Fannie Stebbins Wildlife Refuge

Final Report of 2017-19 Floodplain Forest Restoration

The Nature Conservancy

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Introduction

The Nature Conservancy (TNC) implemented a floodplain forest restoration project from 2017-19 on the Fannie Stebbins Wildlife Refuge in Longmeadow, MA (Figure 1). This work was funded by the Natural Resources Conservation Service (NRCS) as part of their Wetlands Reserve Easement program. This tract is a 330-acre property in Longmeadow, Massachusetts containing diverse floodplain habitats along the Connecticut River including floodplain forest, shrub swamps, and herbaceous marsh. Floodplain forests are among the rarest and most threatened natural communities in Massachusetts, with the major river floodplain forest type largely restricted to a few sites along the Housatonic and Connecticut Rivers (Kearsley 1999a & 1999b). The Massachusetts Natural Heritage & Endangered Species Program ranks floodplain forest as an S2 priority natural community meaning it is imperiled and vulnerable to extirpation from the state. This tract and adjacent lands make up one of the few remaining large examples and a number of rare plant and animal species associated with this habitat have been documented on the property, including bald eagles and wood ducks. Under its Agricultural Conservation Easement Program (ACEP), NRCS holds a permanent Wetland Reserve Easement (WRE) on over 223 acres of the Stebbins property where the majority of restoration occurred. The goal of the restoration was to address several stressors that are impacting the natural processes on the site; this will ultimately result in the expansion and improved resilience of a rare natural community type (i.e., floodplain forest) on the largest remaining tract of floodplain forest on the Connecticut River.

Figure 1. Location of Stebbins Restoration project

Stressors addressed by the restoration:

- **Forest Fragmentation**: Historically floodplain forests at Fannie Stebbins and elsewhere in the region have been cleared for intensive agriculture because of their flat terrain and rich soils. As a result, the floodplain forest remnants are not just few and small in area, but also highly fragmented. The many edges resulting from fragmentation are highly susceptible to invasion by non-native plants such as Oriental bittersweet vines (*Celastrus orbiculatus*) that degrade the forest. Reforestation of the fields fragmenting the floodplain forest at Fannie Stebbins is intended to both increase the area of this rare community as well as dramatically reduce the amount of edge. Once reforestation of the old fields is complete, Fannie Stebbins will be the largest remaining floodplain forest in the Connecticut River watershed.

- **Invasive Plants**: Due to the large amount of edge habitat and the limited resources available in the past for stewardship of the site, many invasive plant species have proliferated at Fannie Stebbins in recent decades. The restoration was intended to suppress populations of the most serious invasive plant species to the point that they can be kept at low abundance with relatively minimal effort when the U.S. Fish & Wildlife Service (USFWS) assumes responsibility for stewardship of the property after the restoration.

- **Altered Hydrology**: The natural hydrology at Fannie Stebbins is for flow in the swales running from North to South. This natural hydrology has been disrupted in a few locations by roadbeds running East-West, sometimes by concentrating gradual sheet flow into faster more erosive flow through culverts and sometimes by causing water to become ponded in places where inundation would have been only seasonal before the road was built. A 500 ft berm associated with one of these roadbeds was identified for removal to restore a more natural hydrology to the site.

Methods & Results

Project Area

In 2016 staff from several organizations including Silvio O. Conte National Fish and Wildlife Refuge (USFWS), Natural Resources Conservation Service (NRCS), The Friends of Fannie Stebbins, and The Nature Conservancy (TNC) completed a restoration plan for 223 acres of Wetland Reserve Easement (WRE) land to be transferred to The Nature Conservancy (244 acres in total) (Marks et al. 2016) (Figure 2). The land transfer occurred in 2017, just before the restoration project began. This land was initially protected starting in the 1950's by members of the Allen Bird Club and included 32.3 acres of old fields that Allen Bird Club had mowed for many years. The land will eventually be transferred to the Conte Refuge to join 127 acres of land protected in 2015-17.

