Hilltop Hanover Farm

Evaluating Hilltop Hanover Farm's Onsite Biodiversity and Native Seed Collection Capacity

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Objective:
Hilltop Hanover Farm (HHF) is looking to expand its Native Plant Program to better support restoration efforts and increase the native plant materials supply chain within Westchester County. There are currently 20 species growing in seed plots within the cultivated farming area alongside vegetables crops. Some of these plots are entering their fourth year of cultivation. Much of the founder stock has been provided by the Ecotype Project, a non-profit organization that supplies farms with wild collected seed from ecoregion 59, which includes Westchester County. By merging with the Westchester County Parks Department, HHF will be able to improve the support provided to county projects, develop targeted species lists, and supply plant materials for restoration plans

The region has been plagued by a series of far-reaching ecological problems from invasive species, introduced pests, and diseases. Some of the most critical threats are endangering our keystone tree species. Both adult beech trees and saplings have suffered high mortality rates since beech leaf disease arrived in 2020. Meanwhile, many large, mature ash trees have gone through the process of defoliating and dying over the past three years as a result of the invasive emerald ash borer. Hemlocks are also in decline due to hemlock wooly adelgid and elongate hemlock scale. Our forests

are going through seismic changes in soil and canopy structure due to disease, Asian jumping worms, invasive plants, and deer herbivory, along with the larger scale issues of development, climate change, and unpredictable weather patterns.

HHF is exploring ways to increase biodiversity on site and strengthen natural communities for seed collection and production. Enhancing natural plant communities for seed production is one way to avoid the genetic pitfalls that can occur in founder plots, such as inbreeding depression and domestication syndrome, where plants are unintentionally selected for shorter seed dormancies and faster germination (Shroder & Rudiger 2013). Founder plots can only produce seed for a limited number of years before they have to be removed to avoid phenotypic and genetic drift (Pedrini & Gibson 2020). Lastly, plant communities can be augmented for seed production by decreasing invasive species, periodically watering, and fertilizing when necessary. Truly wild populations need a 2-3 year gap between seed collections to preserve the community, but seeds from managed communities can be harvested on a yearly basis. (Seeds of Success Technical Protocol, Pedrini & Gibson 2020).

Background: History of Farm
In 2003, Westchester County purchased 187 acres of the 400-year old Hanover Farm to stem the tide of rapidly vanishing suburban farmland, protect the Croton watershed, and preserve homesteading history. Of the 187 acres, more than 130 acres are designated as County parkland; the remaining 53 acres remain a working farm. In 2010, HHF was incorporated as a 501(c)3 to help Westchester County achieve its vision for an agricultural and environmental resource center for residents and professionals, providing educational programming as well as access to green space. HHF is currently in the process of merging with the Westchester County Parks Department, in the Conservation division.

Methods:
Starting in September, field walks were taken throughout the uncultivated areas of the farm. Access to the westernmost sections of the property was a challenge due to a dense, 7ft tall stand of mugwort in the south field that extends into the riparian buffer. GPS points were taken of any site with more than five native species in one area. Plants were keyed in the field or collected to identify later. However, there was no systematic effort to collect voucher specimens. A few trips were also taken in the trails across the street.

Findings:
Due to the late start in the season, there are several gaps in the species list for many of the early flowering plants, particularly the cool season grasses, sedges, ferns, spring and early summer forbs, in addition to early flowering woody species such as willows, alders, serviceberries, crabapples, and hawthorns. The harsh summer weather was another factor that may have contributed to the poor species composition. Westchester experienced a significant drought and extensive heat waves between June and September. An oak stand at 700ft elevation across Croton Heights Road showed early leaf senescence in trees and a reduced understory.

The farm's natural plant communities are up against considerable weed pressure. HHF has many invasive species that are present in large numbers throughout the farm. Mugwort permeates nearly every region outside the crop farming area, but is particularly severe in the south field. This high density continues on the western side of the cultivated fields down a slope and surrounds the riparian buffer where trees planted by the Watershed Agricultural Council (WAC) are located. Very few native species are found in such dense patches of mugwort—only one or two individuals of the hardiest species occur every few meters.

