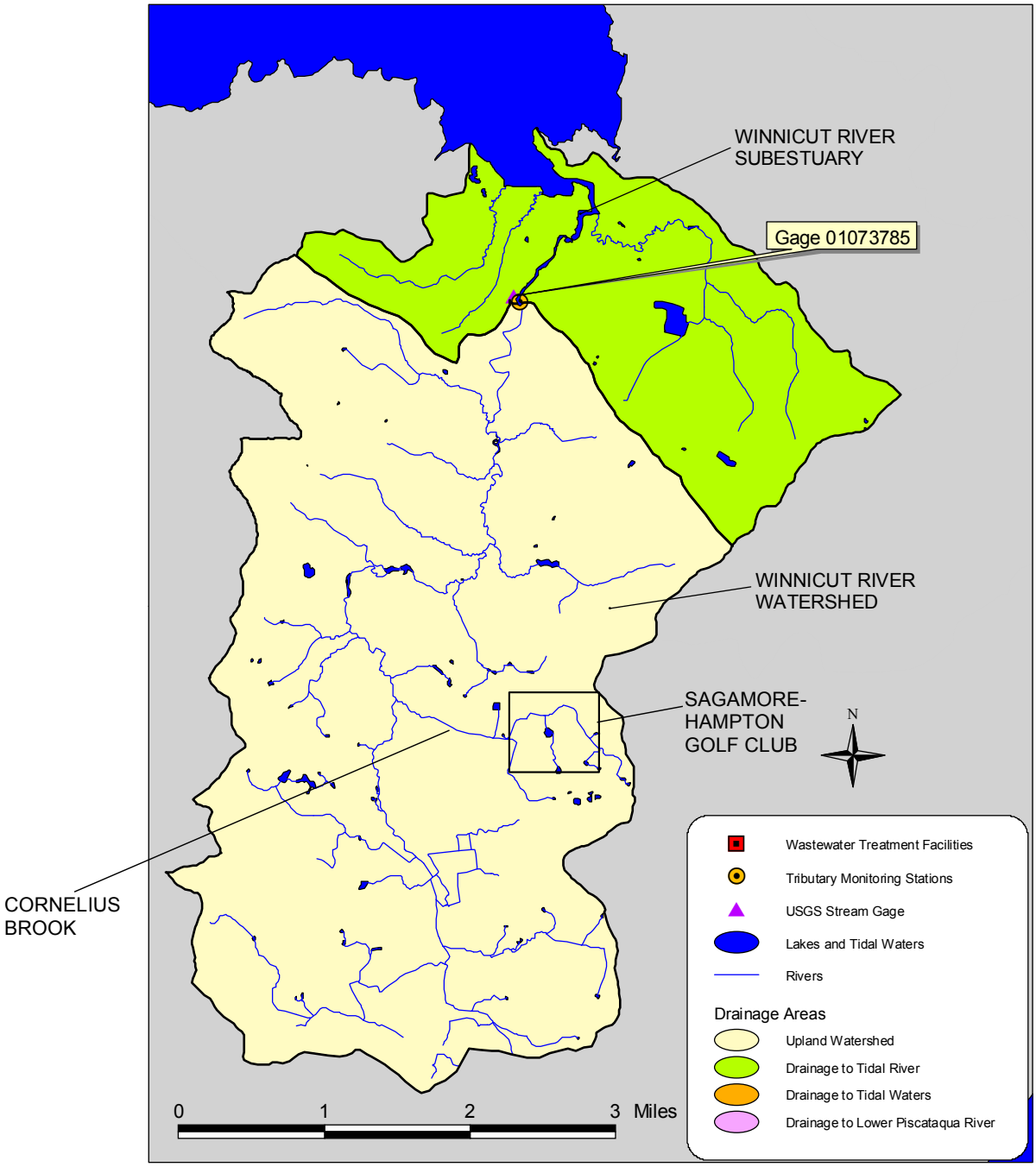
The Great Bay Nitrogen Nonpoint Source (NPS) Study Implementation Phase I - Sagamore-Hampton Golf Club BMPs project addressed NPS pollution from managed turf by partnering with a golf course and volunteers to restore riparian buffers. Cornelius Brook, a headwater stream of the Winnicut River, flows through the center of the Sagamore-Hampton Golf Club and receives runoff from large expanses of managed turf. To address the nutrient load to Cornelius Brook, the Winnicut River and ultimately Great Bay, NH Sea Grant/UNH Cooperative Extension partnered with the Sagamore-Hampton Golf Club and community volunteers through the Coastal Research Volunteer program to implement the project. Project activities included site surveys, planning meetings, recruiting and training volunteers, site preparation, buffer planting and seeding, restoration monitoring and water quality sampling. Funding for the project ($20,000) was through a Section 319 Watershed Assistance Grant issued by the New Hampshire Department of Environmental Services. The match requirement ($13,616) was met through materials and labor provided by the Sagamore-Hampton Golf Club, materials provided by Cathy Neal, PhD (UNH Cooperative Extension), bacteria sample analysis provided by Stephen Jones (UNH Jackson Estuarine Laboratory) and in-kind volunteer effort. At the end of the two-year project (2015-2016), 50,734 ft^2 of riparian buffer was restored resulting in an annual reduction of 10.4 pounds of total nitrogen, 5.2 pounds of total phosphorus, and 6.1 tons of sediment in the Winnicut subwatershed. Twenty-five volunteers were engaged in the restoration process contributing 164 hours of effort; in addition, 3 UNH undergraduate interns participated in various aspects of the project providing them real world experience in NPS mitigation. By engaging community volunteers, this project not only increased the amount of work done, but also created a network of trained citizens with increased understanding of local natural resource values and the threats facing their sustainability.

Introduction

Great Bay (HUC 010600030901) is listed on the NHDES Section 303(d) (2008) list as impaired for aquatic life due to nitrogen loading. The Winnicut River, which discharges into Great Bay, is estimated to contribute a nitrogen load of 31 tons/year to the estuary. Due to the lack of wastewater treatment plants in the Winnicut watershed, the entire nitrogen load in the system is from nonpoint sources. As such, load reduction efforts must come from addressing runoff in the Winnicut River system.