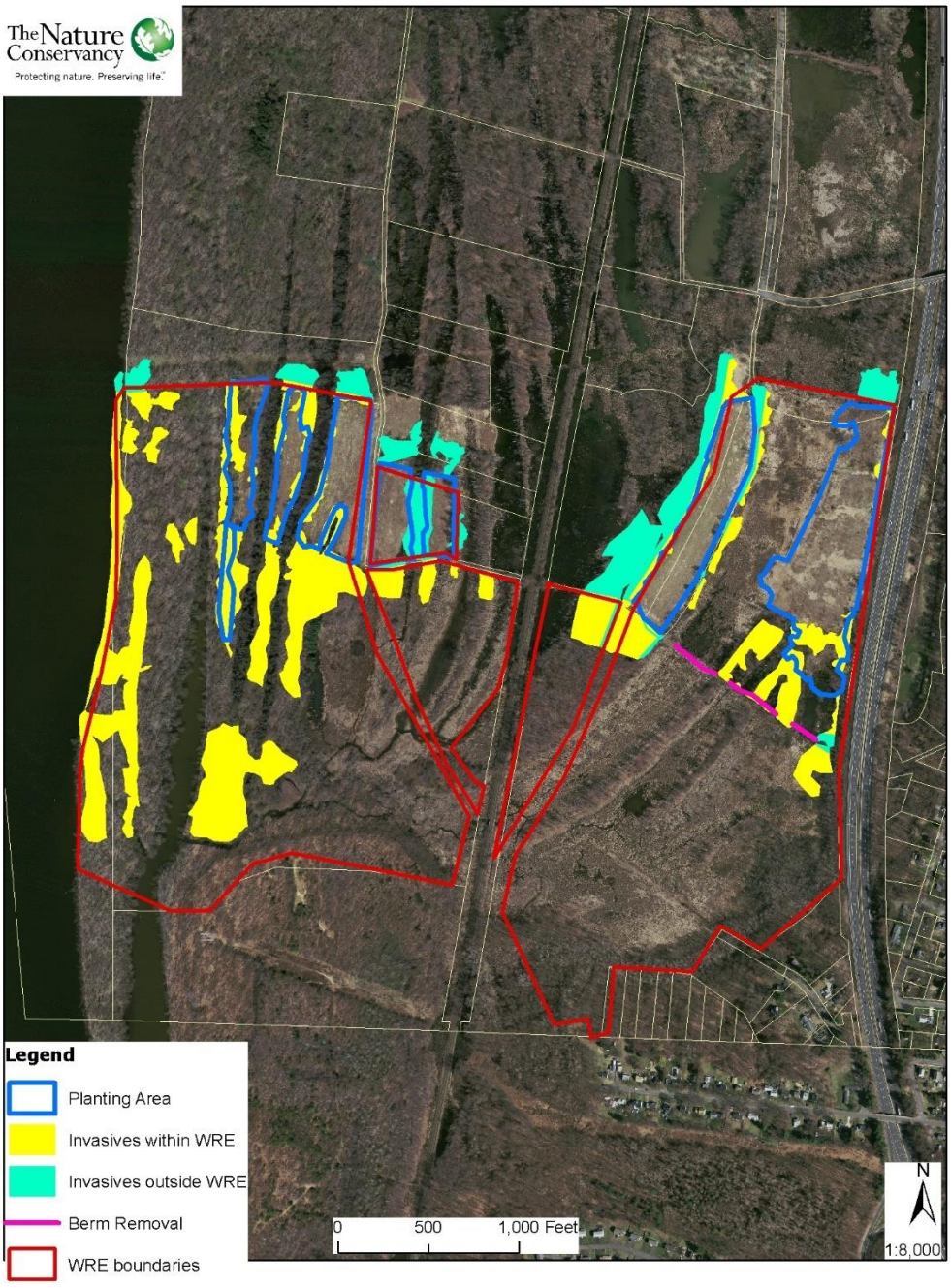

Figure 2: Overview of project area showing the outline of the NRCS easement boundary as well as the fields to be re-forested with native floodplain species and invasive plant control areas. The railway line is visible passing North-South through the center of the image, and the Connecticut River and Interstate Highway 91 are visible at the left and the right edges, respectively.

Funding

The restoration project was primarily funded by an NRCS Wetlands Reserve Easement Restoration grant of $390,492. This funding covered contracts with New England Wetland Plants and Sudbury West for plant growing and the main contractor on the project, All Habitat Services from Connecticut. Tom's of Maine provided an additional $40,000 in private funding for the project that was used to cover initial field mowing, some TNC staff time, and deer control measures.

Permitting

Permitting was completed in the spring and summer of 2017.

- We submitted a Restoration Notice of Intent (NOI) to the Town of Longmeadow and received a five-year permit for the project that also included town and U.S. Fish and Wildlife Service land just outside the Wetlands Reserve Easement.
- Under the MA Environmental Protect Act (MEPA) we were required to put a notice in the Environmental Monitor for the Restoration NOI, but we did not need to apply for a MEPA permit.
- We were required to complete and submit rare species surveys as the project area was in Priority Habitat as regulated by the Natural Heritage and Endangered Species Program.
- We applied for a National Pollutant Discharge Elimination System permit (NPDES) from the Environmental Protection Agency as the site was on the Connecticut River and we were applying herbicides.
- We submitted the proposal to the Army Corps of Engineers and determined that a permit was not required.
- We received a permit from the MA Department of Transportation to access the area along Rt 91 from the WRE to apply herbicides between a fence along the border of the WRE and route 91.
- Yearly pesticide application permits (WM04 Application to apply herbicides in the waters of the Commonwealth) were obtained by the contractor.

Timeline

All restoration activities were completed during three field seasons (Table 1).

Table 1: Timeline of major restoration activities

2017	Contract with nurseries to grow required trees, shrubs, and ferns
	Invasive control in buffers around fields (mechanical & chemical initial treatment)
	Invasive control in forest blocks (mechanical & chemical initial treatment)
	Late spring brush mowing in old fields (pre-herbicide to reduce height of vegetation)
	Herbicide in old fields (chemical)
2018	Invasive control in buffers around fields (mechanical & chemical first follow-up treatment)
	Invasive control in forest blocks (mechanical & chemical first follow-up treatment)
	Disking of old fields to prepare a seedbed as early as possible in spring
	Tree planting in spring – 100 trees per acre w/protectors
	Shrub planting in spring – 25 shrubs per acre
	Herbicide spraying around planted trees and shrubs to control competing herbaceous vegetation (once in late May)
2019	Invasive control in buffers around fields (mechanical & chemical second follow-up treatment)
	Invasive control in forest blocks (mechanical & chemical second follow-up treatment)
	Tree planting in spring – 100 trees per acre
	Shrub planting in spring – 25 shrubs per acre
	Installation of electric deer fencing in five fields
	Roadbed removal
	Wood duck box – steel post mounted with predator guard (18)
	Osprey nesting platform – pole mounted (1)
	Turtle sandy soil nest mound – near old roadbed after removal (1) – *not implemented*

Restoration work completed

The contractor, All Habitat Services, completed all of the restoration work inside the WRE boundaries while USFWS staff completed invasive control work that occurred in buffers outside the WRE.

Field Restoration

We planted 7,892 trees, shrubs and ferns over two years in the seven old fields (Appendix A) and along a ridge south of the western most field (West 5) (Figure 3). Species selection was guided by nine years of previous research at over 100 floodplain forest sites along the Connecticut River (Marks et al. 2014; Marks & Canham 2015), with a focus on sites near Longmeadow, MA. A planting plan was developed based on flood duration, climate, soil pH, and different floodplain topographic features (see Marks et al. 2016 for details). The purpose of planting in the ridge was to fill canopy gaps cleared of invasive shrubs

with shade tolerant native tree species. Planting stock was sourced locally and primarily grown by New England Wetland Plants and Sudbury West.