Reed canary grass *(Phalaris arundinacea)* and other cool season grasses dominate open wet sites, while stilt grass *(Microstegium vimineum)* proliferates in moist shade. There are also several sizable stands of *Phragmities australis*. Invasive woody shrubs and vines on the farm include bittersweet *(Celastrus orbiculatus)*, porcelainberry *(Ampelopsis glandulosa)*, multiflora rose *(Rosa multiflora)*, Japanese barberry *(Berberis thunbergii)*, glossy buckthorn *(Frangula alnus)* and various bush honeysuckle species *(Diervilla spp.* and *Lonicera spp.)*. Invasive trees include tree of heaven *(Ailianthus altissima),* and gray willow *(Salix cinera)*.

The majority of Hilltop's plant communities can be classified as successional old field and shrubland. Ruderal species like Canada goldenrod *(Solidago canadensis),* rough goldenrod *(Solidago rugosa),* grass-leaved goldenrod *(Euthamia graminifolia),* common blackberry *(Rubus alleghenensis),* and panicled aster *(Symphyotrichum lanceolatum)* occur in the highest numbers. The more intact sites are located in the wettest sites and seasonally flooded parts of the farm, particularly in the lower southwestern meadow and near the intermittent stream. Common species here are soft rush *(Juncus effusus),* fox sedge, *(Carex vulpinoidea),* sallow sedge *(Carex lurida),* sensitive fern *(Onoclea sensibilis),* cinnamon willow-herb *(Epilobium coloratum)*, grass-leaved goldenrod, along with an assortment of wetland asters like panicled aster, smooth white oldfield aster *(Symphyotrichum racemosum),* and swamp aster *(Symphyotrichum puniceum).* Of note is swamp agrimony *(Agrimonia parviflora)*, an S4 species that reaches the northern edge of its range in New York state. Other wetland species that occur in smaller numbers are woolsedge *(Scirpus cyperinus),* fowl manna grass *(Glyceria striata),* spotted joe-pye weed *(Eutrochium maculatum),* and common boneset *(Eupatorium perfoliatum).*

Following the farm trail on the western edge of the property is a short strip of native grasses and forbs such as little bluestem *(Schizachyrium scoparium),* broomsedge bluestem *(Andropogon virginicus),* hemp dogbane *(Apocynum cannibinum)*, spreading dogbane *(Apocynum androsaemifolium)*, and rabbit tobacco *(Pseudognaphalium obtusifolium).* After a few meters this site deteriorates into a mugwort stand followed by a rocky outcrop. The rock outcrop consists of mostly non-native weeds but there is a young stand of Junipers *(Juniperus virginiana)* and black cherry trees *(Prunus serotina).* Problematic shrubs and small trees found here are multiflora rose, glossy buckthorn, bush honeysuckles, and tree of heaven *(Ailanthus altissima)*. Other native trees that occur along the edge of the southwest meadows include red maple *(Acer sarccharum),* white oak *(Quercus alba),* black oak *(Quercus velutina),* pignut hickory *(Carya glabra),* shagbark hickory *(Carya ovata),* and a few young white ash trees *(Fraxinus americana)*. Most of the oak trees are relatively young but there are a number of large hickories at least 75 years old.

A larger dry upland meadow occurs along the southeastern edge behind the fenced fields. Switchgrass *(Panicum virgatum),* purpletop tridens *(Tridens flavus),* pasture thistle *(Cirsium discolor),* fleabanes *(Erigeron spp.),* goldenrods, and asters are interspersed with non-native cool season grasses such as bluegrass *(Poa spp.)* and bentgrass species *(Agrostis spp.)*. Shorter mugwort plants are encroaching into this meadow on a southern slope, and the diversity drops after a large rock outcrop to the west.

There is a small patch of cattails (both *Typha latifolia and Typha angustifolia*) between the goat enclosure and Hanover Street. Grass-leaved goldenrod, cinnamon willow-herb, soft rush, sedges, and flatsedges *(Cyperus spp.)* can be found interspersed within the cattails. Along the edge of Hanover Street traveling south, there is a narrow strip of lowland with moist, rocky soil that does not get mowed due to the difficult terrain. Mugwort is the dominant species in this area but competes with Canada thistle. The same common native wetland species grow in small patches along with dogbane and common milkweed.

Recommendations:

How best to manage and expand our most important biodiverse communities?

Wet sites:

First, each of the small, biodiverse wetland areas should be marked with tall visible stakes (rebar and modified pvc pipe, as an example). Each site should be measured to establish a baseline size for monitoring and non-native encroachment. Woody invasive species within each plot or in close proximity should be controlled. Small shrubs can be pulled by hand. Digging up large, established plants is not recommended unless new native plant material is added to the gaps immediately afterward. Japanese barberry, multiflora rose, and bush honeysuckles can be controlled using one or two methods. Bush honeysuckles and Japanese barberry should be cut to the ground in early spring. Plant material from bush honeysuckle must be carefully discarded to prevent accidental spread. Once stems resprout in the summer, using a flame weeder for up to 40 seconds until plants carbonize may kill the shrubs.

