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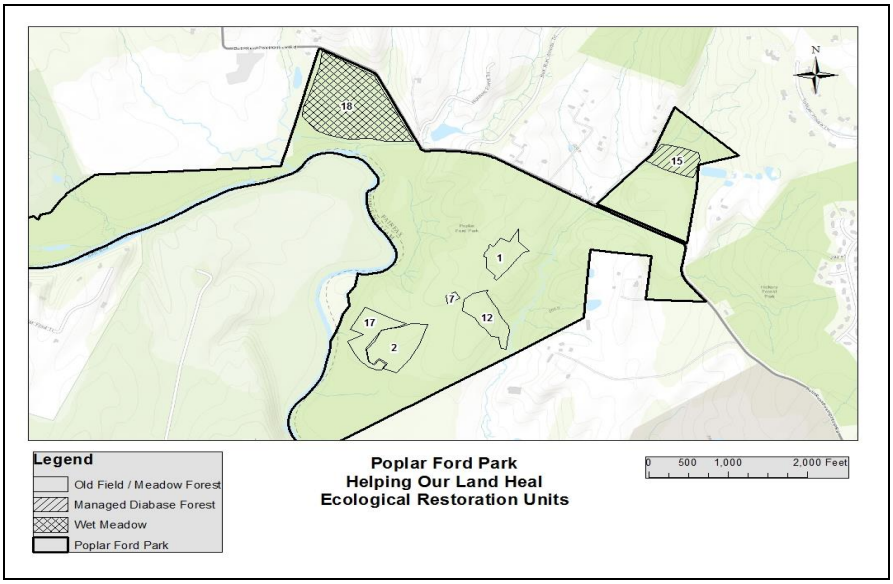
Final Progress Report

Poplar Ford Park Ecological Restoration

Overview

A Helping Our Land Heal (HOLH) project was implemented at Poplar Ford Park (PF) from 2014 to 2018 with the goal of controlling non-native invasive plants (NNI), especially *Eleagnus umbellata* (Autumn Olive). Fairfax County Park Authority (FCPA)'s Natural Resource Branch (NRB) managed the project as part of the agency's ecological restoration program. The project was in compliance with the Sully Woodlands Regional Master Plan and the Poplar Ford Conceptual Development Plan (CDP). The project contributed to achieving actions 16 through 19 in the FCPA natural resource management plan (NRMP). The objectives of the planned restoration were to create native plant dominated ecological communities in treatment areas that were located in the Resource Protection Zones (RPZs) identified in the PF CDP. Planned treatment would cover 24 acres of "old field/meadow forest," 5 acres of "managed diabase forest," and 25 acres of "wet meadow," totaling 54 acres. At the project's end, 70 acres had received treatment of which 44 were grassland, 25 were "wet meadow" and 1 was "managed diabase forest."



Planned treatment units 2016

Timeframe

A methods test was implemented in March, 2014 as a preliminary step and prior to creation of a comprehensive restoration plan. It began as an effort to control autumn olive stands that were rapidly replacing all other vegetation in multiple parts of the park. A complete scoping took place in the fall of 2015 and a plan was created that identified management units. Funding was secured from the Park Authority Board of supervisors (PAB) in March 2016 and implementation began. Work was completed in June of 2018.

Defining the Problem

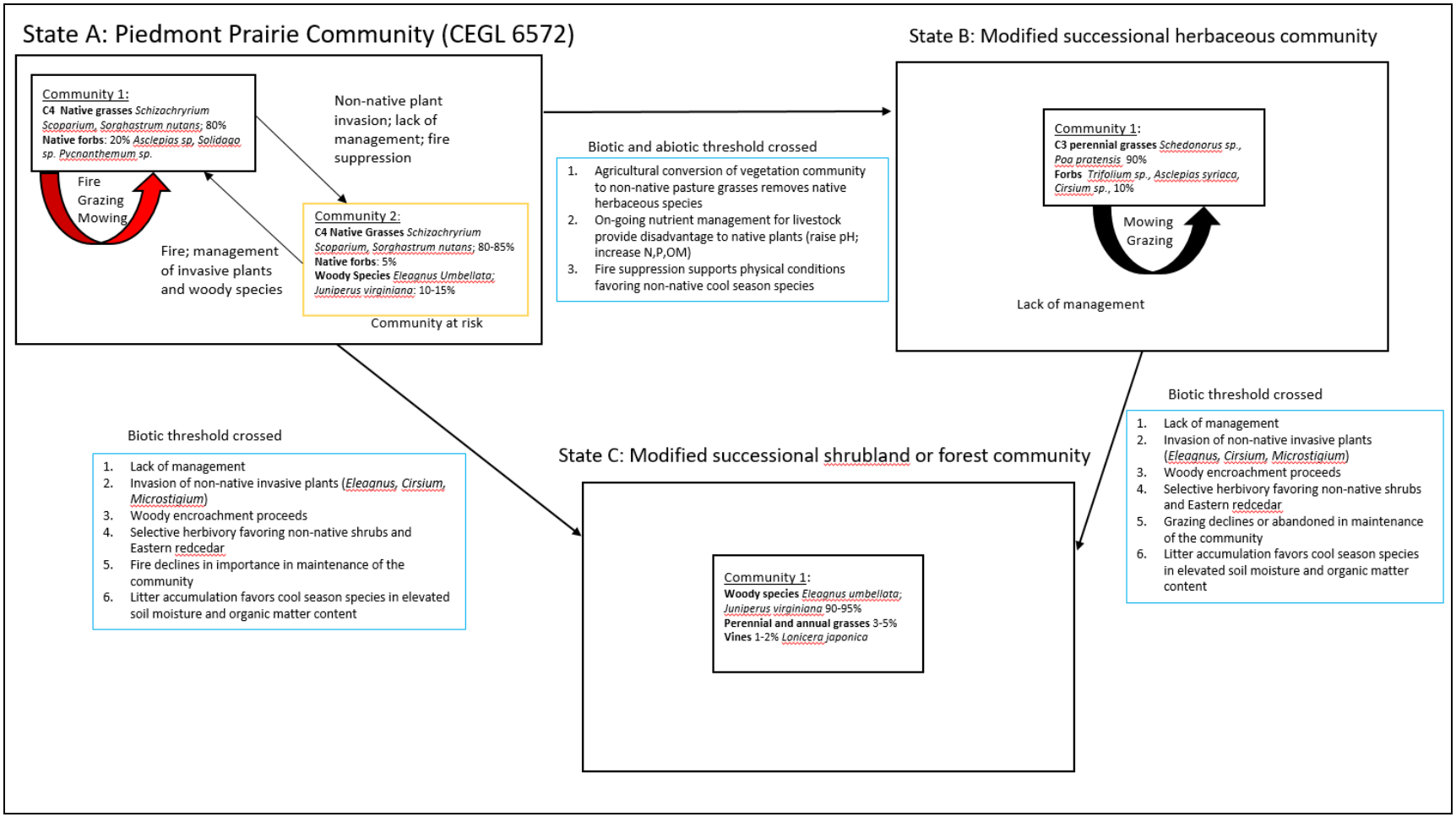
Woody plant encroachment characterized the primary problem on the restoration site prior to treatments. A lack of management allowed non-native invasive plants and single or dual woody species dominated stands to succeed herbaceous communities. Historical aerial photography show that the park used to contain many acres of herbaceous vegetation, presumably pastures. Around the late 1990's the aerial photography begins to show the presence of young coniferous trees. This change in vegetation management allowed stands of autumn olive and eastern red cedar to grow up in dense stands. As of the project commencement in 2016, only 3 isolated fields persisted as herbaceous dominant communities. Most management units had succeeded to a successional modified terrestrial vegetation community dominated by eastern red cedar and autumn olive that had passed the threshold of shrub to tree strata in height and stature.