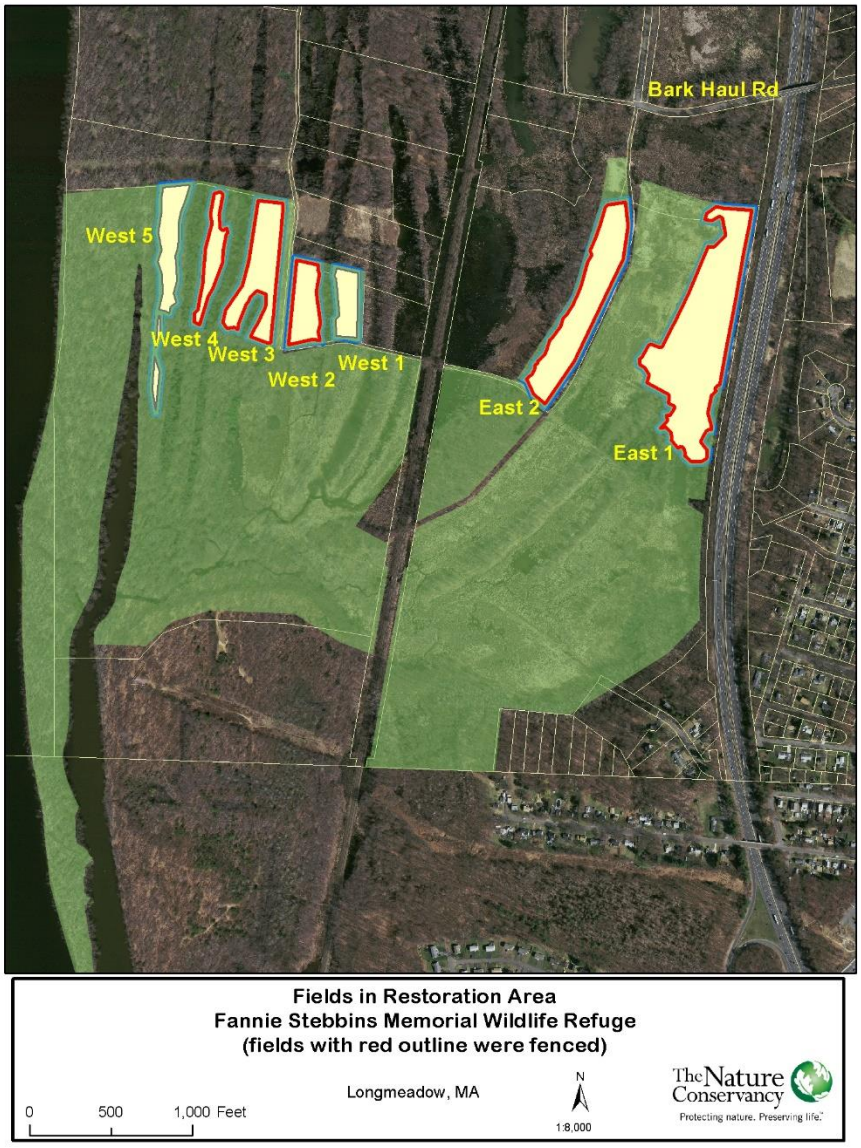

Figure 3: Fields where plantings were located. Both east fields as well as fields west 2-5 were fenced after the 2019 plantings.

Initial vegetation control in the fields occurred in summer 2017 to control herbaceous vegetation (Figure 4). The fields were disked before planting in spring 2018 to expose bare soil for natural silver/red maple and cottonwood recruitment (Figure 5). Species were planted four meters apart with the goal of approximating 250/stems per acre (Figure 5). Planting was completed in April and May of each year (Figures 6 & 7). Vegetation control around plantings was accomplished mid-summer in 2018 and 2019. The original species list in the restoration plan was modified to what was available for purchase (Appendix A).

Ninety-four disease resistant American Elms were included in the plantings (Figure 6; Appendix B). The elms that were planted at Fannie Stebbins Wildlife Refuge were cloned from cuttings that came from trees that have demonstrated high levels of tolerance to Dutch elm disease in rigorous inoculation tests. All of these elm selections are native to northeastern North America (i.e. they are pure *Ulmus americana*). The elm selections that we planted include the following selections: "Valley Forge", "Princeton", "Saint Croix", "Prairie Expedition", "R18-2", and "Delaware-2" (Haugen & Bentz 2017). More details on locations and monitoring are in Appendix B.

An early summer drought (May-July) compromised survival of some species in 2018 and deer were a serious problem at the site throughout the restoration project. Drought tolerant trees such as oaks survived the best. Deer impacts included browse and breaking stems and to address this impact we first tried deer repellent in 2018 and through the winter of 2018-19. When this was not effective electric deer fences were installed in summer 2019 on five fields (Figure 3). These fences will need to be maintained for several years to ensure tree and shrub survival. Despite deer we did, however, note many patches of natural tree seedling recruitment in the fields, especially of red maple.

Figure 4: Herbicide control of herbaceous vegetation in fields in summer 2017


Figure 5: Disking results and planting design, spring 2018

Figure 6: Tree Planting 2018; top photo is of disease resistant American elm

Figure 7: Plantings 2019

Invasive Plant Control

The primary purpose of invasive control in the buffers around the fields was to reduce invasive species propagules falling onto the fields during the restoration when the sites are most susceptible to invasion. In the forested areas the goal was to suppress the invasive species populations to the point where their future management can be maintained with limited resources. Invasive species locations were mapped at the site by Land Stewardship Inc as part of the restoration plan (Figure 8). Invasive plant species were controlled in the floodplain forest and field buffers during three field seasons from 2017-2019 (Figure 9). The focus was on woody species, with the exception of Japanese stiltgrass (Table 2). Work was completed in the late summer and fall in each year.

Invasive plant control outside the WRE was completed by USFWS. The one area that was not treated was along Route 91 due to staff time constraints. This will require a new MA DOT permit in the future.