Mortality can be achieved with one flame treatment using a 400K BTU propane torch, or two treatments at 100K BTU. A similar method can be used for multiflora rose, or rose shrubs can be cut 3-6 times per year. Vines like bittersweet should be cut to the ground in late July while flowering (Travis & Kiviat 2016). Non-native, cool season grasses like reed canary grass should be prevented from going to seed. In the pasture wet meadow next Hanover street, non-native grasses can be sheet mulched or covered with fabric or clear plastic.

Grasses can be dug up or cultivated using a rototiller to form a perimeter around each site for expansion. Suitable species from 2022 wild collections that can be installed in these buffers include woolsedge, fringed sedge *(Carex crinita),* awlfruit sedge *(Carex stipata),* flat-topped aster *(Doellingeria rotundifolia),* sneezeweed *(Helenium autumnale),* seedbox *(Ludwigia alterniflora),* and blue vervain *(Verbena hastata)*. Canadian honewort *(Cryptotaenia canadensis),* and jumpseed *(Persicaria virginaiana)* can be added to shadier sites. Founder plot species that could be added include monkey flower *(Mimulus ringens)*, cardinal flower *(Lobelia cardinalis),* joe-pye weed *(Eutrochium dubium)*, and New York ironweed *(Vernonia noveboracensis),* and swamp milkweed *(Asclepias incarnata)*. 2023 collections that can be made from HHF and added to these sites include swamp agrimony, soft rush, and fox sedge. Fowl manna grass, wood reeds *(Cinna spp.),* and rice cut-grass *(Leersia oryzoides)* can be supplemented from populations across the street in the HHF trails.

Rocky outcrop:
This community experienced significant drought stress and could potentially show different species composition in better years. Invasive shrubs should be managed using the same techniques described above. Mugwort and bluegrasses can be mowed twice and then covered since the area is not as extensive. The numerous trees of heaven can be treated effectively by partially girdling in early spring, and subsequently removing any resprouts. To prepare the site for seeding and transplanting, scalp small sections and replace with little bluegrass, switchgrass, purple lovegrass *(Eragrostis spectabilis),* sensitive pea *(Chamaecrista nictitans),* stiff aster *(Ionactis linariifolia),* round headed bushclover *(Lespedeza capitata),* Carolina rose *(Rosa carolina),* and blue curls *(Trichostema dichotomum)* from 2022 collections. Hemp dogbane, frostweed aster *(Symphyotrichum pilosum),* and path rush *(Juncus tenuis)* can be collected from HHF meadows and black huckleberry *(Gaylussacia baccata),* lowbush blueberry *(Vaccinium angustifolium),* and hillside blueberry *(Vaccinium pallidum)* can be collected from the HHF trail system and added after two years of growth. Other annual species that would work well on dry, thin soils include pearly everlasting *(Anaphalis margaritacea)*, field pussytoes *(Atenneria neglecta),* Philadelphia fleabane *(Erigeron philadelphicus),* rough fleabane *(Erigeron strigosus),* rabbit tobacco, and sleepy catchfly *(Silene antirrhina)*. Perennial and biennial herbs and graminoids include poverty oatgrass *(Danthonia spicata),* wavy hair grass *(Deschampsia flexuosa),* wild strawberry *(Fragaria virginiana),* whorled loosestrife *(Lysimachia quadrifolia),* common evening-primrose *(Oenothera biennis),* and oldfield cinquefoil *(Potentilla simplex)*.

Invasive Species Control

Invasive and non-native weed pressure at HHF is severe. Complete eradication of invasive species is an impractical goal. However, consistent, long-term management using targeted, consistent methods can effectively reduce populations and prevent further spread.

Deer:
Decreasing the deer population would have a substantial effect on HFF's plant communities. Both the trail system and the unfenced parts of the farm show extensive browse damage. If possible, HHF should be added to the Westchester County Parks Adaptive Deer Management Program (DMP), or other lethal means of control should be considered. The 125 acres of the HHF trail system already receives support from DMP hunters. The western and southern perimeter of the farm should be the region targeted for hunting. However, the small size and proximity to roads may make such a strategy impractical. Short term, accessible deer enclosures using nylon netting could be set up around the small wet sites. Since the former pasture on the northeastern edge of the farm already has an existing fence, it should be prioritized for restoration.