This project addressed water quality impairments in the Great Bay watershed associated with nonpoint source pollution by restoring riparian buffers to Cornelius Brook at the Sagamore-Hampton Golf Club. As reported in the Great Bay Nitrogen Non-Point Source Study (2014), managed turf comprises 31% of the chemical fertilizer load (measured as total nitrogen) to the Great Bay estuary. The Winnicut River watershed contains over 420 acres of turf that is managed for golf courses. Given that the Winnicut is the smallest watershed with the greatest nitrogen load from managed turf of any of the direct tributaries to Great Bay, the reduction of nitrogen runoff from golf courses represents an important water quality management strategy in this system. Working with the Sagamore-Hampton golf course and community volunteers to restore buffers along Cornelius Brook presented a unique opportunity to address this source of nitrogen loading and provide a model for working with other golf courses and community members in the future.

Watershed Map



Project Objectives and Verification

The project had two overall objectives: 1. to reduce watershed nitrogen, phosphorus and sediment loading to Cornelius Brook, the Winnicut River and ultimately Great Bay and 2. to engage local community members in the process to create a network of engaged citizens. Each task and verification of how it was achieved is detailed below.

Objective 1. By Spring 2015, shoreline buffer restoration sites will be identified at Sagamore-Hampton Golf Club

Task 1: Coordinate with DES and the Sagamore-Hampton Golf Club to develop criteria for identifying and selecting restoration sites.

> Criteria for site selection were developed through field visits and discussions with the Sagamore-Hampton Golf Club (Sagamore) President and Course Superintendent. Site selection criteria include landscape features (i.e., slope of the land, connectivity to other natural areas, size, presence/abundance of invasive species) as well as golf course features (location with respect to fairways, playability of course, maintenance time, access and cost).

Task 2: Review available data for surrounding land uses to assess the presence and quality of existing buffers.

> The presence and quality of existing buffers was assessed remotely with geographic information system (GIS) software using high-resolution aerial imagery, hydrography data and national wetlands inventory data. Based on these data, a draft GIS shapefile was developed delineating potential buffers to be restored.

Task 3: Work with DES to recruit volunteers and train them to survey existing shoreland condition.

> Volunteers were recruited via the Coastal Research Volunteer (CRV) e-newsletter and The Stewardship Network: New England website to participate in evaluating the current shoreland condition. Volunteers were trained in data collection techniques and identification of common vegetation species on site. The NH DES Volunteer Biomonitoring habitat data sheet (NH DES 2008 Volunteer Biological Assessment Program Draft Protocols) was used to document the current shoreland conditions.

Task 4: Work with volunteers to evaluate the extent, condition, and vegetative composition of existing buffers.

> Two shoreland surveys were conducted with the help of community volunteers and University of New Hampshire (UNH) undergraduate interns. Where buffers were present, dominant plant species were identified and the condition of the

buffers evaluated. Potential areas identified for restoration (task 2) were evaluated in the field.

Data were compiled on a draft restoration map and brought to a meeting with the owner and the superintendent of the golf club. Potential restoration areas and activities were revised on the map based on site selection criteria developed with Sagamore (task 1).

Task 5: Compile data from remote and field based assessments

Data from remote (task 2) and field-based (task 4) assessments, along with input from Sagamore senior staff, were compiled onto a GIS map to represent potential restoration areas (Figure 1). Multiple meetings were held with UNH Cooperative Extension landscape horticulturist, Dr. Cathy Neal, to develop a draft planting plan (Appendix 1). The restoration and planting plans was refined over the course of four meetings with Sagamore senior staff (Figure 2).

Objective 2. Thirty-five thousand square feet of riparian buffers will be restored along Cornelius Brook at the Sagamore-Hampton Golf Course

Task 6: Based on the restoration plan (Objective l, task 5), purchase native plants and planting supplies (e.g., trowels, shovels, stakes, flagging).

With the help of a Coastal Research Volunteer and a UNH undergraduate intern, soil samples were collected from areas identified as potential restoration sites to obtain information on current soil conditions and identify any need for soil amendments prior to planting efforts.

Working with Cathy Neal, PhD., landscape horticulturist for UNH Cooperative Extension, planting plans was developed for the restoration areas (Appendix 1).

A pollinator meadow was designed for the area along the pond that discharges into Cornelius Brook near the 14th hole. Native flowering perennials were used to restore the buffer with the dual goals of mitigating stormwater impacts of nutrients and sediment to the pond and brook as well as providing habitat for native pollinators. Dr. Neal donated the plants to the project. A list of species planted and quantities is provided in Table 1. Sagamore prepared the beds by turning over the top turf and soil and adding 6 inches of compost to each planting plot.

The remaining planting areas were revegetated with five native shrub and two tree species (Table 1). Based on soil test results, amendments were added to shrub plantings to increase the soil nutrients available to plants. Organic soil amendments were used in keeping with the practices of Sagamore. To limit competition between the established turf and the newly planted trees and shrubs, turf in planting areas was cut low with a string trimmer by Sagamore staff prior to

planting. The planting areas were mulched after planting to further limit competition with turf grasses. Tree guards were erected at the base of new planting to prevent destruction by wildlife.

Task 7: Recruit volunteers and train them on the project goals, how to plant the species selected and where the revegetation efforts will take place.

Volunteers were recruited through the Coastal Research Volunteer e-newsletter as well as The Stewardship Network: New England. A flyer was created for each event and shared digitally as well as posted in local libraries (example in Appendix 2). A total of 16 Coastal Research Volunteers learned about the project goals and activities and were trained in planting methods.

Task 8: Install stakes, flagging and ropes to delineate where restoration efforts will occur.

Site walks were conducted with Sagamore staff to review the restoration plan in the field prior to each planting effort to delineate planting areas with stakes. Additional stakes were installed by the Sagamore Course Superintendent after planting. Staff were instructed about areas to avoid and maintenance procedures near planting areas by the Sagamore Course Superintendent.