The Society for Ecological Restoration (SER) developed a recovery scale to characterize the results of ecological restoration projects in their publication, International Standards for the Practice of Ecological Restoration (2016). The scale measures 6 key attributes relative to a set of reference community conditions. The HOLH project manager characterized the pre-treatment problems at Poplar Ford using this scale:

- Absence of Threats: Non-native invasive (NNI) plants dominated many communities and were co-dominant in others.
- Physical conditions: Soil pH was elevated above reference community levels.
- Species composition: Presence of non-native species was variable between vegetation stands but was above 60% in all stands and in some stands as high as 100% in all strata.
- Structural diversity: Shrub dominated stands had a single strata. Herbaceous dominated stands generally also contained scattered sycamore and cedar trees in addition to a developing autumn olive presence. Shrub dominated stands were crossing the threshold to tree sized strata where cedar was dominant.

- Ecosystem functionality: Nutrient cycling would be accelerated by dominance of NNI and lack of management allowed retention of herbaceous litter. The first disturbances involved in the project demonstrated that the site produced non-native species and limited recruitment of very aggressive native plants such as Eupatorium serotinum and Cirsium discolor. Regeneration was limited to very low diversity and showed rapid return to dominance by autumn olive shrubs.
- External exchanges: Herbaceous communities were isolated and relatively small and shrinking with woody plant encroachment. Little transfer of plant or animal genetic material was likely to occur given isolation and small size.

The State and Transition Model below was developed as part of the HOLH project at Poplar Ford to describe the relationships between ecosystem states occurring in plant communities at the park. The model is based on methodology used in the Natural Resources Conservation Service (NRCS) Ecological Site Information System (ESIS) to create Ecological Site Descriptions (ESDs). ESDs identify ecological potential and ecosystem dynamics in an ecological site. More information is available about ESDs at the NRCS website: https://esis.sc.egov.usda.gov/Default.aspx


State A: Piedmont Prairie Community (CEGL 6572)
Community 1:
C4 Native grasses Schizachryrium Scoparium, Sorghastrum nutans; 80%
Native forbs: 20% Asclepias sp, Solidago sp. Pycnanthemum sp.
Fire
Grazing
Mowing
Non-native plant invasion; lack of management; fire suppression
Fire; management of invasive plants and woody species
Community 2:
C4 Native Grasses Schizachryrium Scoparium, Sorghastrum nutans; 80-85%
Native forbs: 5%
Woody Species Eleagnus Umbellata; Juniperus virginiana: 10-15%
Community at risk
Biotic and abiotic threshold crossed
1. Agricultural conversion of vegetation community to non-native pasture grasses removes native herbaceous species
2. On-going nutrient management for livestock provide disadvantage to native plants (raise pH; increase N,P,OM)
3. Fire suppression supports physical conditions favoring non-native cool season species
State B: Modified successional herbaceous community
Community 1:
C3 perennial grasses Schedonorus sp., Poa pratensis 90%
Forbs Trifolium sp., Asclepias syriaca, Cirsium sp., 10%
Mowing
Grazing
Lack of management
Biotic threshold crossed
1. Lack of management
2. Invasion of non-native invasive plants (Eleagnus, Cirsium, Microstigium)
3. Woody encroachment proceeds
4. Selective herbivory favoring non-native shrubs and Eastern redcedar
5. Grazing declines or abandoned in maintenance of the community
6. Litter accumulation favors cool season species in elevated soil moisture and organic matter content
Biotic threshold crossed
1. Lack of management
2. Invasion of non-native invasive plants (Eleagnus, Cirsium, Microstigium)
3. Woody encroachment proceeds
4. Selective herbivory favoring non-native shrubs and Eastern redcedar
5. Fire declines in importance in maintenance of the community
6. Litter accumulation favors cool season species in elevated soil moisture and organic matter content
State C: Modified successional shrubland or forest community
Community 1:
Woody species Eleagnus umbellata; Juniperus virginiana 90-95%
Perennial and annual grasses 3-5%
Vines 1-2% Lonicera japonica

Planning and Design

The original goal of the project was to control autumn olive encroachment on native vegetation communities. Project funding was originally intended to cover treatment of autumn olive in "Old field meadow/forest" RPZ areas in management units 1; 7; 12 in the map above of planned treatment units (2016). These units received a treatment to mechanically remove autumn olive in 2014.

