Pastures to Prairies to Pools: | An Update on Natural Resource Damages Settlement Projects at the Fernald Preserve

Jane Powell*, Tom Schneider**, Bill Hertel***, and John Homer****
* Fernald Preserve Site Manager, DOE Office of Legacy Management, Harrison, Ohio
** Fernald Project Manager, Ohio Environmental Protection Agency, Dayton, Ohio
*** Project Manager, S.M. Stoller Corporation, Harrison, Ohio
**** Environmental Scientist, S.M. Stoller Corporation, Harrison, Ohio

ABSTRACT

The DOE Office of Legacy Management oversees implementation and monitoring of two ecological restoration projects at the Fernald Preserve, Fernald, Ohio, that are funded through a CERCLA natural resource damage settlement. Planning and implementation of on-property ecological restoration projects is one component of compensation for natural resource injury. The Paddys Run Tributary Project involves creation of vernal pool wetland habitat with adjacent forest restoration. The Triangle Area Project is a mesic tallgrass prairie establishment, similar to other efforts at the Fernald Preserve. The goal of the Fernald Natural Resource Trustees is to establish habitat for Ambystomatid salamander species, as well as grassland birds. Field implementation of these projects was completed in May 2012. Herbaceous cover and woody vegetation survival was determined in August and September 2012. Results show successful establishment of native vegetation. Additional monitoring will be needed to determine whether project goals have been met. As with the rest of the Fernald Preserve, ecological restoration has helped turn a DOE liability into a community asset.

INTRODUCTION

The Fernald Preserve is situated on a 425 hectare tract of land, approximately 29 km northwest of Cincinnati, Ohio. The site is located near the unincorporated communities of Ross, Fernald, Shandon, and New Haven in Hamilton County. It is a former uranium-processing facility that was shut down in 1991. Since then, the site has undergone extensive remediation pursuant to the CERCLA. Remedial activities and subsequent ecological restoration have converted the site from an industrial production facility to an undeveloped park, encompassing wetlands, prairies, and forest. Upon completion of large-scale soil remediation and waste disposition in the fall of 2006, the site was successfully transitioned to the DOE Office of Legacy Management.

Sitewide ecological restoration was driven by several factors, including stakeholder input, regulatory compliance, and the negotiated settlement of a long-standing natural resource damage claim under Section 107 of CERCLA. DOE and the Ohio Environmental Protection Agency (Ohio EPA) signed a Consent Decree in November 2008 that finalized the natural resource damage claim, which was originally filed in 1986. A portion of the Consent Decree required DOE to pay $13.75 million to compensate for natural resource injury by restoring, replacing, or acquiring equivalents of the natural resources at or near the Fernald Preserve. Following finalization of a Funds Utilization Plan in February 2010, the Fernald Natural Resource Trustees

(Trustees)—DOE, Ohio EPA, and the U.S. Department of the Interior—agreed to implement several ecological restoration projects at the Fernald Preserve.

The Trustees began planning and designing the Paddys Run Tributary Project and the Triangle Area Project in 2010. The Trustees authorized the implementation of the Paddys Run Tributary Project and the Triangle Area Project in August 2011, with a resolution to release funds from the settlement fund account to construct these projects. DOE added scope to the Legacy Management Support contract via a "work for others" baseline change proposal process in September 2011. Work will be planned and implemented by the LMS contractor, with oversight by DOE and the other Trustees. Design and procurement commenced in the fall of 2011, and field implementation was completed in May 2012. A detailed description of the design for each project is provided in *Natural Resource Damages Settlement Projects at the Fernald Preserve*[1]. A summary of each project is provided below.

Paddys Run Tributary Project

The goal of the Paddys Run Tributary Project is to create vernal pool breeding habitat for Ambystomatid salamanders within a contiguous forest community. The project location is within the migration footprint for several Ambystomatid salamanders located in an adjacent off-property woodlot, according to research conducted by Ohio EPA[2; 3]. This wet forest has been used as a reference for determining the size and location of the vernal pool, along with the woody species diversity and density of planted vegetation. Ambystomatid species using the adjacent reference woodlot include Marbled (*Ambystoma opacum*), Spotted (*A. maculatum*), Jefferson (*A jeffersonianum*), and Smallmouth salamanders (*A. texanum*). The nearest known population of Marbled salamanders is over 50 km away[2], showing the unique quality of this habitat and the need for protection/expansion.