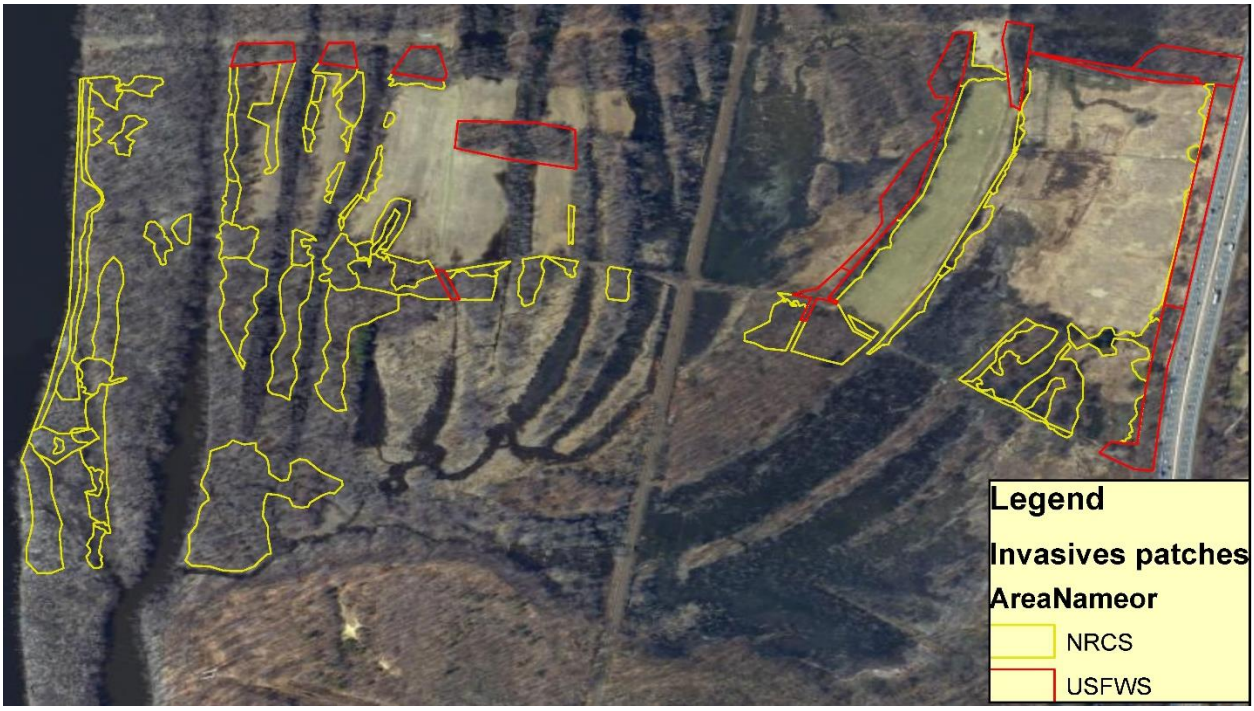

Figure 8: Invasive control treatment areas. Invasive control of areas within the WRE easement boundary was funded by NRCS (yellow patches), whereas invasive control in areas outside the easement was funded and implemented by the USFWS (red patches) as resources allowed.

Throughout the three years that the contractor, All Habitat Services, held a contract for invasive species management at Stebbins, they identified and controlled seventeen invasive species in the field and forest areas (Table 2). Note that garlic mustard was not comprehensively controlled. One additional species, *Eleutherococcus siebodianus*, or five-leaved aralia was identified by TNC staff and included in Figure 2. These species were grouped into several categories based on growth, form and characteristics. The categories include rhizomatic perennial species, shrubs, vines, trees and herbaceous annual and perennial species. These groups of invasive species were addressed with a variety of chemical prescriptions and application techniques depending on their growth stage and the site conditions. All Habitat Services customized a series of management prescriptions that were integrated into the most effective methods.

Rhizomatic perennial species like Japanese knotweed and reed canary grass were controlled using both an aqueous and thin invert emulsion application of an aquatic labeled herbicide with the active ingredient Imazapyr (such as Polaris AC Complete®). It was applied at a rate of two pints per acre. This herbicide was readily absorbed through leaves and stems and rapidly translocated throughout the plant, including underground storage organs, which prevents regrowth.

Smaller diameter (under two inches) and multi-stem tree, shrub, vine and other woody species like Asiatic Bittersweet, autumn olive, glossy buckthorn, Japanese barberry, multiflora rose, Norway maple, porcelain berry, privets, shrub honeysuckles, tree-of-heaven, wine berry, winged euonymus, etc. were

managed using a thin invert emulsion foliar application of a tank mix of herbicides with the active ingredients Imazpyr, such as Polaris®, Glyphosate, such as Rodeo®, and Metsulfuron methyl, such as Escort XP®. These herbicides were selectively applied using backpack sprayers to avoid non-target injury to the native plants.

The larger diameter (over two inches) tree, shrub and vine species like Asian bittersweet, autumn olive, glossy buckthorn, Norway maple and tree-of-heaven were controlled using basal bark applications of an herbicide with the active ingredient Triclopyr BEE, such as Garlon4®, mixed in a methylated seed oil carrier. This herbicide penetrated the bark and translocated throughout the plant, killing the root system. This application was conducted using a low-volume backpack sprayer to wet the entire circumference of the bottom 12 inches of the stem.

Annual and perennial herbaceous species like garlic mustard, Japanese stiltgrass, mugwort, porcelain berry and wine berry were effectively managed using a broadcast foliar application of a tank mix of herbicides with the active ingredients Clopyralid, such as Clean Slate® applied at a rate of 6 ounces per acre and Triclopyr, such as Element 3A® applied at a rate of three quarts per acre.

Table 2: Invasive species controlled at Fannie Stebbins 2017-19.

Scientific name	***Common Name***
Acer plantanoides	Norway maple
Ailanthus altissima	tree-of-heaven
Alliaria petiolata	garlic mustard
Ampelopsis brevipedunculata	porcelain berry
Artemisia vulgaris	mugwort
Berberis thunbergii	Japanese barberry
Celastrus orbiculatus	Oriental bittersweet
*Eleutherococcus sieboldianus**	five-leafed aralia
Euonymus alata	winged euonymus
Fallopia japonica & *F. x bohemica*	Japanese knotweed
Eleagnus umbellata	autumn olive
Frangula alnus	glossy buckthorn
Ligustrum spp	privet
Phalaris arundinacea	reed canary grass
Rosa multiflora	multiflora rose
Lonicera morrowii & *L. maackii*	honeysuckle
Microstegium vimineum (Trin.) A. Camus	Japanese stiltgrass
Rubus phoenicolasius	wineberry

* there was one occurrence along the Pondside Rd field on west side (and there is another large clump outside the project area on West Rd). This was the only reported location of this species MA in 2019 (EDDMapS).