In 2015, the restoration needs of the park were re-scoped, management units were designated and funding was secured for treatment of units 1; 2; 7; 12; 15; and 18. Management unit 15 is part of the RPZ area labeled "managed diabase forest" in the park's CDP, and management unit 18 is the RPZ area labeled "wet meadow." The goals remained the same, to control autumn olive and promote native plants. Implementation costs came in under budget and the surplus was re-invested in the project, treating management units to a greater degree and beginning treatments in new stands. Additional treatments were implemented in units 1; 2; 7; 12; 15; 16; 17; 22; 24; and 34. At this stage, management units were re-scoped for more specific goals.

The new target was to restore suitable management units to grassland herbaceous communities. The piedmont prairie (CEGL06572) was identified as an appropriate reference community and reference plots were visited at Manassas National Battlefield, about 2.5 miles from the restoration site as the crow flies. Observations were made at the reference site and data was reviewed from the Virginia Department of Conservation (DCR) and Recreation's Natural Heritage Program's community classification system.

Additionally, for management unit 15, the northern hardpan basic oak-hickory community (CEGL006216) was chosen as a restoration target. The soils mapped in this unit were suitable to support this community and example reference communities were well documented at the Elklick Natural Area Preserve less than 3 miles away by DCR.

Project Activities

Project activities that were implemented in the field can be generally categorized as removal; site preparation; soil amendment; planting; and establishment activities. Specific activities are as follows:

<u>Removal:</u>

1. Herbicide applications – Foliar applications were made to herbaceous and short/low woody vegetation. Stem applications were made to cut stumps or to

girdle cuts ("hack and squirt") for larger plants that could not be safely or effectively treated with foliar applications.

2. Mechanical treatments – Forestry cutting / mulching – Standing or downed woody stems were masticated and shredded in to small pieces of woody debris that ranged in size from 3''- 8'' long and 0.5'' to 4'' wide and larger. Equipment is available in a variety of sizes for handling a range of tree diameters up to 18". This treatment was useful because material hauling off site was not desired, however, it left a layer of woody debris that can be 1'' to 12'' thick or more and through which only the most aggressive species will grow, usually NNI.

Site Preparation:

1. Forestry tilling – Effectively addresses woody debris left after forestry cutting treatments and foregoes the need to haul the material offsite. Equipment is not widely available. Requires tolerance for significant ground disturbance.
2. Plowing and disking – Partially addresses woody debris but difficult to achieve incorporation of woody debris into the soil, creates uneven surfaces, stresses equipment, creates difficulty for mowing.
3. Mowing and raking – Suitable preparation for overseeding treatments in existing stands of herbaceous vegetation. Raking was used because of undecomposed woody debris but is not always necessary. This would not be sufficient site preparation for seed drilling over a fresh bed of woody debris.
4. Prescribed fire – Excellent for clearing excess residue, litter, and preparation for seed drilling. Not reliable for removing woody debris except with repeated burns conducted several years in a row. This method would be suitable for overseeding treatments.

Soil amendment:

1. Sulfur application – Based on pH measurements of the soil and reference community conditions, elemental sulfur was applied in selected management units to lower the soil pH. Sulfur was spread using a tractor drawn broadcast spreader.

Planting:

1. Hand broadcasting – seeding by hand, covered extensively in the restoration literature.
2. Overseeding – No-till seed drill application on an existing stand of herbaceous vegetation. Requires preparation of the site to remove woody stems and NNI for best results. This method is best for enhancing diversity, especially forbs, but may require site preparation to control highly aggressive or dominant species.
3. Broadcasting and cultipacking – Mechanical seeding with tractor drawn broadcaster and cultipacker to press the seed into the soil for better germination. This was effective after forestry tilling treatments.

Establishment:

1. Mowing – During the first season of growth of seedlings, vegetation that reached 12'' tall was mowed to 6'' tall as many times as necessary until September 15. This allowed light and space for slow growing perennial seedlings to establish despite competition from fast growing annuals and aggressive perennials.
2. Herbicide – Spot foliar applications to aggressive NNI in establishing stands of seedlings.

The table below details restoration activities used in sequence in management units.

	Activity			
Unit	**Removal**	**Site preparation**	**Planting**	**Establishment**
1	Forestry cutting - Apr 2014 Herbicide - 2014-2017	Mowing and raking June 2017	Overseeding w/no-till seed drill July 2017	High mowing and herbicide July - Sept 2017
2	Forestry cutting Apr 2016	Plow and disk May 2016	Hand broadcast May 2016	High mowing and herbicide July - Sept 2016
17	Herbicide - Apr 2016, Oct 2016, and Apr 2017	Prescribed fire - Feb 2017 Mowing - June 2017	Overseeding w/no-till seed drill July 2017	High mowing and herbicide July - Sept 2017
24	Forestry cutting Feb 2017	Forestry tiller June 2017	Broadcast and cultipacked July 2017	None needed

Project Outcomes

Upon completion, the project treated a total of 70 acres: 44 acres of grassland, 1 acre of forest and 25 acres of "wet meadow" RPZ.

The project manager has evaluated the restoration work according the SER recovery scale. The project scored overall 2.8 out of 5. This indicates that significant improvements have been made and that continued change and maintenance will be required to move the system closer to reference community conditions.