The total project area includes approximately 2.8 ha (7 acres). Three planting areas were installed. Installation of vegetation involved the planting of 1,255 "large" trees and shrubs and approximately 5,150 bare-root seedlings. The larger-sized plants include 5 cm (2-inch) caliper balled-and-burlapped (BB) canopy trees, as well as a variety of container-grown plants ranging in size from 3.8 to 56.8 L (1 to 15 gallons [gal.]). Three planting areas were developed. Planting Area A included all of the container-grown and large tree plantings, while bare-root seedlings were installed in Areas B and C. Table I lists the woody vegetation that was installed.

Table I. Paddys Run Tributary Project Planted Woody Vegetation

				Number Planted		
Species	**Common Name**	**Form**	**Size[a]**	**Area A**	**Area B**	**Area C**
Acer rubrum	red maple	tree	15 gal.	5		
Acer saccharinum	silver maple	tree	bare root	750	100	
Acer saccharum	sugar maple	tree	2-inch BB	14		
Acer saccharum	sugar maple		bare root			100
Aesculus glabra	Ohio buckeye	tree	bare root		100	100

				Number Planted		
Species	**Common Name**	**Form**	**Size[a]**	**Area A**	**Area B**	**Area C**
Asimina triloba	pawpaw	sm tree	3 gal	150		
Carpinus caroliniana	American hornbeam	sm tree	3 gal	50		
Carya cordiformis	bitternut hickory	tree	2 gal	50		
Carya ovata	shagbark hickory	tree	2-inch BB	12		
Celtis occidentalis	hackberry	tree	bare root	150		100
Cephalanthus occidentalis	buttonbush	shrub	1 gal	150		
Cercis canadensis	redbud	sm tree	bare root		100	100
Cornus amomum	silky dogwood	shrub	1 gal	150	100	
Corylus americana	American hazelnut	shrub	bare root			100
Fagus grandifolia	American beech	tree	2 gal	75		
Fagus grandifolia	American beech	tree	bare root			100
Lindera benzoin	spicebush	shrub	3 gal	150		
Liriodendron tulipifera	tuliptree	tree	bare root	600		100
Nyssa sylvatica	blackgum	tree	bare root		100	
Platanus occidentalis	sycamore	tree	bare root	750	100	
Quercus bicolor	swamp white oak	tree	15 gal	7		
Quercus bicolor	swamp white oak	tree	bare root		100	
Quercus imbricaria	shingle oak	tree	1 gal	75		
Quercus imbricaria	shingle oak	tree	bare root		100	
Quercus macrocarpa	bur oak	tree	1 gal	75		
Quercus macrocarpa	bur oak	tree	bare root		100	
Quercus palustris	pin oak	tree	15 gal	15		
Quercus palustris	pin oak	tree	bare root		100	
Quercus rubra	red oak	tree	15 gal	20		
Quercus rubra	red oak	tree	bare root			100
Rhus glabra	smooth sumac	shrub	bare root			250
Rosa palustris	swamp rose	shrub	3 gal	150		
Rubus allegheniensis	common blackberry	shrub	bare root		150	250
Salix nigra	black willow	tree	bare root		100	
Sambucus canadensis	common elderberry	shrub	bare root		150	
Tilia americana	American basswood	tree	bare root			100
Ulmus americana	American elm	tree	15 gal	7		
Ulmus americana	American elm	tree	bare root		100	
Viburnum prunifolium	blackhaw	shrub	bare root			100

[a] Container sizes: 1 gal = 3.8 L; 2 gal = 7.6 L; 3 gal = 11.4 L; 15 gal = 56.8 L

The constructed vernal pool, along with several additional smaller depressions, was constructed within Planting Area A. Woody vegetation establishment was concentrated around these features, with the intent of creating canopy closure as quickly as possible. The constructed depressions were also enhanced with herbaceous wetland vegetation. Over 730 potted plants were installed within the vernal pool areas (Table II). These species are characteristic of Ohio

vernal pools[4]. Deer exclosure fencing was installed around the planting area as well. Figure 1 shows the as-built condition of Planting Area A. All disturbed areas were seeded with appropriate seed mixes (i.e., wetland or mesic prairie) following construction.