Mowing:
Many of the invasive species on the farm can be reduced through systematic mowing with the blades set at 2 inches (Sheley & Goodwin 2017). Mowing mugwort twice a year in early summer and fall prior to seed maturation may decrease mugwort abundance. Mowing more frequently has not shown to be any more effective, with some studies demonstrating less than a 30% decrease in rhizome densities (Aulakh 2020, Jordan & Jacobs 2002). Combining herbicide applications with systematic mowing is generally more effective than mowing by itself for large invasions (Lower Hudson Prism, Bradley & Hagood 2002). Mowing invasive species before seed set will still prevent further additions to the seed bank and deplete nutrient storage reserves over a longer time frame (Annen et. al 2009). The steep slopes at HHF are a challenge to mow with the current equipment at the farm. Furthermore, any tough woody shrubs and young trees present would require an initial cutting prior to mowing. Wetland sites should be monitored for compaction.

Further Control Recommendations:
Bittersweet and porcelainberry have grown over some of the important tree species on the farm like hickories, oaks, and cherries. These vines should be cut to the ground between July and August and monitored for resprouts at frequent intervals. Lower Hudson Prism recommends weekly cutting. Another approach would be to combine a cutting with an herbicide treatment. Cut bittersweet vines prior to the growing season to take the stress off the trees, and then continue to cut all new growth through the end of June. Allow 8 weeks of regrowth and then apply a foliar herbicide (Templeton et. al 2020).

Gray willow is a tier 2 emerging invasive species in the lower Hudson Valley that readily hybridizes with native willows. It is abundant throughout the farm on moist to wet soils. Young plants can be dug up and pulled, but larger individuals vigorously resprout following mechanical interventions. Lower Hudson Prism recommends cut stump treatments with herbicide.

Reed canary grass forms long monocultures in large parts of the riparian area. This is another problematic species that is tolerant of frequent mowing, along with many of the other cool season grasses present on the farm. Mowing over 5x annually for several years may be the best strategy for large sites that do not get seasonally inundated. Some sections could be covered with thick shade cloth, clear plastic, or even thick layers of sheet mulch for a year and seeded afterward. Cover crops could be an option for monocultures of mugwort and reed canary grass where there is flat terrain and soils are drier soils. This would make tilling cover crops possible (Jordan et al. 2017).

There are a few large stands of phragmites but they are not as extensive as the mugwort or reed canary grass. The perimeter of each stand should be marked and monitored for further expansion. If staffing permits, small sites can be cut once a year with a brush cutter during flowering. Volunteer events could target larger stands. Further mechanical interventions such as ditching or dredging a pond can be considered as increased water levels also provide some control for reed canary grass (Travis & Kiviat 2016, Annen et al. 2009).

How to manage and utilize our wild seed to stock our growing operation?

One of the most important priorities for wild seed management is invasive species control following the methods outlined in the previous section.

Soil tests should be performed in the uncultivated sections of the farm to determine whether there are excess nutrient levels present in the soil that can inhibit the growth of native species. HHF's crop farming fields were tested at the end of 2022 and showed high levels of phosphorus among others. Two sites near the fields outside the cultivation area were also tested. The results still showed a high concentration of phosphorus but levels were within the recommended range. Given HHF's history of raising livestock, further amendments containing

phosphorus and potassium should be avoided. Techniques to lower nutrient levels include scraping surface soils or removing topsoil, soil inversion, and deep tillage (Shaw et al. 2020).

Species suitable for collection at HHF include: swamp agrimony, hemp dogbane, common milkweed *(Asclepias syriaca),* deer-tongue rosette grass *(Dichanthelium clandestinium),* little bluestem, switchgrass, purple tridens, soft rush, path rush, sallow sedge, fox sedge, common yarrow *(Achillea millefolium),* pasture thistle, frostweed aster, smooth white oldfield aster*,* swamp aster, panicled aster*,* rough-leaved goldenrod, sensitive fern, white avens *(Geum canadense)*, and black cherry. Some species like christmas fern *(Polystichum acrostichoides)*, fowl manna grass*,* black cherry, juniper, and hickories and oaks can be further supplemented with collections from HHF trails. For example, in spring 2022 we counted 20 individuals of wild geranium *(Geranium maculatum)* in the southwest meadow. A collection from this meadow should be combined with a collection from HHF trails, which can be grown out to increase the Geranium population within the farm property.