Figure 9: example of invasive shrub control on field edge

Berm Removal

The berm removal was completed in November 2019 and included removing 500 ft of the old Meadow road where it crossed several swale wetlands south of the eastern most field near Rt 91 (Figure 10). This included removal of roughly 74 cubic yards of material along 500 linear feet of an old roadbed. The profile cuts were based on engineering profile outlays and showed four critical cuts to return proper flow. The contractors used a handheld GPS to find the proposed cut grade sections. Once the sections were marked out, they staked and flagged the areas. As the digging was performed, they used a laser level to find elevations to match the cut profiles. The area was under an unusually high amount of water as a result of the heavy rains that season. They were able to match the profile cuts using the stadia rod and laser level to ensure the elevations all matched.

In the process of making these cuts, the removed soil was evenly spread along the "proposed excavated material on-site spreading area" along the eastern edge of the berm. The contractors removed roughly three tons of concrete, which was hauled off and disposed of properly. They also removed and disposed of an old section of guiderail with 2 concrete anchors. The plans called for removing a 20-foot section of old PVC pipe, but they were unable to locate and remove the pipe.

Figure 10: area of berm removal (post removal during high water)

Wildlife Structures

Twenty wood duck nest boxes with predator guards were placed in or adjacent to wetlands (Figure 11) One osprey nest platform was placed in the wetland east of the Pondside Rd field (Figure 12). Locations are indicated in Figure 13.

Figure 11: Wood duck nest box installation (photo credit: All Habitat Services)

Figure 12: Osprey nest platform

Figure 13. Locations of installed wildlife structures including wood duck nest boxes and an osprey nest platform.

Turtle nest mound

While this feature was planned for installation, challenges with size and lack of appropriate material on site in the berm location for the structure, led to the decision that this could not be installed as planned.

Public Outreach & Media

The team felt that it was important to connect folks in the Longmeadow community to the project as many townspeople feel strongly attached to Fannie Stebbins. The Nature Conservancy presented to a large audience at the Longmeadow library before the project started. News articles about the project ran in the Longmeadow News and the Springfield Republican and a WGBY/Connecting Point piece ran on local television. TNC and Friends of Stebbins both had events during the project that included walks profiling the restoration work as well as a workday when we planted hickory nuts and willow cuttings. We also installed signage in two areas to educate the public about the project (Figure 14). The design and signs were provided by NRCS and USFWS installed the signs. There were some public concerns expressed during the project due to the reduction in pollinator habitat in the fields and safety concerns with the electric fences, however, concerns were generally minimal. The short-term impact of the restoration activities was an increase in pollinator habitat because the herbicide that removed dominant grasses and the disking allowed germination of many wildflowers (Figure 14).

Figure 14. Educational Signage about restoration project (left) and swallowtail on joe pye-weed (right).

Monitoring

Rare species monitoring was completed in 2017 as the project was being permitted and contracted. This was completed by Nature Conservancy staff with assistance from the MA Natural Heritage and Endangered Species Program and volunteers. Due to the confidential nature of the data, results are not included in this report.

While monitoring was not required by the project some invasive species assessments were carried out by Land Stewardship Inc, before the project that can be used for assessment in the future.

Plantings were also tracked by field they were planted in. This data can be used for monitoring the plantings to assess survival at this site over time.

Qualitative assessments throughout the project indicated a good amount of natural tree seedling regeneration. The amount of regeneration seems to increase from east to west which probably reflects greater seed rain in the narrower western fields. Although many of the planted silver maples died, we should get lots of natural regeneration of silver maple in the western fields. The eastern fields have more red maple regeneration, which again reflects seed rain based on the tree species surrounding the field.

Challenges & Lessons Learned

General

- Collaboration on restoration plan was important and the plan was helpful as a reference even if aspects changed during the implementation.
- An active Amtrak rail line runs through the project area and was a significant safety hazard. Dealing with Amtrak was challenging, however, we determined that we had the right to cross the tracks to do restoration work on our land. This could have been anticipated as a problem earlier in the planning process.
- A project manager with ample time to oversee the project is essential. Getting the project off the ground in the first year took substantial amount of time including rare species surveys, permitting, and contracting. It was useful to have a restoration team assisting the project manager given the project complexity.
- NRCS gives one year after closing on an WRE for restoration to begin, but this is often not enough time and getting the project off the ground was rushed due to permitting/rare species surveys and complex RFP/contracting. This led to work delays the first season.
- Rare species monitoring should have been completed a season before the project started and will need additional funding if expertise and time are not available.

- There is a need to identify contingency funding in projects this big so that funding that can be moved into place quickly to address urgent issues that arise as well as cover costs that NRCS does not cover such as permitting ($1000 in fees) and rare species monitoring.

Permitting

- Completing permitting during same time as bid project was challenging
- Permitting went smoothly due to restoration team members, Chris Polatin and Dave Sagan, who had relationships in Longmeadow. Chris had done previous projects with the town and this paved the way for the Stebbins project. Extra time might be needed when working with smaller towns that could be unfamiliar with large complex projects.

Public outreach and management during project

- Library outreach meeting before project started was helpful and well attended.
- The general public had just a few issues including spraying herbicides. There was minor vandalism on contractor vehicles (dog poop).
- More communication with interpretative signage would have been helpful and should have been included in the planning process.
- An onsite site communication plan would have been helpful.

RFP/bid process

- The contractor thought it went well overall. There were conflicting issues between the contract and RFP process that weren't caught due to large volume of documents.
- AHS focused on larger aspects of the work earlier in the project, but this led to challenges in the last year with finishing up the contract.
- The restoration team did not meet regularly until later in project, but earlier meetings would have ensured continuity through the project and could have anticipated challenges with the next steps.