Table II. Paddys Run Tributary Project Planted Herbaceous Vegetation

Species	Common Name	Quantity
Carex crinita	tasseled sedge	49
Carex granularis	meadow sedge	49
Carex grayi	Gray's sedge	98
Carex lupulina	hop sedge	98
Carex muskingumensis	Muskingum sedge	98
Carex tribuloides	blunt broom sedge	49
Cinna arundinacea	common wood reed	98
Glyceria striata	fowl manna grass	98
Iris versicolor	northern blue flag	49
Scirpus cyperinus	wool grass	49

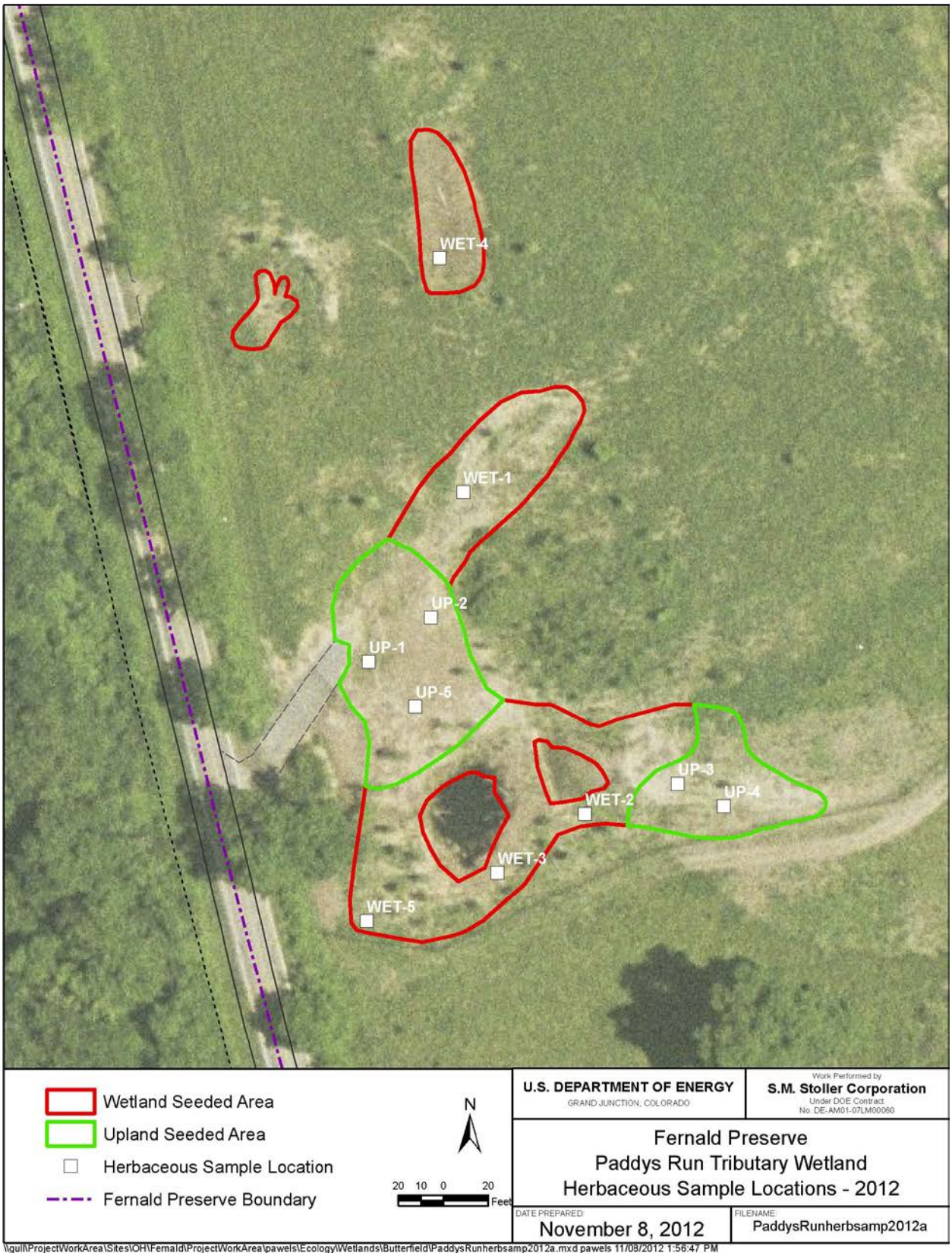

Figure 1. Paddys Run Tributary Project Planting Area A.