- Absence of threats: **
    - Contamination: N/A
    - Over-utilization: N/A
    - Invasive species: Threats from adjacent areas beginning to be managed or mitigated. Nearby seed sources will continue to pose problems but intensive restoration measures have drastically reduced onsite NNI presence and dominance. Some stands were not managed because of a lack of planning designations in the park's CDP.
- Physical conditions: **
    - Water chemo-physical: N/A
    - Substrate physical: N/A
    - Substrate chemical: Substrate chemical properties (especially pH) is on track to stabilize within natural range. pH has been addressed in four treatment units using sulfur amendments to the soil. pH in some units has reached similar levels to reference communities, near pH of 4. Other treatment units are continuing to stabilize.
- Species composition: ***
    - Desirable plants: A subset of key native species (about 25% of reference) are establishing over substantial proportions of the site in treatment areas. However, there is still an onsite threat from undesirable species and continued management and maintenance is required.
    - Desirable animals: *Ammodramus savannarum* (Grasshopper Sparrow) was observed as a probable breeding adult (S7) in April 2018 through July 2018 in the largest grassland restoration unit. This is the first documented observation of this species in the park and represents a new native animal species. A subset of other key species are also present in 2018 including *Dendroica discolor* (Prairie warbler), *Spizella pusilla* (Field sparrow), *Circus hudsonius* (Northern Harrier) and in 2016 a *Sturnella magna* (Eastern Meadowlark).
    - No undesirable species: The threat of undesirable species onsite has been greatly reduced but unmanaged stands will continue to act as seed sources.
- Structural diversity: ****
    - All vegetation levels: All strata present in herbaceous communities and spatial patterning evident. Trophic complexity developing relative to the reference ecosystem.
    - All trophic levels: All strata present in producers and consumers.
    - Spatial mosaic: The grassland emphasis of poplar ford's restoration work increases structural diversity on the county level in which most natural areas consist of edge and forest habitat structures. There is relatively very little grassland habitat in the county. On a park scale, vegetation stands represent a variety of ages and intervals between disturbances.
- Ecosystem functionality: ***

    - Productivity/cycling: Evidence of functions commencing in nutrient cycling in the slowing of invasive plant growth and recolonization of native plants with high levels of productivity.
    - Habitat & interactions: Evidence of provision of habitat for avian wildlife species listed on the Virginia Wildlife Action Plan and likelihood of reproduction onsite. Habitat provision and substantial evidence of reproduction of state rare (S2) plant, *Asclepias purpurescens* (Purple Milkweed) in management units 15 and 17.
    - Resilience/recruitment: Evidence of recruitment of a range of species following fire and mowing treatments. However, fire appears to stimulate increased presence of non-native species that require management in some stands.
- External exchanges: ***
    - Habitat links: Connectivity is likely increasing with nearby Manassas National Battlefield, utility easements and Elklick Preserve meadows.
    - Gene flows: Connectivity increasing.
    - Landcape flows: Exchanges becoming evident with immigration of breeding Grasshopper Sparrow.

Lessons Learned

Many methods were tried as a part of this project involving many different activities. The results of these activities are captured in the following lessons learned:

1. <u>The seedbank was unreliable</u>: The first treatments involved mechanical removal of autumn olive with a forestry mulching machine followed by several applications of herbicide to re-sprouts and other aggressive herbaceous NNIs that followed the removal. After 2 years, the stands showed progress in structural diversity regarding woody to herbaceous proportions, but NNIs dominated the plant community (*Setaria faberii, Cirsium sp., Schedonorus sp., Microstigium vimineum,* etc.). Autumn olive persisted at reduced levels but demonstrated the ability to return rapidly without intensive management.

   The only native perennial plant that established from the seed bank in treatment areas was *Eupatorium serotinum*, a tall, aggressive plant that also outcompetes many native plants. *Circium discolor* also expressed strongly and out competed other species. It became clear that reliance on the seedbank of native plants would not produce desirable composition and that more aggressive intervention was required.

Management Unit 17 – Fall 2016: *Setaria sp.* and *Eupatorium serotinum* dominance following herbicide applications to *Schedonorus sp.*

2. Artificial regeneration (seeding) provided best results: Treatments were most successful where native plant seed was purchased and installed. Species were chosen based on reference community data and distribution followed approximate proportions in plot data, modified for commercial availability and ease of propagation from seed in the wild. Trials assisted in developing a list of species that are known to be reliable in the restoration context. The closest possible ecotypes to Northern Virginia were purchased. Local seed was largely unavailable and could not approach the quantities required for many acres.

3. Managed competition is essential during establishment of seedlings: Fast growing plants required control to allow light and space for slower growing perennial natives. Fast growing plants included both native and NNI annual and perennial species. Mowing was used to cut taller vegetation to 6 inches whenever it reached 12 inches and herbicide was used in spot applications to any especially aggressive species or where uniform monocultures formed at the ground surface, preventing germination. Mowing was done 5 times during the first growing season, ceasing in early September.

4. Woody debris required processing for herbaceous restorations: Mechanical treatments in April of 2014 left woody debris from mechanical treatments on the ground. By April of 2016, they were approximately 50% decomposed but remained present until 2017, after which they were reasonably well mixed with soil, about 75% decomposed.

Woody debris presented a variety of problems:

- It retained high amounts of moisture at the ground surface and created difficulty in ignition of prescribed fires.
- It prevented planting or seeding native plants because it formed a layer thick enough to cause failure of direct hand broadcast seeding; refused plowing, tilling or disking with traditional agricultural equipment to create a seed bed; and contained a volume of material that was too high to economically gather and remove from the site.
- It decomposed too slowly for the 3 year project cycle to wait and seed afterwards
- It improved soil moisture conditions for germination and growth of NNI weeds, especially cool season species.

Plowing provided limited success at creating a receptive seed bed but stressed equipment and broke plowing implements multiple times. Plowing was time consuming, messy and difficult to scale up for a project area greater than 5 acres. It provided approximately 50% bare soil for seeding but created an uneven surface that could not be smoothed without covering up bare soil and counteracting plowing efforts.

A recommendation was made to use the forestry mulching machine to mix the woody debris into the soil. This was not effective and was a strain on the equipment.