Task 9: Coordinate volunteers and Sagamore-Hampton Golf Club staff to revegetate shoreland buffers along Cornelius Brook.

On 16 October 2015, three Coastal Research Volunteers assisted in planting over 500 native perennials in 3 beds to create a riparian pollinator meadow covering 7709 square feet (site 1 in Figure 2). On 6 November 2016, with the help of a school-aged Coastal Research Volunteer, a seed mixture was created of native species that germinate well from direct seeding. The mixture was broadcast across the three pollinator plots among the seedlings. On 21 June 2016, eleven Coastal Research Volunteers and 1 UNH undergraduate intern planted native shrub and tree species (sites 2 and 3 in Figure 2). On 23 June 2016, staff from Sagamore planted native shrub and tree species (site 4 in Figure 2). A total area of 50,734 ft^2 of riparian buffer was planted.

Objective 3: A maintenance and monitoring plan will be created for the buffer restoration sites along Cornelius Brook to evaluate project success and the need for adaptive measures.

Task 10: Identify buffers areas to be subject to no mowing or reduced mowing frequency and ongoing monitoring plots with stakes/flagging. Ensure that golf course maintenance staff is aware of no or low mow areas and monitoring plots through signage and/or maps.

The potential for no or reduced mowing regimes has been discussed with Sagamore staff. Although the golf club management were open to the idea, changing the mowing regime of areas directly adjacent to the stream presents

challenges in terms of maintenance access and often these areas are in play. As such, buffer restoration activities for this project consisted of planting efforts only.

A fact sheet developed by Dr. Neal (Appendix 3) was provided to Sagamore staff detailing the growth requirements of the native perennial wildflowers planted in the Sagamore pollinator meadow. In addition to the stormwater mitigation and habitat functions provided by the species planted in the pollinator meadow, they were also selected due to the lack of required maintenance.

A water and monitoring plan was established with Sagamore after shrubs and trees were planted in June 2016. Sagamore staff watered the newly planted trees and shrubs daily for the first week, every other day for the next 2 weeks, and then 1-2 times per through the remainder of the summer

All plots locations and dimensions were discussed with Sagamore in the planning stages to allow for Sagamore staff to easily navigate maintenance equipment around them. After planting, Sagamore senior staff staked off the plots to delineate them and indicate areas of no mowing for the grounds crew.

Task 11: Coordinate with DES and the Sagamore-Hampton Golf Club to develop guidelines for ongoing maintenance of restoration sites.

As the appearance and maintenance of all plantings are important considerations for Sagamore, buffer plantings were selected to require minimal maintenance. Native species were selected that are well-adapted to thriving under local climate conditions. Species were also selected with growth forms that do not require maintenance (e.g., pruning) to maintain aesthetic qualities. Spacing and quantity of plantings were selected to allow access for Sagamore Staff to areas requiring maintenance. Sagamore staff will monitor restored vegetation for mortality over time.

Task 12: Provide information on project goals, function of buffers and maintenance plans to all groundskeeping staff at Sagamore-Hampton Golf Club.

Sagamore groundskeeping staff provided a large in-kind effort to this project in terms of site preparation, planting activities, and post-restoration watering and monitoring. As such, groundskeeping staff learned about the project goals and maintenance plans through actively working on the project. Further project information was provided to grounds keeping staff by the Course Superintendent. In addition, signs have been created to install at each restoration site to inform both staff and patrons about the restoration areas Appendix 4).

Task 13: Collect water quality samples at four locations before, during and after the buffer restoration activities for the following parameters: total nitrogen, total phosphorus,

bacteria, dissolved oxygen, temperature and pH (following a DES Volunteer River Assessment Program Quality Assurance Project Plan).

With the help of 5 volunteer and 3 undergraduate interns, water quality samples were collected on 5 August 2015, 18 November 2015, 2 June 2016, and 1 November 2016. Water quality data are provided in Table 2.

Nitrogen samples consistently exceeded the excessive nitrogen standard for all sites at each of the collection dates. Phosphorus samples exceeded the more than desirable or excessive standard in all but 1 sample. Several years of data will be required to ascertain water quality trends and the effectiveness of the restored buffers in mitigation nutrient loads.

Task 14; Coordinate volunteers to observe plant growth and survival at monitoring plots. If growth and/or survival are unsatisfactory, coordinate with DES and Sagamore-Hampton Golf Club to evaluate the challenges and develop a new approach.

Photomonitoring stations were established at each planting plot on the day of planting. Pictures were captured at each site visit to document growth and survival over time. Example pictures are provided in the Photographic Documentation section. Monitoring observations suggest a survival rate of 85% at two of the pollinator plots and 45% at the westernmost plot subject to the wettest soil conditions. Seeding efforts were successful based on observations of *Rudbeckia* and *Elymus* throughout the three pollinator beds in 2016. Native perennials can take 2-3 years to establish and outcompete species pre-existing in the soil seed bank so the observed success so soon after planting and seeding is promising. At the close of the project, survival of shrub and tree species was 100%

Task 15: Coordinate with DES to develop a Site Specific Project Plan (SSPP) for modeling load reductions due to buffer enhancement efforts.

A Site Specific Project Plan was developed with Sally Soule (DES) and is included in Appendix 4.

Task 16: Submit electronic semi-annual reports documenting all work performed during the project periods as follows:

Two semi-annual reports were submitted for work completed April 1 - September 30, 2015 and work completed October 1, 2015- March 30, 2016.

Task 17: Submit a comprehensive final report jn both electronic and hard-copy to DES on or before the project completion date. The final report shall include load reduction estimates, photo-documentation of installed system components, and comply with the

DES and EPA requirements found in the final report guidance document on the DES Watershed Assistance Section webpage.

This document serves as the final report.