Triangle Area Project

Following a 2010 walkdown of the Triangle Area, a former pasture area at the Fernald Preserve, the Trustees determined that the area is an optimal candidate for prairie establishment. The Triangle Area, which measures 2.8 hectares (7acres), is similar in setting and community to adjacent on-property grasslands that were successfully converted to mesic tallgrass prairie. The seeding approach is consistent with other grassland establishment efforts at the Fernald Preserve[5]. Existing cool season grasses were eradicated with two applications of glyphosate herbicide; one in the fall of 2011 and a second about 2 weeks prior to seeding in May 2012. Seeds were installed with a tractor-pulled seed drill. Originally, the entire seeding area was planned as a mesic prairie. Following a spring 2012 field walkdown, the Trustees determined that a portion of the Triangle Area should be seeded with a wetland seed mix. Figure 2 shows the as-built seeding areas for the Triangle Area Project.

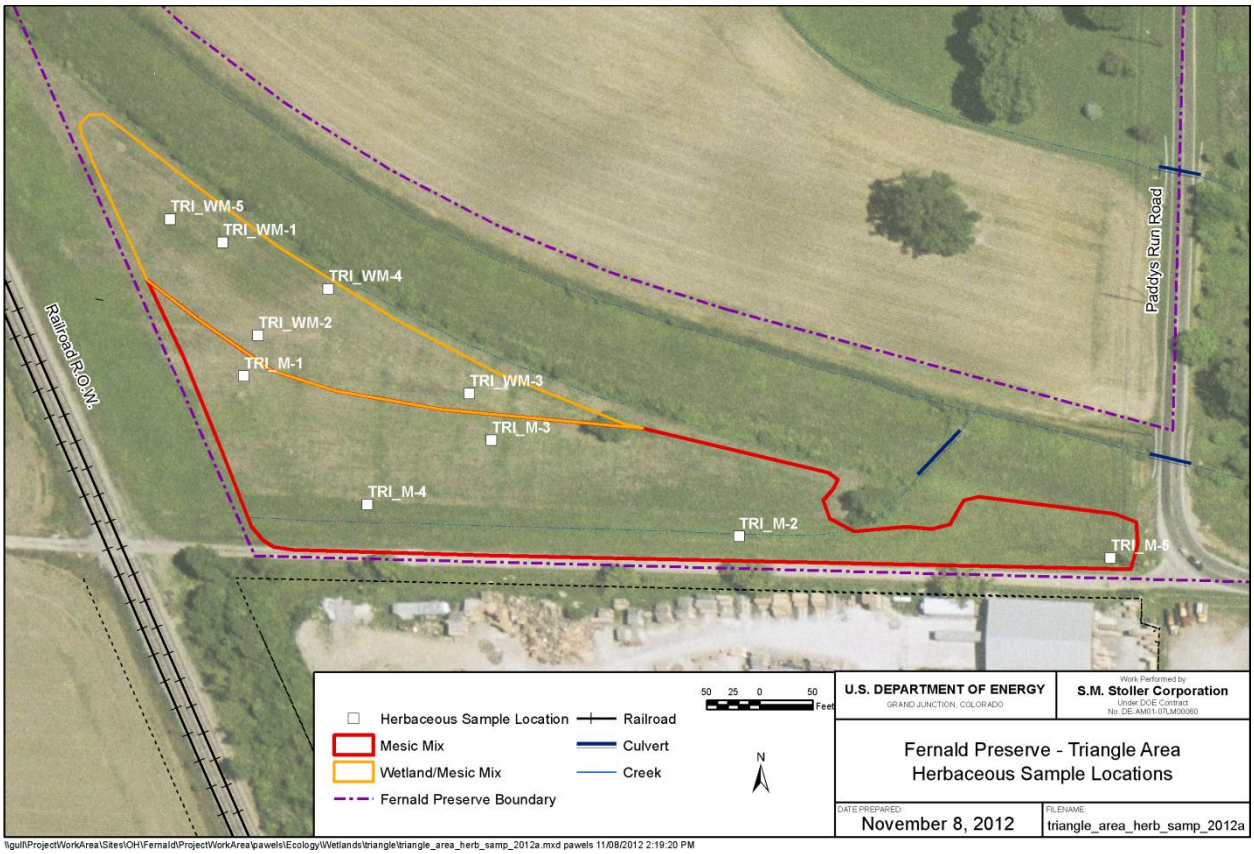

Figure 2. Triangle Area Project.