Forestry grade tilling equipment effectively incorporated woody debris into the soil sufficient for seeding to take place. A contractor used a FAE brand forestry tiller operated by a 75 horsepower tractor and tilled debris and stumps. These machines are scarce in the Northern Virginia area and a single contractor had one available.

Management Unit 24 – Summer 2017: FAE forestry tiller incorporating woody debris

5. Soil pH: Soil pH was measured using a hand-held field probe. The pH levels averaged 6.05 in project areas and ranged from 5.3 to 6.8. Reference community pH levels averaged 5.2 and ranged from 4.8-5.9 based on data from Virginia Department of Conservation and Recreation's Natural Heritage Program. In addition, many forest communities routinely measure pHs in the 3.6 to 4.0 range. To address this discrepancy, elemental sulfur amendments were applied to lower the soil pH. It was hypothesized that this would restore ecosystem function and physical conditions in the soil. Nutrient cycling would slow and availability would decrease at lower pH levels, favoring slower growing, long-lived, competitive perennials instead of faster growing NNI species and annuals.

   The first application was made in management unit 2 in April of 2016 with a target of pH 4.5. The unit's pH levels averaged 3.5 in May of 2017, lower than intended, and measured an average of 3.5 again in January of 2018. In May of 2017, the second growing season for the seedlings, the foliage of plants showed yellowing, suggesting the possibility of N deficiency. No signs of yellowing were observed in the first growing season in 2016. Plant foliage appeared to return to normal colors as the growing season in 2016 progressed and for following growing seasons, perhaps because perennial roots had reached down below soil layers with N deficiencies.

Management Unit 2 – May 2017: Yellow foliage suggests nitrogen deficiency in the second season of growth. Discoloration returned to normal by the end of the season

In addition, there was a notable lack of growth of *Microstigium vimineum* in the growing season of 2016 and 2017, suggesting the possibility that soil conditions impacted germination or establishment of that and other plants. It was further hypothesized that annual NNI species would suffer the most because of their preference for rapid nutrient uptake whereas long-lived perennial native plants could eke out small amounts of N from sources that were more difficult to process such as organic forms of Nitrogen.

Additional trials are needed: Sulfur amendment test plots of 1000 ft^2 each targeted pHs of 3.5, 4.0 and 4.5 and these did not duplicate the results of unit 2. Additional sulfur amendments have been made in management unit 22, 24 and 34. Unit 22 received the amendment in June of 2017 and was tilled after sulfur was applied. Little change was observed in pH as of May 2018 and the tilling may have affected results at the surface by burying sulfur pellets and diffusing their impacts.

Based on results from this project, it is thought that pH stabilizes about 12 months after a sulfur amendment.

6. No-till seed drilling "overseeding" results: A no-till seed drill was used to apply a mix of native seed to management unit 17 and management unit 1 in early July of 2017. The mixes contained warm and cool season grasses and forbs.

   Site preparation in unit 17 included herbicide treatment of *Schedonorus sp.*, autumn olive, and a variety of other NNI. *Setaria faberii, Setaria italic, Setaria pumila* and NNI *Cirsium sp.* had established a strong presence on the site following the herbicide treatment. The site was burned in January of 2017 and mowed low in June prior to overseeding. The site was mowed to 4-6'' multiple times after seeding to prevent fast growing weeds from outcompeting seedlings. Relatively few native seedlings were observed in the first growing season and it was thought to be a failure. However, the 2018 growing season revealed that many species had successfully established and were competing with existing vegetation. Successful grass species included *Elymus virginicus* and *Dicanthelium clandestinum* comprising 5% and 9% of the seed mix. There was no sign of warm season grass species, especially *Schizachrium scoparium*, which comprised 40% of the seed mix. Forb species observed from the seed mix included *Asclepias tuberosa, Liatris spicata, Monarda fistulosa, Pycnanthemum tenuifolium, Symphyotrichum novae-angliae, and Verbena hastata.* As of this writing in July 2018, it is possible that later blooming plants are present but have not yet been observed. Based on these results however, cool season native grasses and forbs appear to be successful in overseeding.

Management unit 1 is the same area in which autumn olive was mulched in the original mechanical treatment in 2014. This area had been treated with herbicide for the 3 years following mulching and was dominated by *Setaria sp.* and *Eupatorium serotinum* at the time of overseeding in early July 2017. The site was not burned. Instead it was mowed low and then residue and any remaining woody debris was raked off with a York rake. After seeding this unit received the same mowing regimen as unit 17. The results in the first year appeared to be similarly poor as in unit 17 but in the growing season of 2018, *Schedonorus sp,* previously not present to any significant degree in this unit, had established itself as the dominant species and there was a very minor presence of *Elymus virginicus* and *Monarda fistulosa.* This seeding treatment was deemed a failure and was treated with tilling and reseeding in June 2018.

7. Best success was achieved with aggressive treatment: Management unit 22 and 24 received the most aggressive set of treatments and showed the best results at the end of the project cycle. The unit was a thick stand of *Juniperus virginiana* and autumn olive that had excluded nearly every other species except for a minor presence of *Microstigium vimineum, Lonicera japonica* and an occasional *Prunus serotina, Platanus occidentalis*. The 12 acre stand was mulched in the winter of 2016-2017, tilled with the forestry tiller and seeded in July 2017. Seeding was done with a broadcast spreader onto the tilled soil surface which provided easy seed to soil contact.

   During the first growing season, plants did not achieve a height, nor a density that required any mowing. All species appeared to be very slow growing. It was clear that *Schizachryum scoparium* was a strong presence by the end of the growing season. Frost action over the winter may have reduced *S. scoparium* establishment because of unconsolidated soil and woody debris. The unit also did not require significant herbicide applications. A small application was made to a very small amount of autumn olive sprouts.