Tree/shrub planting

- Creating the planting layout was challenging. A high-resolution digital elevation model would have helped with mapping of species for planting along wetland contours, but it was not fully available when the plan was developed
- We needed better field vegetation management generally throughout the project to prevent larger or vining herbaceous species from impacting tree and shrub plantings. The field herbaceous vegetation was very dense and should have been controlled early in the growing season if possible when there is less of it (this was delayed due to rare species monitoring requirements and contracting delays). The first season could have benefited from an additional herbicide application as well.
- Identifying possible species substitutions before tree planting would have been helpful.

- Contracts for growing stock needs to be planned earlier to get appropriate sizes and ensure enough stock. Sourcing plant material will be even harder in the future as one of the vendors is going out of business. We may need to go outside the region in the future or develop another source. Groups who implement restoration with plantings (e.g. Society for Ecological Restoration, TNC, NRCS, and organizations implementing forest adaptation projects) need to proactively increase/support the native plant capacity in the New England region. Future restorations may need to rely more on natural regeneration. Long term outcomes at Fannie Stebbins could reveal if the red maple and other seedlings that germinated in the prepared seedbeds are a viable alternative to the trees that were planted as a reforestation approach.
- Using container stock improved survival; bare root would have had lower survival rates.
- The two-year planting timeline was beneficial due to drought and deer issues in the first year. Also, it would have been difficult to plant the entire amount of stock in one year given the narrow planting window in April/early May.
- It was difficult to obtain planting stock of the necessary size to avoid deer browse and deer protection on individual plants was cost prohibitive We also underestimated the numbers of deer present at the site and had to install electric fences during the second growing season. We attempted a deer spray in the first season, but this was only moderately successful, and we had problems with the deer leaning on and breaking saplings.
- Nurseries did not understand the contract process as they are generally used to just invoicing for material purchased. As a result, the invoicing was confusing. The nurseries also provided the bottom size of plant material size ranges.
- Monitoring in the future should assess survivability of both methods (planting and natural recruitment). Monitoring of trees over time should be included in project, even if it is just photo monitoring.

Invasive Plant control

- In the first year we missed the window of early treatment due to rare species survey requirements and contracting delays that caused delay of visible progress into second year. We saw better control in years two and three.
- Tennessee Gas was good partner to coordinate with along pipeline.
- USFWS still needs to work with Mass DOT along Rt 91 as this area has not been sprayed yet.
- Japanese stiltgrass is starting to creep into fields and is a major concern going forward. This spread could have been anticipated.
- Monitoring and maintenance of invasive species is important going forward. Early detection is vital and is needed two to three times per year. New species will come in via transportation corridors at Stebbins. Permits can allow for ongoing maintenance.
- The invasive species seed bank is large and so spot treatment will be necessary. It will not be realistic to tackle maintenance with volunteers in the next several years;
- An invasive species plan will be important for USFWS and Town moving forward given the need to continue to re-treat areas treated as well as to treat new areas (particularly along Rt 91, on

adjacent town and Tennessee gas lands, and further south on the peninsula). There is a need to explore other funding for future projects.

Wildlife structures

- Placement/layout of wood duck boxes could be improved in the future; some are now flooded and one is already missing as it was too close to a trail. A high-resolution digital elevation model could be combined with flood records for the site to predict typical flooding depths in locations for wildlife structures.
- The turtle nesting mound may not have been all that critical as there is lots of turtle habitat at site and mounds can attract predators. The bid that came in was not adequate to complete a nesting mound, so it was not constructed. It would have been helpful to discuss this idea with Division of Fish and Game during the planning phase to determine the value of creating turtle nesting habitat.

Berm removal

- Entire removal of the berm was very challenging due to high water, crumbling bituminous pavement and loose material. This project should not been left until the end of the project period when contingency plans were not possible.
- The contractor suggested more interaction between partners on this portion of the project earlier in process; for example, they did not know NRCS needed to do inspection as it was not included in contract.

References

Haugen, L. M. and S.E. Bentz. 2017. American elm clones of importance in Dutch elm disease tolerance studies. In: Pinchot, Cornelia C.; Knight, Kathleen S.; Haugen, Linda M.; Flower, Charles E.; Slavicek, James M., eds. Proceedings of the American elm restoration workshop 2016; 2016 October 25-27; Lewis Center, OH. Gen. Tech. Rep. NRS-P-174. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station: 109-118. (https://www.fs.usda.gov/treesearch/pubs/54952).

Kearsley, J. B. 1999a. Rare and non-native plants of Massachusetts' floodplain forests. Rhodora 101(906): 200-205.

Kearsley, J. B. 1999b. Inventory and vegetation classification of floodplain forest communities in Massachusetts. Rhodora 101(906): 105-135.

Marks, C.O., B. Schreier, C. Polatin, C. Boettner, and D. Sagan. 2016. Restoration plan for Fannie Stebbins Memorial Wildlife Refuge.

Marks, C. O. and C.D. Canham. 2015. A quantitative framework for demographic trends in size-structured populations: Analysis of threats to floodplain forests. *Ecosphere* 6: art232

Marks, C.O., K.H. Nislow and F.J. Magilligan. 2014. Quantifying flooding regime in floodplain forests to guide river restoration. *Elem Sci Anth*, 2, p.000031.
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- Volunteers: Nan Childs, Kate Wellspring, Rebecca Budd