Project Monitoring

Project monitoring is required to ensure successful establishment of vegetation and to determine whether project goals are met. An ecological monitoring program has been specified by the Trustees as part of the *Fernald Preserve Natural Resource Restoration Plan* (NRRP)[6]. The program involves a two-tiered approach that includes implementation monitoring and functional

monitoring. Implementation monitoring is designed to determine whether vegetation has been successfully established following construction. Functional monitoring is a long-term process to assess whether project and sitewide ecological goals are being achieved. Implementation monitoring was initiated for both projects in 2012. The methods and results are presented below.

METHODS

Field methods for both implementation and functional monitoring are specified in the Fernald Preserve Legacy Management and Institutional Controls Plan[7]. For 2012, implementation monitoring was required. This involves determination of woody vegetation survival and characterization of herbaceous cover.

Woody Vegetation Survival

Survival was evaluated for all balled-and-burlapped and container-grown plants installed in the Paddys Run Tributary Project. This involved a physical evaluation of each plant and an assignment of one of four categories: alive, resprouting, vital (i.e., alive but less than 50 percent of the crown remains), and dead. Trees and shrubs are considered "alive" when their main stem and/or greater than 50 percent of the lateral stems are viable. "Resprouting" trees and shrubs have a dead main stem, with one or more new shoots growing from the stem or the root mass. Plants are categorized as "vital" when less than 50 percent of its lateral branches are alive. "Dead" trees have no signs of life at all. Only "alive" trees are counted as surviving. The Trustees have established a goal of 80 percent survival following the first growing season. A second year of monitoring is typically conducted as directed by the Trustees. Note that woody survival is not recorded for bare-root seedlings. These species are planted in a much higher density (e.g., 1,000 stems per acre) with the expectation that a smaller percentage will survive. As a result, implementation monitoring was limited to Area A.

Field observations were conducted as required at the end of the first growing season following installation, in September 2012. Not all of the smaller container-grown trees and shrubs were located. This may because smaller plants are obscured by tall vegetation or because the plant has died and the plant stem was uprooted or knocked over.

Herbaceous Cover

Pursuant to the NRRP, seeded areas are evaluated for two criteria: percentage of native species and total cover. The Trustees have established goals of at least 50 percent native vegetation establishment and 90 percent total cover by the end of the first growing season following seeding. Seeded areas are evaluated via random sampling. Five 1 m^2 quadrats are randomly located within a given area. All seeded areas are evaluated within each restoration project. Depending on the size of the restoration project, seeded areas may be grouped into habitat-specific subareas. For each distinct area, five 1 m^2 quadrats are randomly distributed and surveyed. Field personnel estimate the total cover and list all species present within each quadrat. The data collected will be used to determine total cover, percent native species composition, and relative frequency of native species, as described below.

For total cover, the quadrat-specific cover estimates are averaged. A 1-to-10 cover class is assigned to each species, as specified by Ohio EPA[8]. The midpoint of each percent range within the cover class is used to calculate percent cover. Native species composition is evaluated in two ways. First, percent native species composition is calculated by dividing the total number of species surveyed into the total number of native species present. Second, the relative frequency of native species is determined. The number of times a species appears in each quadrat is divided by the total number of quadrats surveyed. These species-specific relative frequencies are summed and divided by the total of all frequencies within a given area.

Herbaceous field data for both projects was collected in August 2012.

RESULTS

Paddys Run Tributary Project

The woody-vegetation survival rates for the Paddys Run Tributary Project is presented in Table III. In general, the large container and balled-and-burlapped trees performed well, along with wetland shrubs. Small container-grown trees that were planted away from wetland areas had less survival.