   In 2018, a wide variety of plants established that had been seeded as well as many that were volunteers. Strong presence of seeded species include *Schizachryum scoparium, Elymus virginicus, Dicanthelium clandestinum, Sorghastrum nutans,* and *Asclepias syriaca, Conoclinium coelestinum, Monarda fistulosa, Pycnanthemum tenuifolium, Rudbeckia fulgida, Solidago sp., Silphium trifoliatum.* Our expectations for the seedbank in this unit were exceeded and many volunteer species expressed, including *Dichanthelium sp., Desmodium sp., Erigeron strigosus, Oenothera sp., Rudbeckia hirta, Solidago sp., Sabatia angularis, Verbena hastata* and many graminoids including a variety of more than 4 *Carex* species, *Scirpus georgiana, Juncus tenuis, Juncus effusus* and *Eleocharis sp..* NNI species present were largely insignificant and included small amounts of *Lespedeza sp.,*

Microstigium vimineum, Schedonorus sp., Verbascum thapsus, and Brassicaceae species.

8. Forest planting failure: A one acre planting was installed in management unit 15, where soils were suitable for restoration of a northern hardpan basic oak hickory forest community. The site was cleared with the forestry mulcher, seeded with native species, allowed to establish and then planted with bare root stock in November of 2016. The planting failed and suffered nearly 100% mortality by June of 2017. The contractor felt that his firm had been at fault and replanted the site in November of 2017. The planting failed again and the cause for failure is unclear. The plantings were protected with tree shelters from herbivory and the site was protected from deer with a 8' tall fence. This problem requires further investigation but it is thought that extreme soil moisture variation may have contributed to tree mortality in heavy clay soils, with shallow bed rock. It is also possible that herbicide drift applied around plantings to reduce vegetative competition may have impacted survival despite tree tube shielding of foliage.

Long-Term Management

The restored systems will require on-going management to control woody species and NNI. NNI pressure on these systems is extremely high from neighboring properties and even within the park in unrestored areas. It is recommended that management take place every 2-3 years at a minimum and an ecologist monitoring visit occur every 5 years at a minimum.

Primary management methods will be prescribed fire, mowing and herbicide spot applications. Each grassland unit will require close monitoring to determine the pressure from woody encroachment but it is recommended that each unit receive either a mowing treatment every 2 years or a burning treatment every 3 years at the longest. Waiting longer than 3 years may allow woody species to grow large enough to resist mowing and fire, causing the process of woody succession to begin. Herbicide spot applications will likely be needed every year or 2 for several years, until systems have been established for a longer period of time, at which point it may be possible to lengthen the herbicide application interval.

Late dormant season burning appears to have the best results because it favors warm season plants and discourages cool season plants and annuals. Mowing is recommended to take place in May to discourage cool season NNI grasses and other species, while favoring warm season perennials.

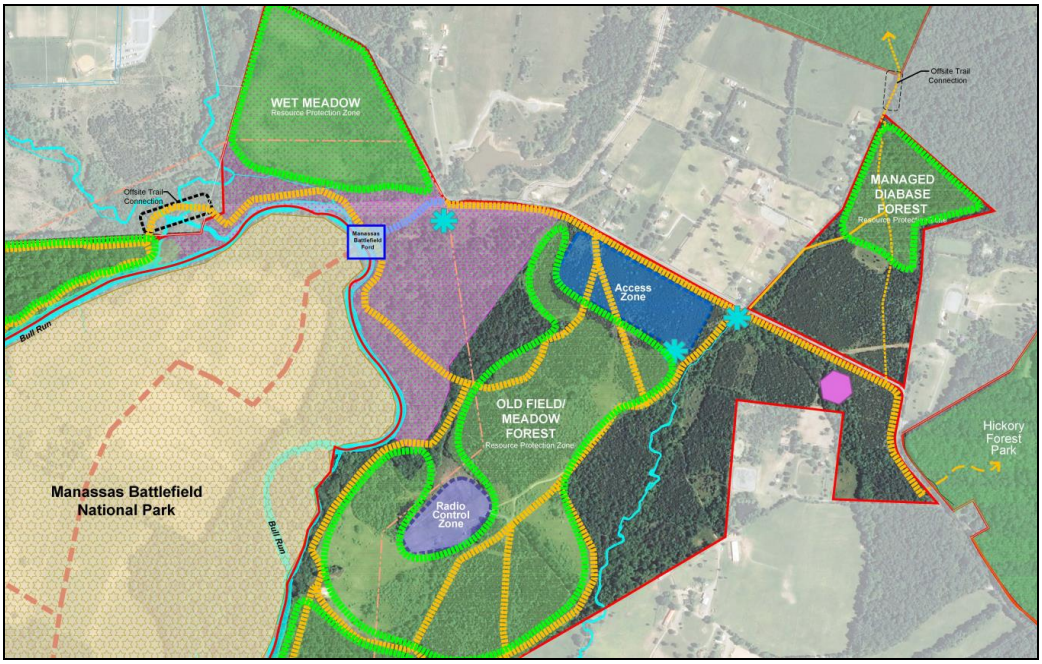
It is recommended that each restored grassland unit be allowed to establish for a minimum of 2 growing seasons and preferably 3 seasons, before burning if it has been seeded.