Project Outcomes & Measurable Results

This project resulted in the following outcomes and results:

- Restored 50,734 ft^2 of riparian buffer, including a pollinator meadow as well as native shrubs and trees with an approximately 78% mean survival rate for the pollinator meadow and 100% survival for trees and shrubs as of November 2016.
- Reduced pollutant loading to Cornelius Brook by 10.4 pounds of total nitrogen, 5.2 pounds of total phosphorus, and 6.1 tons of sediment as modeled by the EPA Region 5 Bank Stabilization model.
- Provided educational opportunities for 3 UNH undergraduate students, providing real world restoration planning, implementation and monitoring experience
- Engaged 25 volunteers in data collection and restoration activities, in the process creating opportunities for local community members to learn about stormwater pollution and methods for mitigating it.
- Created a network of golf course staff and patrons informed about the current restoration project as a stormwater management practice

Conclusions and Recommendations

In addition to restoring a riparian buffer to achieve nutrient and sediment load reductions, Phase I of the Great Bay Nitrogen Nonpoint Source Study Implementation created a successful model of partnering with a golf course and community volunteers to implement stormwater BMPs.

The importance of having a golf course partner that is interested and engaged in the project cannot be understated. This project would not have been successful without a committed partner like Sagamore. Sagamore was willing to take the risk of engaging in this project and altering the landscape of the course. The Sagamore President and Course Superintendent provided ongoing input at planning meetings, site walks and through frequent correspondence, and they provided critical resources such as site preparation, and watering and monitoring after planting.

Working with UNH undergraduate interns as well as community volunteers also proved quite successful. Not only did engaging volunteers and interns provide authentic learning experiences in stormwater management and restoration, the additional people engaged created the opportunity for more work to get accomplished on the ground.

The original expectation of this project was to alter Sagamore's mowing regime combined with minimal planting efforts. An important lesson learned was that changing

the mowing regime was quite challenging to Sagamore maintenance efforts as it is time and labor intensive to frequently change mower blade heights and high vegetation heights in certain areas can create access challenges. As such, the restoration effort was focused exclusively on revegetation via planting efforts rather than reduced mowing. We were not able to engage local 6th graders as originally expected due to a mismatch in the timing of suitable project activities with the school schedule

The project created a model of NPS pollution management that can be transferred to other golf courses in the watershed and the state. For instance, a great deal of time was focused on site selection to achieve the dual goals of both maintaining a functioning golf course and creating effective BMPs. Information such as the site selection criteria and process are potentially transferable to other golf course restoration efforts.

Given the successful partnership with Sagamore, important opportunity exists for accomplishing additional work in terms of both on the ground BMPs as well as outreach. Future opportunities include restoring the additional high and medium priority restoration areas identified in this project and developing resources for transferring knowledge gained in this project to other NH golf courses.

Tables and Figures

Table 1. Species lists for each planting area developed with Dr. Cathy Neal (UNH Cooperative Extension)

Planting area no.	Plant common name	Species	Quantity	Status	Area (ft^2)	Height (ft)
1	Lavender hyssop	*Agastache foeniculum*	18	completed	7709	3
	Wild columbine	*Aguilegia candensis*	81			3
	Swamp milkweed	*Asclepias incarnata*	15			5
	Butterfly milkweed	*Asclepias tuberosa*	21			2
	Lanceleaf coreopsis	*Coreopsis lanceolata*	18			2
	Pale purple coneflower	*Echinacea pallida*	40			4
	Purple coneflower	*Echinacea purpurea*	40			4
	Sweet Joe-Pye weed	*Eutrochium purpureum*	15			6
	Joe-Pye weed	*Eutrochium maculatum*	15			6
	Ox eye sunflower	*Heliopsis heliantoides*	9			6
	Dogtooth daisy	*Helenium autumnale*	15			5
	Cardinal flower	*Lobelia cardinalis*	20			4
	Great blue lobelia	*Lobelia siphilitica*	20			4
	Yellow coneflower	*Ratibida pinnata*	40			5
	Smooth aster	*Symphotrichum laevis*	53			4
	New England aster	*Symphotrichum novae angliae*	12			5
	Ironweed	*Vernonia fasciculata*	16			6
	New York ironweed	*Vernonia noveboriensis*	8			6
	Culver's root	*Veronicastrum virginicum*	40			6
	Black- eyed susan	*Rudbeckia hirta*	seed			2
	Wild bergamot	*Monarda fistulosa*	seed			3
	Yellow coneflower	*Ratibida pinnata*	seed			5
	Canada wild	*Elymus canadensis*	seed			3
2	Swamp white oak	*Quercus bicolor*	1	completed	15,129	50-60
	River birch	*Betula nigra*	8			40-70
	Sweet pepperbush	*Clethra alnifolia*	11			4-6
	Gro-low sumac	*Rhus aromatica "gro low"*	50			2
3	River birch	*Betula nigra*	4	completed	4147	40-70
	Sweet pepperbush	*Clethra alnifolia*	5			4-6
	Buttonbush	*Cephalanthus occidentalis*	5			5-12
	Winterberry	*Ilex verticillata*	5			8
4	River birch	*Betula nigra*	18	completed	23749	40-70
	Sweet pepperbush	*Clethra alnifolia*	3			4-6
	Buttonbush	*Cephalanthus occidentalis*	3			5-12
	Winterberry	*Ilex verticillata*	3			8
5	Gro-low sumac	*Rhus aromatica "gro low"*	22	future project?	3782	2
6	see species for planting area 1		TBD	future project?	4282	varies