Table III. Paddys Run Tributary Project Woody Vegetation Survival

Species	Common Name	Qty.	Resprout-ing	Vital (<50% alive)	Dead or Unaccounted	Percent Survival
Acer rubrum	red maple	5	0	0	0	100%
Acer saccharum	sugar maple	14	0	1	2	79%
Asimina triloba	pawpaw	150	3	2	100	30%
Carpinus caroliniana	blue-beech	50	0	2	11	74%
Carya cordiformis	bitternut hickory	50	1	4	20	50%
Carya ovata	shagbark hickory	12	0	2	5	42%
Cephalanthus occidentalis	buttonbush	150	0	0	0	100%
Cornus amomum	silky dogwood	150	0	0	16	89%
Fagus grandifolia	american beech	75	1	7	64	4%
Lindera benzoin	spicebush	150	14	15	88	22%
Quercus bicolor	swamp white oak	7	0	0	0	100%
Quercus imbricaria	shingle oak	75	2	1	57	20%
Quercus macrocarpa	bur oak	75	0	1	34	53%
Quercus palustris	pin oak	15	0	0	3	80%
Quercus rubra	red oak	20	0	0	2	90%
Rosa palustris	swamp rose	150	1	0	27	81%
Ulmus americana	american elm	7	0	0	0	100%

Species	Common Name	Qty.	Resprout-ing	Vital (<50% alive)	Dead or Unaccounted	Percent Survival
Totals		**1,155**	**22**	**35**	**429**	**58%**

Herbaceous results for the Paddys Run Tributary Project are provided in Table IV. Except for wetland area total cover, herbaceous native species and cover goals were met.

Table IV. Paddys Run Tributary Project Herbaceous Data Summary

Area	Total Species	Native Species	Percent Native Species	Percent Relative Frequency of Native Species	Percent Cover
Wetland	31	19	61%	55%	83%
Mesic prairie	30	19	63%	67%	97%

Triangle Area Project

A summary of herbaceous cover data for the Triangle Area Project is presented in Table V. Both native species and total cover goals were met.

Table V. Triangle Area Project Herbaceous Data Summary

Area	Total Species	Native Species	Percent Native Species	Percent Relative Frequency of Native Species	Percent Cover
Mesic prairie	31	20	65%	56%	97%
Wet/mesic prairie	30	20	67%	68%	94%

DISCUSSION

Establishment of herbaceous vegetation for both the Paddys Run Tributary and Triangle Area Projects was generally acceptable. All but two quadrats (WET-3, WET-4) in the Paddys Run Tributary Project (Figure 1) scored a cover class of 10 (95% to 99% cover). The lower percent cover in these two quadrats was due to the fact that they are part of or adjacent to the emergent wetland area. This resulted in a lower cover class of 8 (50% to 75% cover). Results from the Triangle Area Project are consistent with other prairie establishment efforts on Fernald Preserve property where topsoil is still intact. Native species include a combination of seeded grasses and forbs, along with volunteer species that are common in disturbed communities.

Mowing in the first one to two years is often required to ensure sufficient establishment of seeded vegetation. The Natural Resource Trustees conducted a walkdown of the project areas in late June and determined that no mowing would be necessary.

Woody vegetation survival did not meet the 80 percent survival goal in 2012. Most of the large trees and plants located near wetland areas survived much better than smaller vegetation that was installed in the former mesic prairie area. This is due to several factors. First, the Fernald Preserve was affected by drought conditions in early summer 2012. The monthly precipitation total for June 2012 was 2.48 inches, as measured at the Butler County, Ohio, Regional Airport. This is the lowest June total since 2004. Site conditions were even drier. A rain gauge installed on Fernald Preserve property measured 1.14 inches of rain for June 2012.

The lack of rain resulted in the need to water planted vegetation. Due to the remote location of the project area, water had to be trucked to the field. Site personnel were required to irrigate individual large trees and wetland vegetation that were less tolerant of dry conditions. The primary wetland basin in the project area was also filled with water several times, in an effort to ensure survival of herbaceous plants and emergent wetland shrubs. These focused efforts resulted in less irrigation of smaller plants and upland vegetation.