Funding

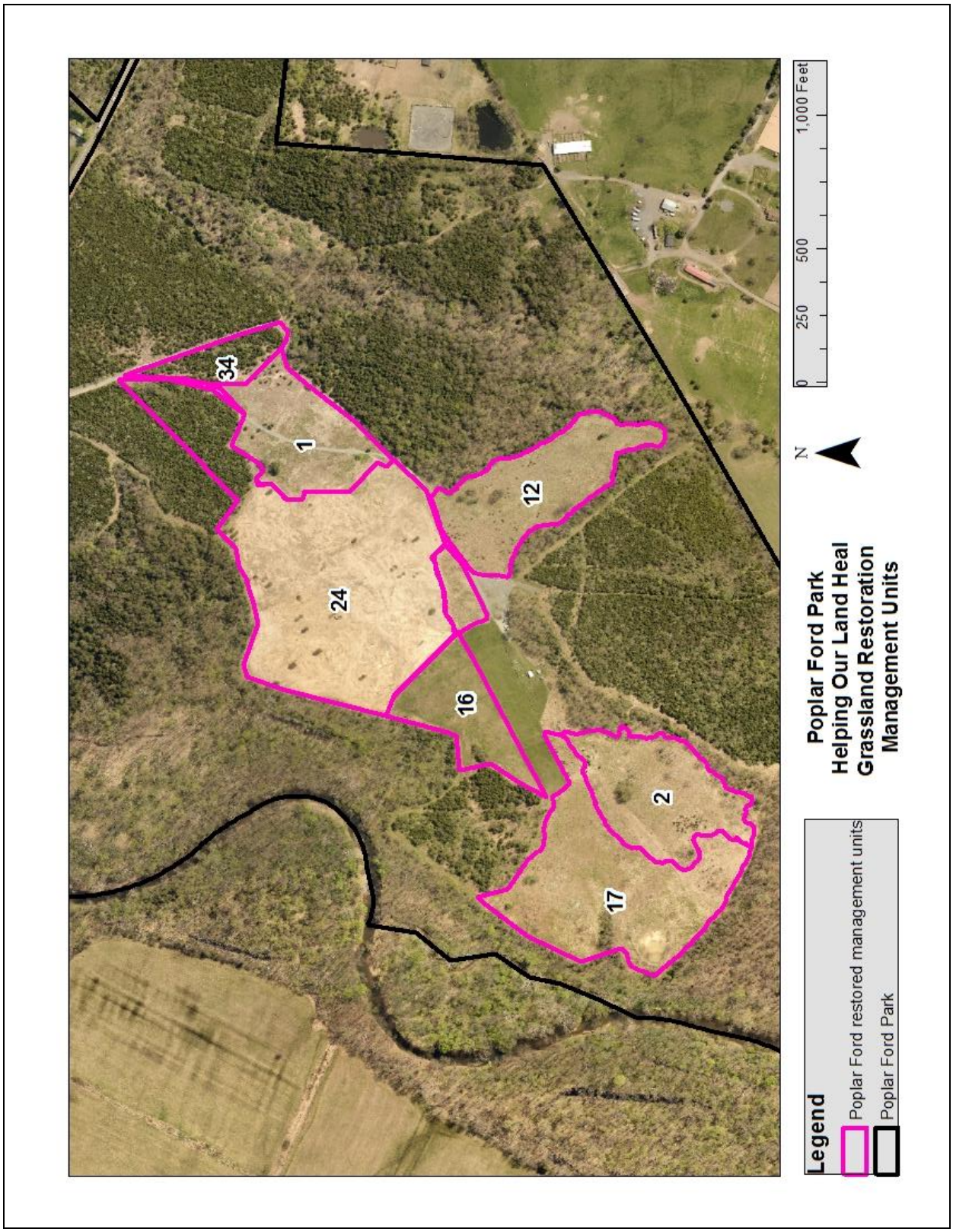
The project was paid for with capital funding from a taxpayer bond purchased in 2008.

Project Maps

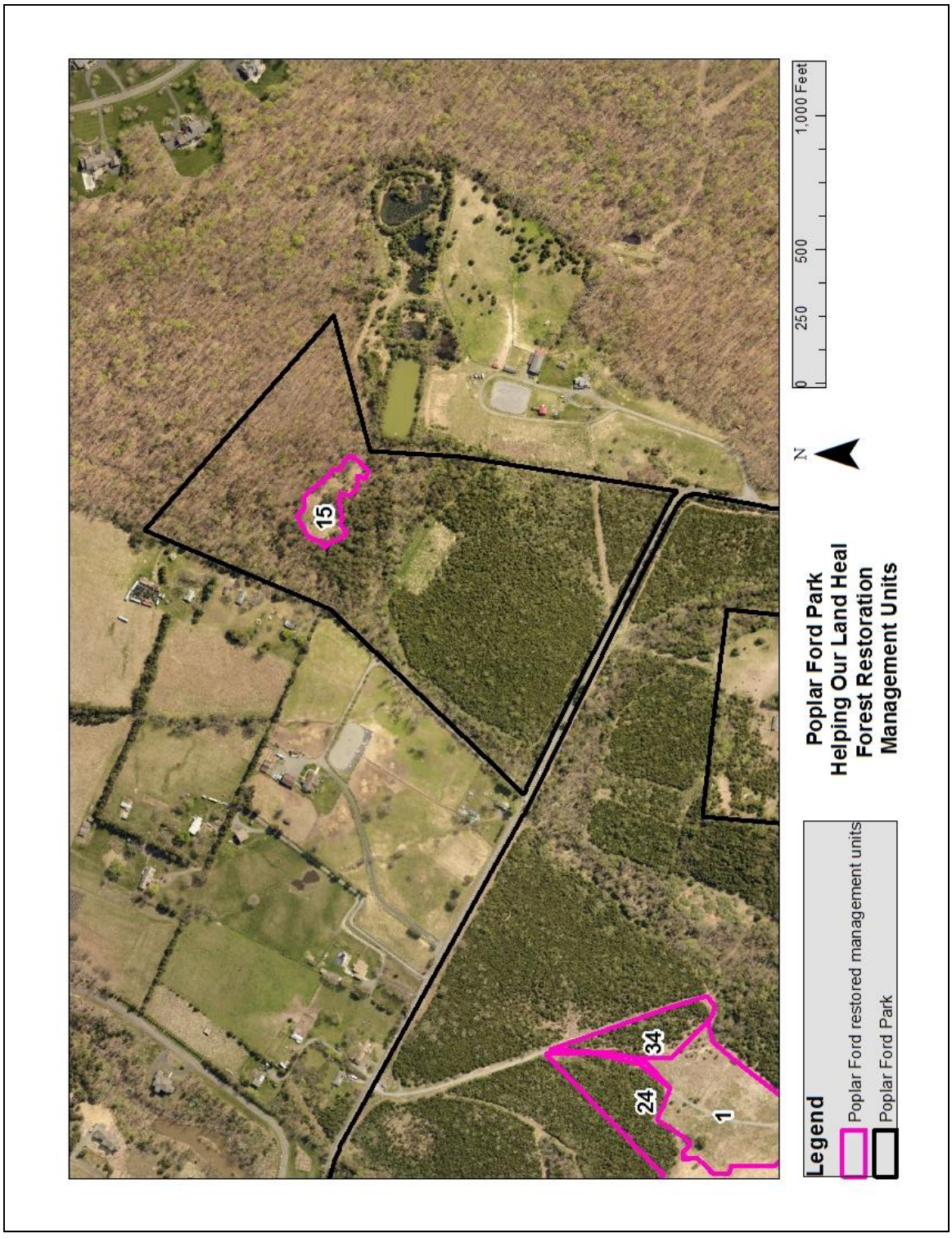
Conceptual Development Plan for Poplar Ford Park:
Resource Protection Zones treated include "Old Field/Meadow Forest," "Managed Diabase Forest," and "Wet Meadow."