Table 2. Water quality data

Site ID	Collection_Date	Site description	pH	Spec_Cond µS	DO_Conc mg/L	DO%	Temperature degrees C	E. coli concentration (#/100mL)	Total phosphorus (mg/L)	Total Nitrogen (mg/L)
CB 1	8/5/15	Cornelius Brook downstream, near rte 95	7.4	meter malfuntion	4.13	47.8	22.4	56	0.061	0.640
CB 2	8/5/15	Cornelius Brook midpoint	7.4	meter malfuntion	5.07	55.3	19.9	820	0.040	1.290
CB 3	8/5/15	Cornelius Brook upstream, near N Rd	6.5	meter malfuntion	2.86	31.5	20.1	2000	0.139	1.930
PD 1	8/5/15	Irrigation pond	8.1	meter malfuntion	8.57	99.6	22.8	10	0.189	1.160
CB 1	11/18/15	Cornelius Brook downstream, near rte 95	7.6	363.7	10.06	78.3	4.9	4	0.178	1.148
CB 2	11/18/15	Cornelius Brook midpoint	7.6	307.6	7.76	60	4.6	0	0.016	1.241
CB 3	11/18/15	Cornelius Brook upstream, near N Rd	6.5	621	7.79	58	3.1	4	0.098	0.800
PD 1	11/18/15	Irrigation pond	8.1	459.1	11.84	93.1	5.1	4	0.032	1.113
CB 1	6/2/16	Cornelius Brook downstream, near rte 95	7.4	325.9	7.86	88.3	20.6	190	0.036	1.051
CB 2	6/2/16	Cornelius Brook midpoint	6.8	204	4.91	50.7	17.0	150	0.052	1.946
CB 3	6/2/16	Cornelius Brook upstream, near N Rd	6.5	1529	4.77	50.1	17.8	60	0.340	1.551
PD 1	6/2/16	Irrigation pond	7.8	478.6	9.68	107.9	21.1	12	0.053	1.724
CB 1	11/1/16	Cornelius Brook downstream, near rte 95	7.5	337	9.05	76.2	7.9	40	0.056	1.432
CB 2	11/1/16	Cornelius Brook midpoint	7.2	332.3	10.86	91.9	8.7	40	0.043	1.318
CB 3	11/1/16	Cornelius Brook upstream, near N Rd	6.8	443.5	6.94	56.1	6.5	64	0.039	0.964
PD 1	11/1/16	Irrigation pond	8.1	431.5	11.24	94.9	8.0	6	0.054	1.026
PD 2	11/1/16	Pond	6.8	185	12.92	112.3	9.3	210	0.081	1.979

violates higher (more stringent) NH Water Quality Standard (e.g., class A, low to moderate impact)

violates lower (less stringent) NH Water Quality Standard (e.g., class B, high impact)

Figure 1. Buffer restoration potential. Potential areas for restoration were identified remotely, field checked via a shoreland survey, and vetted with Sagamore staff to determine restoration potential.

