MONITORING PROPOSAL FOR ASSESSING

DEER IMPACTS IN ANN ARBOR NATURAL AREAS

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Proposal submitted by

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LESSONS FROM PILOT STUDY (2015-2016) AND RECOMMENDATIONS FOR NEXT YEAR

This proposal outlines recommendations for monitoring methods to assess deer impacts on vegetation in Ann Arbor natural areas in 2016–2017. To choose the best approach, I offer a brief review of how this year's monitoring protocol worked to address key questions about deer impacts, while also balancing cost and time considerations. Then I outline lessons learned from the pilot study and suggest what more would be needed to fully address those questions.

KEY QUESTIONS ABOUT DEER IMPACTS

Ecological concerns about the impacts of deer on natural areas go beyond assessing whether deer are damaging a few plants. The larger and deeper issues are whether deer damage is leading to declines in biodiversity—in the abundance and distribution of native species—and whether that damage can lead to long-term changes in ecological communities and functions.

How are deer affecting native plant species and plant community processes?

How are deer affecting other species in local food webs, serving as a "keystone herbivore" or initiating a "trophic cascade" in which browsing on plants may in turn lead to declining resources and habitat for pollinators, songbirds, or other forest species?

PILOT STUDY

The preliminary study focused on using nursery grown red oak seedlings as "sentinel seedlings" to obtain a standardized measurement of browse intensity across a range of sites. Red oaks were selected for several reasons:

- They represent a key tree species and forest community type (oak-hickory forest) that plays an important role in providing food and habitat for numerous other species.

- They are a common tree species that naturally occurs in all 10 of the Ann Arbor natural areas selected for this project.

- Declining oak regeneration has been a concern in much of eastern North America, so what happens to oak saplings is an important indicator of trends in and possibilities for forest regeneration.

- They are considered to be of intermediate browse preference—not likely to be the first browsed when other food sources are plentiful, but not browse resistant.

LESSONS FROM PILOT STUDY

- **CONTAINER PLANTED SEEDLINGS WOULD BE MORE STANDARD AND HAVE LOWER MORTALITY THAN BARE ROOT NURSERY STOCK.** Although the pilot study proposed using seedlings grown in and planted directly from plant tubes or containers, we used bare root nursery stock because of the timing of study approval. The bare root seedlings had highly variable diameters and branching within the given size class (which was based on height), and seedling condition was often poor. Initial seedling condition likely led to relatively high transplant mortality and greater sensitivity to this year's drought than was shown in a small pilot of plant tube seedlings planted in June. Initial seedling condition might also have affected the observed browse rates.

- **RED OAK SEEDLINGS DID NOT ALONE FULLY INDICATE/REPRESENT BROWSE DAMAGE OBSERVED AT VARIOUS SITES.** In some sites, few of the planted seedlings were browsed by deer, despite heavy deer browse on herbaceous and/or woody plants growing nearby or even immediately adjacent. There are several possible reasons:

    1. Some bare root seedlings were in poor condition and may not have been as attractive to browse as healthy plants.

    2. Browse damage on any individual species may vary depending on the presence and abundance of other plant species (some of which may be more preferred), so a single indicator species may not fully represent browse intensity at a site.

    3. There is a certain amount of spatial and seasonal randomness in deer browse patterns, and deer browse behavior could also be affected by other factors (including proximity to trails used by people and dogs, as well as to preferred trails used by the deer) that may were hard to gauge during initial planting times.

- **BROWSE DAMAGE VARIED CONSIDERABLY ACROSS PARKS BUT THE PRELIMINARY STUDY WAS NOT ABLE TO ASSESS THE SOUTHWEST PART OF THE CITY (WARD 4).** Although we did aim to monitor a range of sites (large and small parks in areas with higher and lower estimated deer density) geographically distributed across the city, city park natural areas themselves are not evenly distributed across the city, and there were no sites monitored within the southwestern part of Ann Arbor (the 4th ward).

RECOMMENDATIONS FOR 2016–2017

- **PLANT AND MONITOR ANOTHER SET OF RED OAK SAPLINGS BUT USE FIRST-YEAR SEEDLINGS AND TRANSPLANT THEM IN PLANT TUBES.** Seedlings would be in better condition, more standard size, and more likely to survive, so they would provide a better and more standardized yardstick for gauging deer browse intensity. If data are needed by October 2017 to contribute to management decisions for 2018, seedlings should be planted during fall of 2016, before the hard freeze, in order to supply data from a full year of monitoring.

- **CONTINUE MONITORING SEEDLINGS PLANTED IN 2015-2106 TO ASSESS SURVIVAL.** While the initial proposal recommended pulling out plants at the end of one year, leaving them in place for another 1-3 years will allow site-specific correlations between deer browse and seedling survival to help assess the proportion of seedlings browsed that will allow tree regeneration in Ann Arbor sites.