Appendix A

Field Plantings Species List

Species name	Common name	Growth form	Total
***Acer nigrum* Michx. f. ***	black maple	tree	0
***Acer rubrum* L.**	red maple	tree	154
***Acer saccharinum* L.**	silver maple	tree	791
***Acer saccharum* Marsh.**	sugar maple	tree	226
Carpinus caroliniana* Walter	American hornbeam	tree	0
Carya cordiformis* (Wangenh.) K. Koch	bitternut hickory	tree	0
***Carya ovata* (Mill.) K. Koch**	shagbark hickory	tree	160
Celtis occidentalis* L.	northern hackberry	tree	0
***Liriodendron tulipifera* L.**	tuliptree	tree	58
***Nyssa sylvatica* Marsh.**	blackgum	tree	62
***Pinus strobus* L.**	eastern white pine	tree	250
***Platanus occidentalis* L.**	American sycamore	tree	311
***Populus deltoides* Bartram ex Marsh.**	eastern cottonwood	tree	628
***Populus tremuloides* Michx.**	trembling aspen	tree	487
***Prunus serotina* Ehrh.**	black cherry	tree	656
***Quercus bicolor* Willd.**	swamp white oak	tree	858
***Quercus palustris* Münchh.**	pin oak	tree	253
***Tilia americana* L.**	American basswood	tree	42
***Ulmus americana* L.**	American elm	tree	94
***Alnus incana* (L.) Moench ssp. *rugosa* (Du Roi) R.T. Clausen**	speckled alder	shrub	183
***Cephalanthus occidentalis* L.**	buttonbush	shrub	117
***Cornus amomum* Mill.**	silky dogwood	shrub	163
***Cornus sericea* L.**	red osier dogwood	shrub	163
***Corylus americana* Walter**	American hazelnut	shrub	207
Hamamelis virginiana* L.	witch hazel	shrub	0
***Ilex verticillata* (L.) A. Gray**	winterberry	shrub	174
***Lindera benzoin* (L.) Blume**	spicebush	shrub	486
***Prunus virginiana* L.**	choke cherry	shrub	520
***Rosa palustris* Marsh.**	swamp rose	shrub	50
***Sambucus nigra* L. ssp. *canadensis* (L.) R. Bolli**	common elderberry	shrub	91

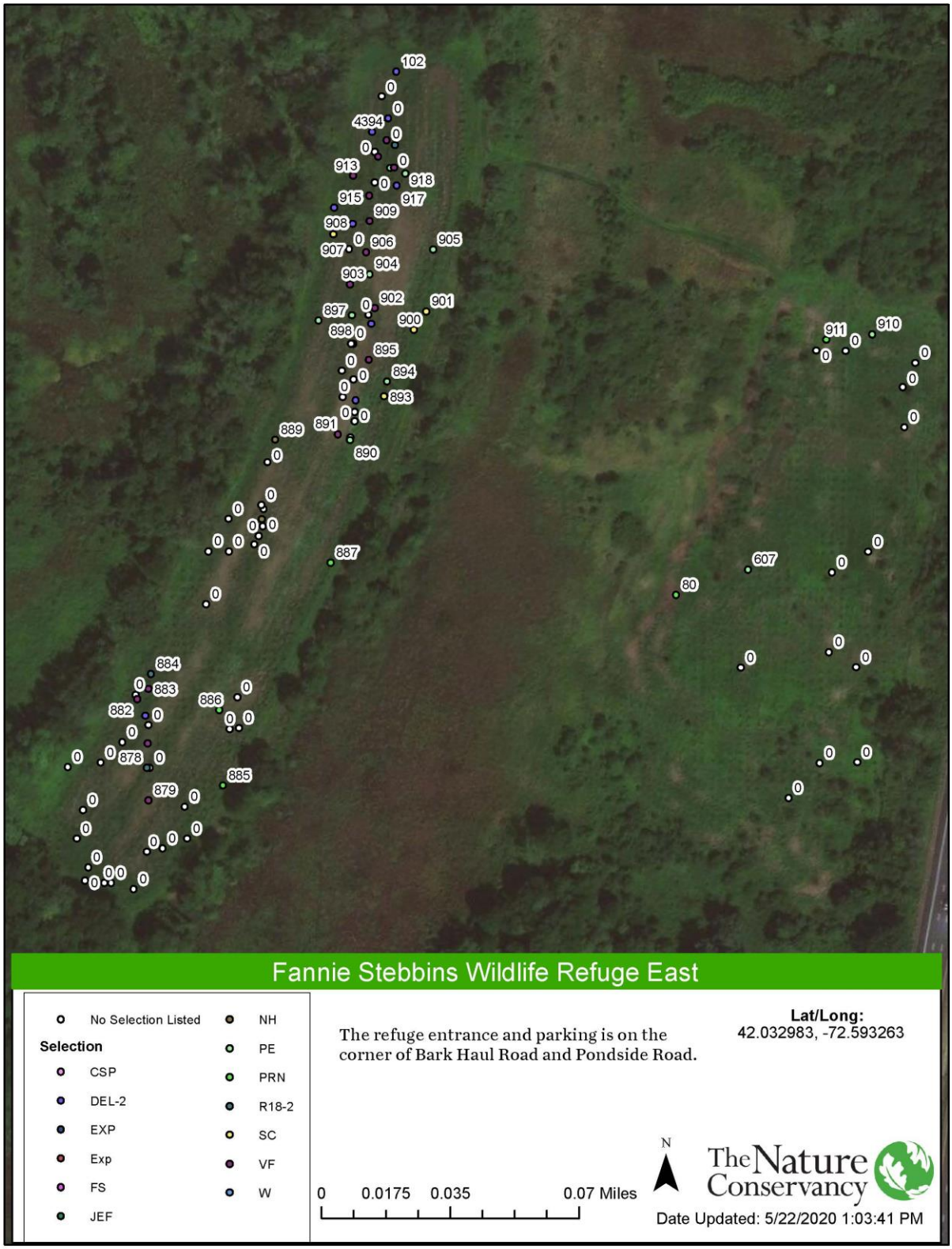
Staphylea trifolia* L.	American bladdernut	shrub	0
***Viburnum dentatum* L.**	arrow wood	shrub	176
***Viburnum lentago* L.**	nannyberry	shrub	87
***Matteuccia struthiopteris* (L.) Todaro**	ostrich fern	herb	445
Total fern			445
Total shrub			2417
Total tree			5030
Total plantings			**7892**