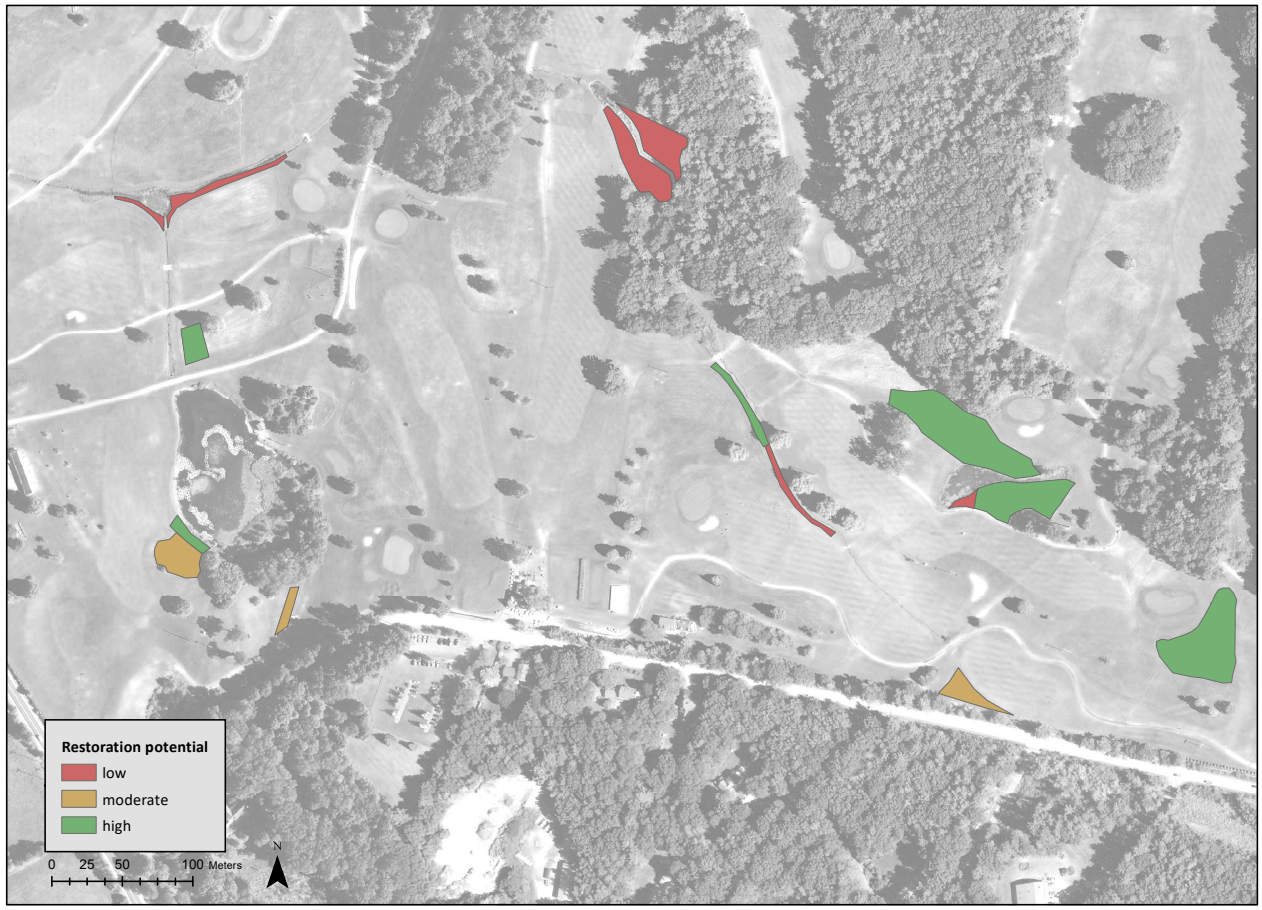
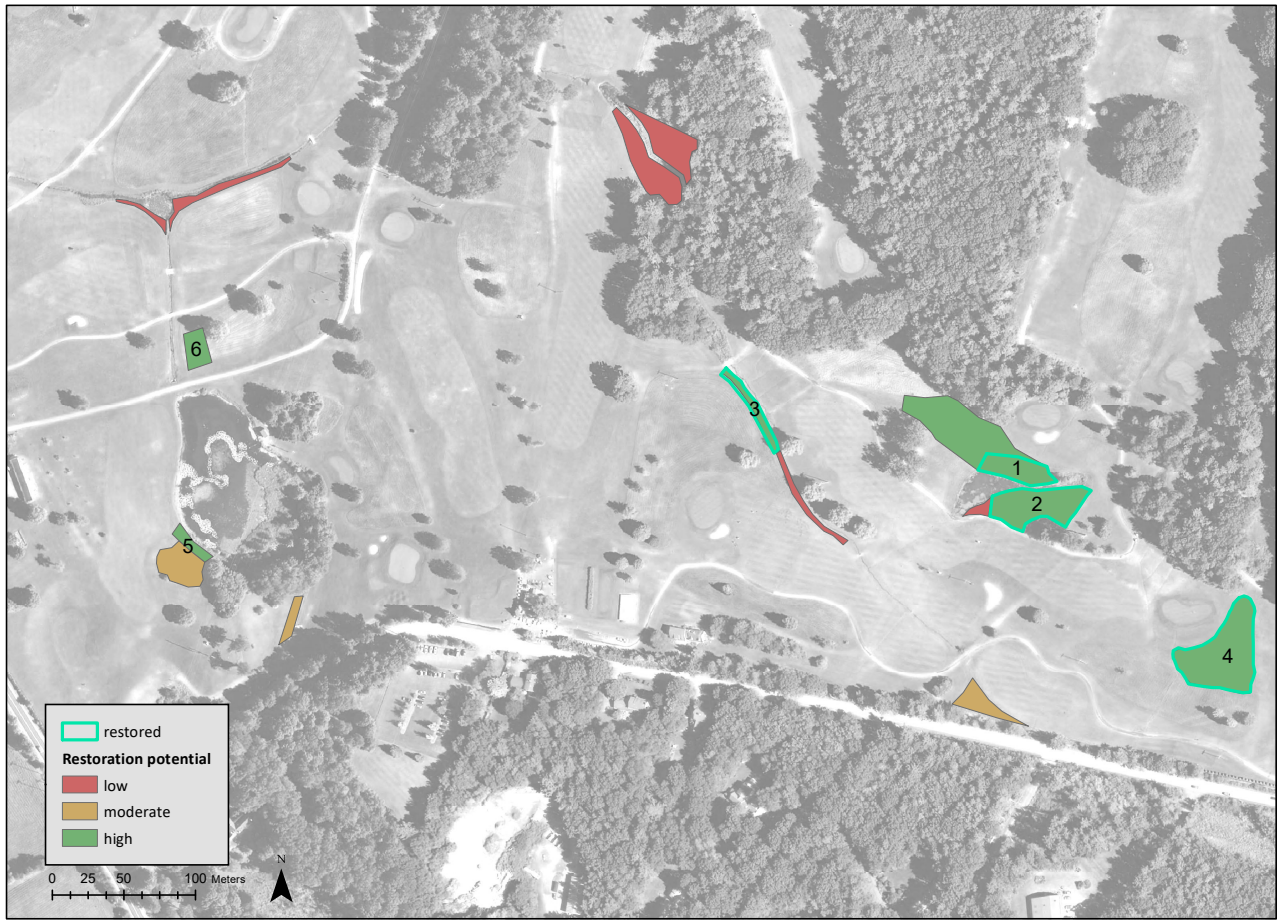


Figure 2. Restoration areas. Restored areas completed in this project are indicated with a bright green outline. The number for each area planted corresponds to table 1, that details plant lists for each area. The two areas indicated with a number but not marked as restored (i.e., areas 5 and 6) are areas of high restoration potential for which planting plans were developed but a lack of resources did not allow for inclusion in the current project.



Photographic Documentation

Delineating planting plots with Dave Bergquist, Sagamore Course Superintendent.

A UNH undergraduate intern and a Coastal Research Volunteer collecting soil samples at potential restoration areas.

Coastal Research Volunteers plant a buffer of over 500 native perennial wildflowers adjacent to the pond near the 14th hole.

A Coastal Research Volunteer creates a seed mix for spreading amongst seedlings in the newly restored buffer.

Coastal Research Volunteers and a UNH undergraduate intern planting a swamp white oak *(Quercus bicolor*) at site 2.

Coastal Research Volunteers planting trees and shrubs at site 2.