Increasing community seed capacity

A more intensive approach to increase wild seed stocks would be to set up establishment gaps—4m x 4m plots and long narrow strips at 10m x 1m to 100m x 10m of native species within HHF's natural areas (Valkó & Deák 2016, Kiss & Deák 2020, Burmeirer et al. 2010). For the narrow plots, after each site is prepared by removing initial vegetation, roots and rhizomes, warm season grasses such as big bluestem *(Andropogon gerardii),* broomsedge bluestem, little bluestem, switchgrass, purple tridens, and yellow Indiangrass *(Sorghastrum nutans)* can be added to the plots through planting and seeding. Competitive, ruderal species such as rough-leaved goldenrod*,* grass-leaved goldenrod, and mountain mints *(Pycnanthemum spp.)*. By focusing on ruderal species first, plots will be colonized rapidly, suppress weeds, and eventually exclude invasive species (Coiffait-Gombault & Buisson 2011, Valkó & Deák 2016). The rectangular plots should be located in areas of high invasive pressure but not in the middle of the densest stands. For example, a rectangular plot can be set up along the southern edge of the south meadow where mugwort starts to take over but is not completely excluding all native species.

Square plots should be set up adjacent to high biodiversity sites. They can also be installed within the rectangular plots once native grasses have fully established. Square plots should be planted and seeded with a diverse seed mix containing 25 to 35 species and can include small shrubs and forbs. These plots will take a few years to prepare due to the high number of species and seeds required for success. Seed mixes should be sown at high densities of up to $10g/m^2$ (Valkó & Deák 2016, Kiss & Deák 2020). Monitoring programs that measure establishment, species composition, and percent cover should be implemented on a biannual basis (at minimum) to fully capture all species, evaluate success, and catch any problems that may require prompt interventions.

If invasive species can be successfully excluded from a broad section, seeds can be harvested with restoration goals in mind. For example, mature grass seed can be harvested with the stems and leaves using a brush or plot harvester. The plant material can be immediately transferred to a prepared site. The excess material will function as a mulch that can provide additional benefits to restoration sites by conserving moisture, improving microsites, and reducing erosion. Alternatively, the seeds can be separated and threshed while the hay is dried and stored for future use (Shaw et al. 2020).

In drought years like the 2022 growing season, upland sections of the farm could benefit from periodic watering (Pedrini & Gibson 2020). However, further interventions such as fertilization and more frequent watering should be avoided in order to promote continued adaptation to difficult environmental conditions (Basey & Fant 2015).

Which species are best suited to our program objectives and will flourish in founder plots?

HHF has a limited capacity to grow plots of shade-tolerant species at this time. As a result, sun-loving, herbaceous species are the best candidates for founder plots. Some shade species may benefit from being interplanted with tall species like New York ironweed and joe-pye weed. We successfully grew a crop of wild columbine (*Aquilegia*

canadensis) that is currently located in full sun. This was most likely due to the species' early phenology, which occurs prior to leaf emergence in trees.

The crop farming area is gently sloped with dry fields at the top on the northern end, and wetter sites occurring further downslope. A range of species with different moisture regimes are suitable for founder plots within the crop farming area. Modifications will have to be made for species that prefer fully saturated or flooded soils, or they can be planted in the wet pasture. Within the fields, PH levels range between 5.9 and 6.7, with most fields measuring 6.2. Species that require higher acidity levels should be planted outside the crop fields.

Suitable herbaceous species on the farm include swamp agrimony, hemp dogbane, common milkweed, deer-tongue rosette grass, little bluestem, switchgrass, purple tridens, soft rush, path rush, sallow sedge, fox sedge, common yarrow, pasture thistle, frostweed aster, smooth white oldfield aster, swamp aster, panicled aster, sensitive fern and white avens. Switchgrass and pasture thistle were collected in the fall and currently in stratification.

Herbaceous species occurring on the farm that cannot be collected due to low population counts but would still make good candidates for founder plots include pearly everlasting *(Anaphalis margaritacea),* spotted joe-pye weed, common boneset, rabbit tobacco, New York aster *(Symphyotrichum novi-belgii),* woodbine *(Clematis virginiana),* oldfield cinquefoil *(Potentilla simplex),* woolsedge, and Virginia wild rye *(Elymus virginicus).* These species should be targeted nearby.