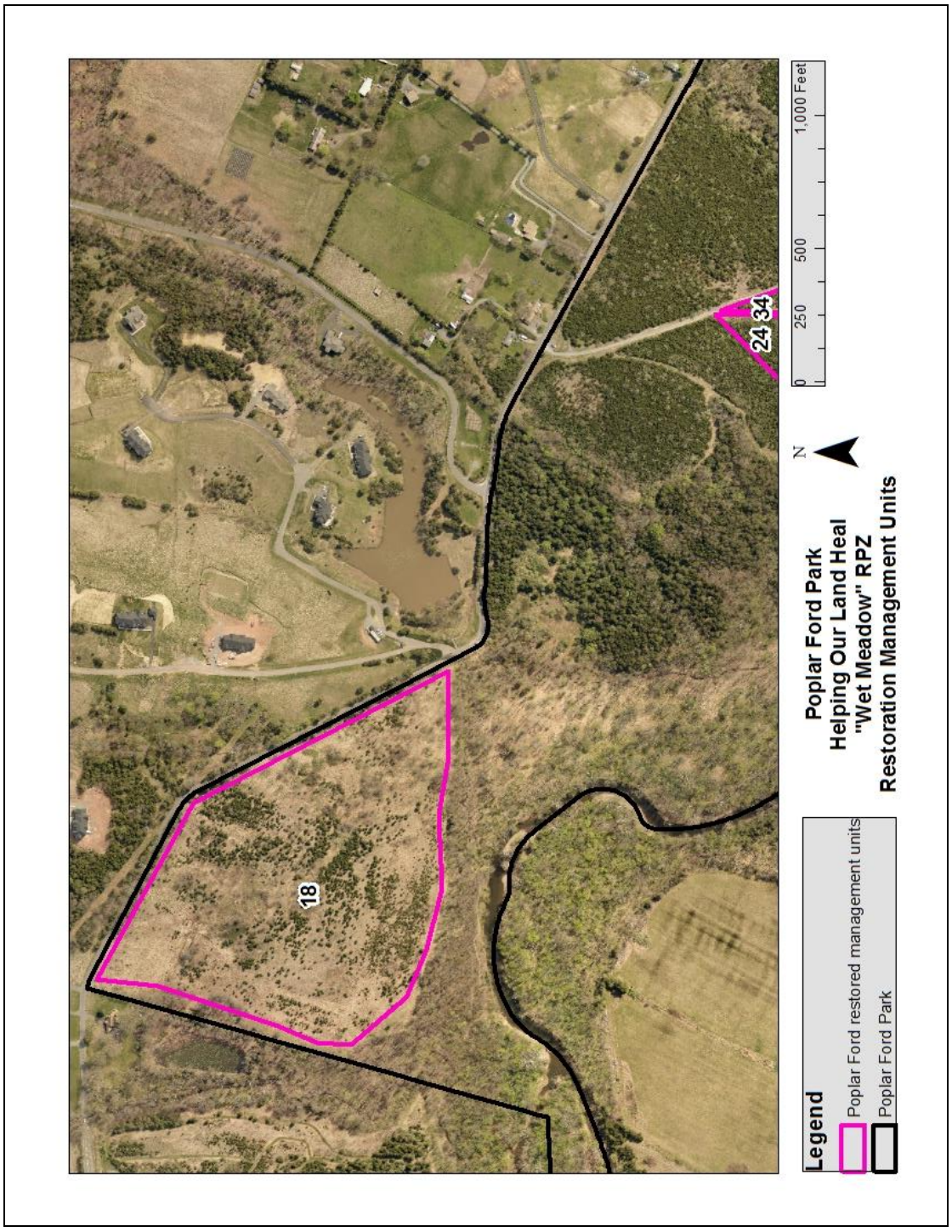
Grassland restoration in management units 1,2,7,12,16,17,24,34: (aerial photo 2017)



Forest restoration in management unit 15: (aerial photo 2017)



Wet Meadow RPZ restoration in management unit 18: (aerial photo 2017)



Management Unit 2 (2015) – Autumn olive monoculture

Management unit 2 (2016) – Autumn olive removal via forestry mulching

Management Unit 2 (2018) – Native grass dominated community

Management Unit 1 (2015) – Cedar and autumn olive dominated "old field"

Management Unit 1, 24 (2015) – Cedar and autumn olive dominated "old field"

Management Unit 24 (2017) – A layer of woody debris after forestry cutting treatment

Management Unit 24 (2017) – Incorporating woody debris with a forestry tiller

Management Unit 24 (2018) – Restored grassland community

Management unit 15 (2015) – "Managed Diabase Forest" pre-treatment

Management unit 15 (2018) –Bare root plantings and native herbaceous cover

Management unit 17 (2016) – Fescue (*Schedonorus sp.*) dominated field

Management unit 17 (2018) – Diversified native dominated herbaceous community