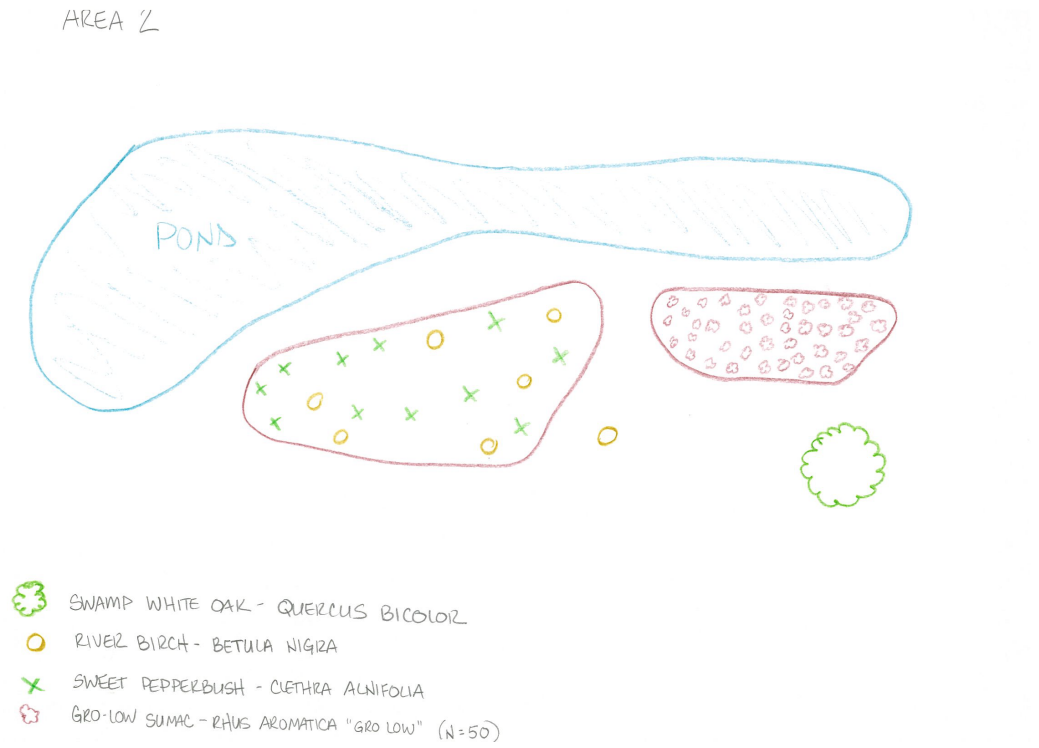
View of site 2 prior to planting trees and shrubs (20 June 2016) and after planting trees and shrubs (21 June 2016)

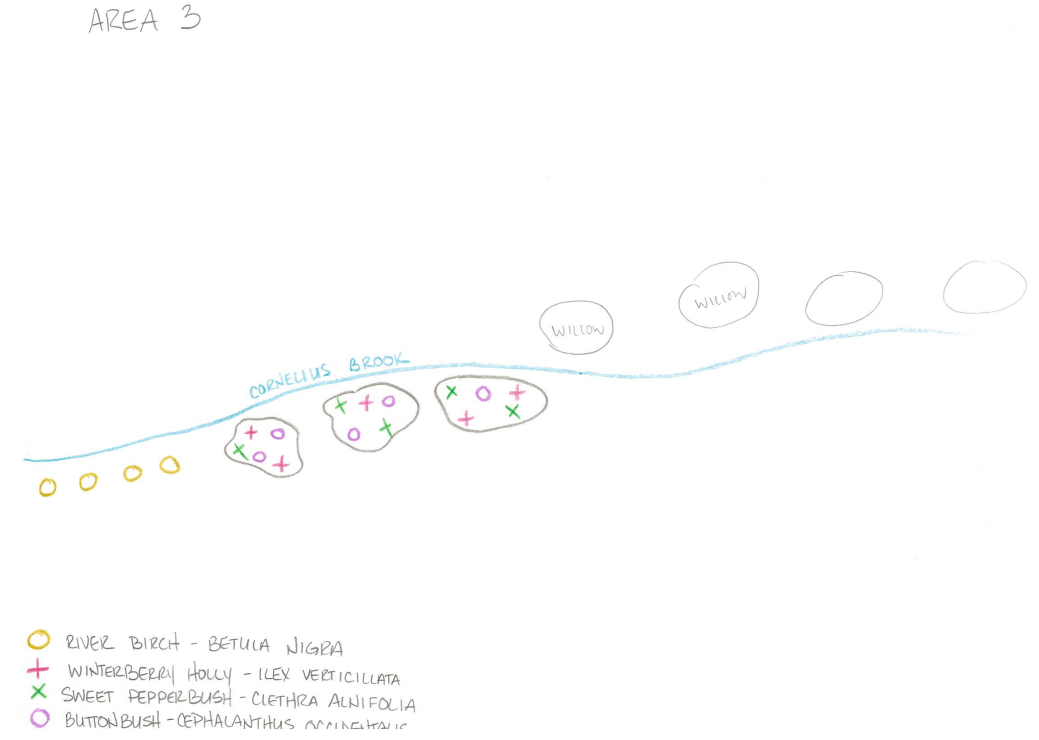
Columbine (*Aguilegia candensis) flowering in the pollinator meadow one year after planting.*

Alyson Eberhardt (UNHCE/NHSG) and a Coastal Research Volunteer collect water quality data.

Appendices

Appendix 1. Example buffer restoration planting plans for sites 2 and 3.





Appendix 2. Volunteer recruitment flyer for the pollinator meadow planting effort

VOLUNTEERS NEEDED

TO HELP PLANT A STREAM BUFFER

Join the Coastal Research Volunteers to plant trees and shrubs along Cornelius Brook in North Hampton, NH.

Together we will:

- Discuss how this project will improve water quality
- Review planting methods
- Restore a stream buffer

Sagamore Hampton Golf Club
Tuesday, June 21, 2016; 8AM-11AM

TO SIGN-UP ALYSON.EBERHARDT@UNH.EDU
603.862.6709

Environmental Services · CRV · Sea Grant New Hampshire · University of New Hampshire Cooperative Extension · Sagamore

Funding for this project was provided in part by a Watershed Assistance Grant from the NH Department of Environmental Services with Clean Water Act Section 319 funds from the U.S. Environmental Protection Agency.

Appendix 3. Handout - Growth requirements of pollinator plantings

Wildflowers for New England Meadows and Pollinator

University of New Hampshire Cooperative Extension

compiled by Cathy Neal, Landscape Horticulture Specialist, UNH Cooperative Extension and Resasercher, NH Agricultural Experiment Station and Amy Papineau, Field Specialist, Merrimack County Extension. July, 2015.