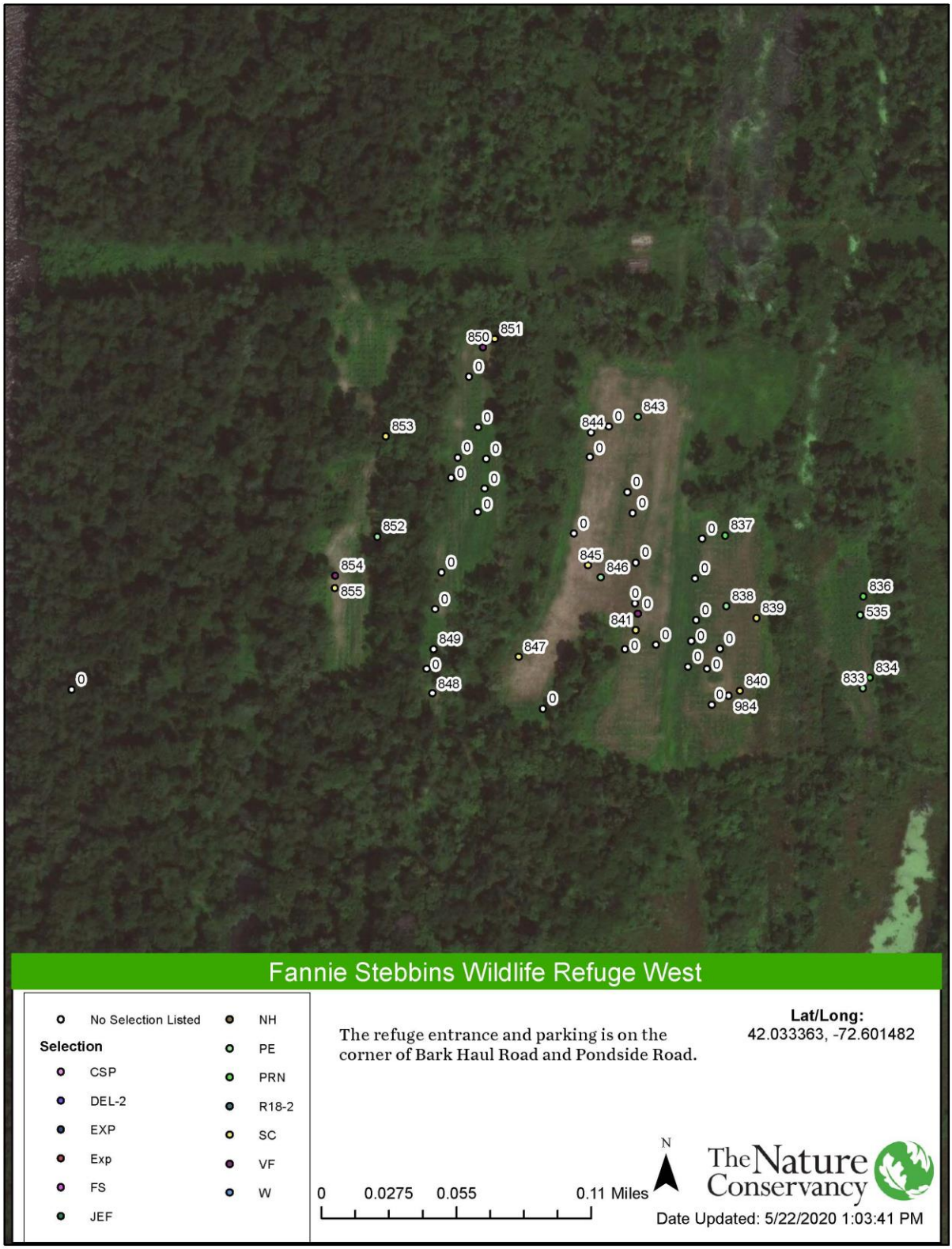
*Requested for planting per restoration plan, but not available

Appendix B

Monitoring planted elms at the Fannie Stebbins Wildlife Refuge

The maps below show the locations of disease tolerant elms that survived in the initial years after planting as of spring 2020. All of these elms are native selections of *Ulmus americana*. The planted elm include the following disease tolerant varieties: Princeton (PRN), Valley Forge (VF), Saint Croix (SC), Prairie Expedition (PE), R18-2 (R18-2), and Delaware-2 (DEL-2), as well as some new varieties whose level of disease tolerance is still untested. Although the smaller elms suffered from deer browse in the first weeks after planting, they were subsequently protected by an electric fence. Most elm seedlings have now recovered from the initial deer browse or antler rub damage and have started growing quickly. The elms labelled with tags in spring 2020 and lower side branches were pruned off. Unlike other planted trees at the refuge, the elms have plastic tree wrap around their stems to protect against girdling of the bark by rodents. This tree wrap will need to get removed in two or three years when it becomes tight around the stem as the trees continue to grow in girth. An ArcGIS shape file version of the elm monitoring map is available from Gus Goodwin of TNC's Vermont field office. We recommend using the ArcGIS on-line map and the collector App for future monitoring of elm growth and survival. The ArcGIS on-line map includes additional monitoring data such as tree heights and tag numbers. In spring 2020, elm saplings were between 0.3 and 4.3 meters tall. Monitoring is easiest in May before the herbaceous vegetation in the old fields gets tall because it makes finding the elms much easier. Elms should get monitored at least once every second year until the trunks are over 3 cm diameter and the tree wrap has been removed.


Fannie Stebbins Wildlife Refuge East
No Selection Listed
Selection
CSP
DEL-2
EXP
Exp
FS
JEF
NH
PE
PRN
R18-2
SC
VF
W
The refuge entrance and parking is on the corner of Bark Haul Road and Pondside Road.
Lat/Long:
42.032983, -72.593263
0
0.0175
0.035
0.07 Miles
N
The Nature Conservancy
Date Updated: 5/22/2020 1:03:41 PM


Fannie Stebbins Wildlife Refuge West
No Selection Listed
Selection
CSP
DEL-2
EXP
Exp
FS
JEF
NH
PE
PRN
R18-2
SC
VF
W
The refuge entrance and parking is on the corner of Bark Haul Road and Pondside Road.
Lat/Long:
42.033363, -72.601482
0
0.0275
0.055
0.11 Miles
N
The Nature Conservancy
Date Updated: 5/22/2020 1:03:41 PM