Species from the 2022 wild collections that should be considered for founder plots are big bluestem, broomsedge bluestem, purple lovegrass, switchgrass, purpletop tridens, fringed sedge, woolsedge, sensitive pea, smooth small-leaved tick-trefoil *(Desmodium marilandicum)*, sneezeweed, stiff aster, round headed bushclover, seedbox, marsh fleabane *(Pluchea odorata),* mad dog skullcap *(Scutellaria lateriflora),* silver rod *(Solidago bicolor),* seaside goldenrod *(Solidago sempervirens),* common late purple aster *(Symphyotrichum patens),* American germander *(Teucrium canadense),* blue curls, and blue vervain. Species like little bluestem should be installed outside of the crop fields to function as a cover crop for invasive species suppression.

Many wildflowers like sensitive pea attract parasitic wasps and other beneficial insects. Milkweeds and other crops, including vegetable crops that are attractive to pests should be interplanted with species that provide food and habitat to predatory insects as an alternative to insecticides. (Xerces Society 2017).

Which plant species are most needed to increase local biodiversity*?*

Early successional, competitive species that rapidly colonize new sites are especially important for lower Westchester, which is densely populated and much more fragmented than Northern Westchester. Furthermore, Westchester's proximity to New York City along with a number of international airports make it a hotspot for new diseases and invasive species introduction. Deer herbivory is a pervasive problem throughout the county, making it difficult to establish many species. In addition to deer resistant plants like mint family species, ferns, sedges, and other graminoids, large species with thorns like wild blackberries and native roses could be planted strategically to provide some level of protection and deer browse.

Forests in lower Westchester have high tree densities but very little native understory. The current losses of major keystone tree species make forests vulnerable to invasive species and other ecological problems. Early and mid-successional woodland species should be prioritized to help mitigate these effects. Powerline cuts that are located within forests and unfragmented habitats often have these species in abundance as a result of being periodically mowed.

With climate change and rising sea levels, marsh and wetland species should be a high priority. In addition to being biodiversity hotspots, wetlands provide a number of ecological functions including floodwater storage, erosion

control, carbon sequestration, and water filtration. Wetland restoration should be a top priority to buffer communities from flooding events, especially in coastal areas. The seed supply of tidal, brackish, and freshwater wetland species should all be increased and stored in large quantities so the county can rapidly respond to destructive storms.

Seeds from all tree species should be collected, including species we are currently losing. Ash and Hemlock seeds can tolerate long-term storage if kept in proper conditions. Beech nuts produce recalcitrant seeds so universities and other organizations interested in or currently conducting research related to beech leaf disease should be contacted if any viable seeds are found. Hickories and oaks are major keystone species that should be targeted for collection and conservation, especially oaks. Oak wilt has not been detected in Westchester county but the disease has been found in Brooklyn and Long Island (DEC 2020).

Certain functional plant groups have been found to occur together in high-quality tall grass prairies in the midwest and could serve as a model for Westchester. The groups identified include sedges, C3 or warm season grasses, hemiparasites or partial parasitic plants, and perennial nitrogen fixers predominantly from the legume family (Sivicek & Taft 2011).

How best to incorporate the results of the study in our education programming?

Workshops and classes can be taught following each restoration initiative taken. Best practices for invasive species control can be taught to the community using non-chemical methods. Regular volunteer groups can help maintain and monitor restoration sites. They can also help with seed collection, processing and propagating plant material for restoration plantings.

High School Senior interns can learn real skills required for restoration practitioner jobs. Starting with wild seed collection on the property, growing out plant material, to site preparation, installation and after care/monitoring. Students can also create their own research projects.

Once each of the more diverse sites are marked with visible stakes, monitoring plots of various sizes should be created and simple surveys can be designed to record native and invasive species, percent coverage, canopy coverage, and ecological characteristics. Assessments can be done with middle school and high school science students. In the future when some restoration work has been carried out, students can look at change over time and assess whether our methods have worked to increase biodiversity at the farm.

We can also conduct seedbank tests for each plot. Soil samples can be taken at different depths and at increasing distances from each plot, then germinated in a small tray (Burmeier et al. 2011). Each tray should be photographed after germination and a few months afterward to document which species dominate. This would be a fun hands-on-workshop with different sessions for sampling, growing, photographing, and identifying each plant.

Citizen science initiatives using apps like iNaturalist can be taught to the community. Basic plant identification workshops can be scheduled in preparation for a bioblitz type event. iNaturalist events could be held throughout the year where community members use iNaturalist to record plant species that adhere to a monthly theme.

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