Perennial Wildflowers [a]	Common Name	Photo key	Bloom Period						Flower Color	Height (maxi-mum)	Site [b]		Best Use [c]			NE Native[d] ?
			May	June	July	August	Sept.	October			Sun/ Shade	Soil/Moisture	Garden Use	Meadow from Seed	Meadow from Plugs	
Agastache foeniculum	Lavender Hyssop	1			X	X	X		purple	3'	S PS	M-D	x	x		n
Aquilegia canadensis	Red Columbine	2	X	X					red	3'	PS Sh	M-D	x		x	y
Asclepias incarnata	Swamp (Red) Milkweed			X	X	X			pink	5'	S PS	M-W	x	x	x	y
Asclepias syriaca	Common Milkweed				X	X			pink-purple	5'	S PS	M-D	x	x	x	y
Asclepias tuberosa	Butterfly milkweed	3		X	X	X			orange	2'	S	M-D	x		x	y
Baptisia australis	Blue Wild Indigo		X	X	X				blue	3'	S PS	M	x			n
Baptisia tinctoria	Yellow Wild Indigo				X	X			yellow	3'	S	M-D	x			y
Coreopsis lanceolata	Lanceleaf Coreopsis	6		X	X				yellow	2'	S	M-D	x	x	x	n
Echinacea pallida	Pale Purple Coneflower			X	X				pink	4'	S	M-D	x	x	x	n
Echinacea purpurea	Purple Coneflower	7			X	X			purple	4'	S PS	M-D	x	x	x	n
Eupatorium perfoliatum	Boneset				X	X			white	4'	S PS	M-W	x			y
Eutrochium purpureum	Sweet Joe Pye Weed	8			X	X	X		pink	6'	S PS	M-W	x		x	y
Gentiana clausa	Closed Gentian					X	X	X	blue	2'	PS Sh	Mo-W	x		x	y
Helenium autumnale	Dogtooth daisy					X	X		yellow	5'	S PS	Mo-W	x			y
Heliopsis helianthoides	Oxeye Sunflower	9		X	X	X	X		yellow	6'	S	D-M-Mo	x	x	x	n
Liatris spicata	Dense Blazing Star	10			X	X			purple	3'	S	M-Mo	x			n
Lobelia cardinalis	Cardinal Flower				X	X	X		red	4'	S PS	Mo-W	x		x	y
Lobelia siphilitica	Great blue lobelia				X	X	X		blue	4'	S PS	M-Mo	x		x	y
Lupinus perennis	Sundial Lupine	11	X	X	X				blue-purple	2'	S PS	D	x			y
Monarda punctata	Spotted beebalm				X	X	X		lav-white	2'	S	D		x		n
Monarda fistulosa	Wild Bergamot				X	X	X		lavendar	4'	S PS	D-M-Mo	x	x	x	y
Oligoneuron rigidum	Stiff Goldenrod	14				X	X		yellow	4'	S PS	M-D	x	x	x	y
Penstemon digitalis	Foxglove Beardtongue	12		X	X				white	4'	S PS	M-Mo	x	x	x	y
Pycnanthemum virginianum	Virginia Mountain Mint				X	X	X		white	3'	S PS	M-Mo	x			y
Ratibida pinnata	Yellow Coneflower				X	X	X		yellow	5'	S	D-M-Mo	x	x	x	n
Rudbeckia hirta	Black Eyed Susan	13		X	X	X	X		yellow	2'	S PS	D-M-Mo	x	x	x	n
Senna hebecarpa	American Senna	5			X	X			yellow	5'	S	M-Mo	x		x	y
Solidago juncea	Early Goldenrod					X	X		yellow	5'	S PS	D-M-Mo	x	x	x	y
Solidago speciosa	Showy Goldenrod					X	X		yellow	5'	S PS	Mo	x	x	x	y
Symphyotrichum laeve	Smooth Blue Aster					X	X	X	blue	4'	S	M-D	x	x	x	y

Perennial Wildflowers [a]	Common Name	Photo key	Bloom Period: May	June	July	August	Sept.	October	Flower Color	Height (maximum)	Site [b]: Sun/Shade	Soil/Moisture	Best Use [c]: Garden Use	Meadow from Seed	Meadow from Plugs	NE Native [d]?
Symphyotrichum novae angliae	New England Aster	4				X	X	X	purple	5'	S PS	M-Mo	x	x	x	y
Tradescantia ohiensis	Ohio Spiderwort			X	X	X			blue	3'	S PS	M-D	x			y
Verbena hastata	Blue Vervain	15			X	X	X		blue	5'	S	M-Mo-W	x	x		y
Vernonia noveboriensis	New York Ironweed					X	X		purple	6'	S	M-Mo-W	x			y
Veronicastrum virginicum	Culver's Root				X	X			white	6'	S PS	M-Mo	x			y
Zizia aurea	Golden Alexanders		X	X					yellow	3'	S PS	M-Mo-W	x	x		y
Grasses																
Elymus canadensis	Canada Wildrye	16			X	X	X			3'	S PS	Mo		x		y
Schizachyrium scoparium	Little Bluestem				X	X	X	X		3'	S PS	Mo-M-D	x	x	x	y
Sorghastrum nutans	Indian Grass					X	X	X		6'	S PS Sh	Mo-M-D	x	x	x	y
Sporobolus heterolepis	Prarie Dropseed				X	X	X			2'	S	D	x			y

Footnotes

a This list includes species that have performed well in our pollinator habitat and meadow trials at UNH in Durham, NH and elsewhere. Flowering times and plant heights will vary by site, age and density of planting. For more information, please visit our webpage

http://extension.unh.edu/Sustainable-Landscapes-and-Turf/Wildflower-Meadows

b Site key: S - full sun PS - partial sun Sh- Shade tolerant; D - dry M - medium Mo - moist W - wet

c Best use indicates liklihood of success starting from seed or transplants (more expensive) in a mixed meadow planting, or if a plant is suited for garden culture.

d All of the plants listed are either native (marked y for yes) or widely distributed in New England. For more information, consult Go Botany at https://gobotany.newenglandwild.org/

Appendix 4. Signs to be installed at each restoration area

Qty: 2

Qty: 2

Qty: 1

Qty: 2