A second factor that influenced survival was the difficulty of finding smaller-sized vegetation in the months following installation. Planting Area A is located within a former mesic tallgrass prairie restoration area. The warm-season grasses that are seeded in the project area include big bluestem (*Andropogon gerardii*), indiangrass (*Sorghastrum nutans*), switchgrass (*Panicum virgatum*) and Canada wildrye (*Elymus canadensis*). These species often grow over 2 m (6.6 ft) high. The project area was mowed, raked, and baled prior to the start of construction, but by the summer of 2012 much of the site was characterized by thick stands of vegetation. This meant the smaller 1- to 3-gallon container plants were difficult to locate in the field, either to water or to determine survival. Of the 1,155 plants installed, 368 were unaccounted for. These were conservatively counted as “dead” when calculating survival. If all unaccounted for plants were counted as “alive,” then overall survival would be approximately 90 percent.

CONCLUSIONS

Vegetation has been successfully established in both the Paddys Run Tributary and the Triangle Area Projects. Continued management will be required to ensure that native species composition within these areas is maintained. Some replanting will be required in the Paddys Run Tributary Project in order to improve woody vegetation survival. Field implementation of the projects resulted in a combined cost underrun of approximately $57,000. As a result, the Trustees completed a third restoration project in the footprint of the former Silos Area at the Fernald Preserve. Additionally, a reserve was held for Paddys Run Tributary replanting efforts in 2013.

Path Forward

It is anticipated that some replanting activities will take place at the Paddys Run Tributary Project in 2013. Species and quantities to be installed will be determined by the Natural Resource Trustees. The Trustees do take the extent of native volunteer recruits into consideration when deciding on replant requirements. A number of sycamore (*Platanus occidentalis*) and cottonwood (*Populus deltoides*) are establishing in the project area. A second year of woody vegetation survival counts are planned as well.

The goal of the Paddys Run Tributary Project is to create breeding habitat for Ambystomatid salamanders. In practice, this will take decades to achieve, as the site succeeds from prairie to second-growth forest. In contrast, the Triangle Area will resemble other on-property seeded prairies in a much sooner timeframe. Regardless, both projects will be added to the site functional monitoring program. Functional monitoring compares vegetation and wildlife parameters of restored communities to pre-restoration baseline conditions and high-quality reference sites. The Triangle Area will be evaluated in 2013 with other restored prairie areas across the site. Wetland communities will be characterized in 2015. Additionally, the Trustees will conduct amphibian monitoring at the Paddys Run Tributary project starting in 2013.

REFERENCES

1. Powell, Jane, Tom Schneider, Bill Hertel, and John Homer, 2012. *Natural Resource Damages Settlement Projects at the Fernald Preserve*, presented at the Waste Management Conference, Phoenix, Arizona, February 26–March 1.

2. Bartosek, J., and K. Greenwald, 2009. A Population Divided: Railroad Tracks as Barriers to Gene Flow in an Isolated Population of Marbled Salamanders (*Ambystoma opacum*). Herptological Conservation and Biology 4(2): 191-197.

3. Gara, Brian, 2010. E-mail regarding Graphical Geographic Information System analysis of existing vernal pools and the potential for restoration in nearby locations on the western portion of the Fernald Preserve, February 23.

4. Mack, John J., 2007. *Characteristic Ohio Plant Species for Wetland Restoration Projects v. 1.0*, Ohio EPA Technical Report WET/2007-1, Ohio Environmental Protection Agency, Wetland Ecology Group, Division of Surface Water, Columbus, Ohio.

5. DOE (U.S. Department of Energy), 2010. *Fernald Preserve Restored Area Maintenance Plan*, LMS/FER/S05080-0.0, Fernald Area Office, Cincinnati, Ohio, March.

6. DOE (U.S. Department of Energy), 2008. *Natural Resource Restoration Plan, Fernald Preserve, Fernald, Ohio*, 212E-PL-0003, Fernald Area Office, Cincinnati, Ohio, July.

7. DOE (U.S. Department of Energy), 2012. *Fernald Preserve Comprehensive Legacy Management and Institutional Controls Plan*, LMS/FER/S03496-5.0, Fernald Area Office, Cincinnati, Ohio, January.

8. Mack, John J., 2007. *Integrated Wetland Assessment Program, Part 9: Field Manual for the Vegetation Index of Biotic Integrity for Wetlands v. 1.4*, Ohio EPA Technical Report WET/2007-6, Ohio Environmental Protection Agency, Wetland Ecology Group, Division of Surface Water, Columbus, Ohio.