- **USE MORE SPECIES, INCLUDING SOME THAT MIGHT BE MORE PREFERRED BY DEER, IN ORDER TO GAUGE EFFECTS ON SENSITIVE SPECIES AS WELL AS SPECIES THAT PROVIDE FOOD AND HABITAT FOR POLLINATORS AND SONGBIRDS.** Depending on site history and context, deer appeared to browse red oak seedlings in some sites more than others. Various other deer monitoring studies have used a larger suite of indicator species to gauge deer impacts—either by tagging and tracking existing plants (in situ) or by transplanting or bringing in containers of plants and using them as experimental browse indicators, as with the red oaks. Trillium is often used, and is being focused on in a separate pilot study, for which preliminary results will be available in mid-2017. Other studies have used a suite of 3-4 trees and shrubs and 3-4 spring and fall wildflowers. Additional species to plant and track as experimental browse indicators could include the following:

    - Flowering shrubs: Maple-leaf viburnum, gray dogwood, common elder. These species are suitable for growing in many Ann Arbor natural areas, and have been observed in some of the sites assessed.
    - Spring flora: Trillium, Solomon's seal (several species). Spring flora provide resources for pollinators early in the season, and their fruits are used by insects, birds, and small mammals.
    - Summer/fall wildflowers: heart-leaved and calico asters and zigzag goldenrod are common woodland species that are found in many sites, along with wild lettuce and tall wild lettuce; all offer pollinator resources. Jewelweed or touch-me-not, widespread in moister sites, also offers an important nectar source to native bees.

Plant material from Michigan genotypes is available at local native plant nurseries for all of these species, but cost and availability are still being assessed.

- **SEEK COOPERATION FROM ANN ARBOR PUBLIC SCHOOLS TO MONITOR IN IN THE 4TH WARD AND FOR MORE COMPLETE GEOGRAPHIC COVERAGE OF ANN ARBOR.** Pioneer Woods is the most significant area of mature forest in the 4th ward and would be a good site to monitor to increase geographic coverage in the city. Additional school properties with important natural areas include Skyline, Eberwhite, and Scarlett Mitchell. Monitoring in these areas could provide important controls to assess areas where deer management is not undertaken, and could also be an avenue for getting high school teachers and students educated about forest biodiversity, regeneration, and ecological interactions.

- **CONSIDER CHANGING LOCATIONS OR INCREASING THE NUMBER OF SEEDLINGS USED.** A detailed review of where deer browsed the planted oak seedlings within different natural areas, and how that damage compared to observed damage on other species nearby, will help gauge whether numbers of seedlings should be increased, monitoring locations within parks be changed, or both. Final site selection will be based on consultation with NAP staff.

- **CONDUCT ADDITIONAL SURVEYS TO ASSESS GROWTH, FLOWERING SUCCESS, AND BROWSING ON SITE-SPECIFIC SPECIES.** As conservation managers throughout the Northeast and Great Lakes states grapple with deer impacts, three recent studies (two not yet published) have focused on rapid assessment methods for monitoring deer impacts.

    - Waller (2016, unpublished ms.) has developed a quick method for assessing twig age that does not require identifying deer browse damage but is well-correlated with browse intensity and can show growth patterns over 2-3 years. This method has not yet been demonstrated in areas without deer exclosures, but should be explored to find how deer management can be correlated with tree twig growth over time. A challenge is that it relies on having the same species available across sites with twigs in the deer “molar zone” of 2” to 6.’

    - Rawinski (2016, unpublished ms.) has developed a “Tallest Ten” method for establishing permanent circular plots and monitoring growth of indicator species on site over time; the method can be supplemented with surveys of flowering and fruiting status. This method offers a way to look at site-specific effects on species that occur or are abundant in only one or a few of the sites being monitored.

    - Hines (2016) developed a rapid monitoring method using transect lines radiating from a center point and assessing key woody species along the transects for the height at which browse damage is noted, with the assumption that any browse that occurs at heights over 2-3 feet is a sign of deer overbrowsing (this height can be adjusted according to site-specific factors). This method can be used within sites to identify areas of highest browse intensity that could become foci for management.

These various new monitoring methods offer quick assessments of a broad range of species, and those found only on one or a few sites. They should be used to complement the experimental study (which offers a standardized gauge that can be used across all sites, regardless of initial vegetation).

RECOMMENDED MONITORING PROTOCOL FOR 2016–2017

Based on lessons learned from the pilot monitoring research done in 2015–2016, we recommend an integrated approach that should be embarked on as soon as possible during fall 2016. This plan continues the approach used in 2015 and will allow for results to be compared from one year to the next, but also assesses deer impacts more species and more ecological functions. By starting as soon as possible, red oak seedling data will be available by October 2017 for use in developing deer management plans for the coming year.

Cost estimates are provided in Table 1.

1. **Plant 400 red oak seedlings across more sites and in more areas within sites during fall 2016.**
   - Seedlings in plant tubes will likely have better survival, but sometimes have high rates of small mammal damage from digging in the first weeks after planting. Seedlings will have to be rechecked several times in the first weeks after planting and will be replanted if dead or damaged by small mammals. Total seedlings required for initial and replanting: 500–600.
   - Although the pilot study used fencing to allow for a control, the key metric for comparison year to year is the proportion of unfenced seedlings browsed. If we do not fence half of the seedlings seedlings, but allow all to grow unprotected, this will effectively double the number of seedlings available for deer to browse, and will allow planting in more sites and more locations within larger sites.
   - Final planting numbers and locations to be determined in consultation with Natural Area Preservation staff and city deer management team.
   - ***Vegetation metric: Proportion of oak seedlings browsed.***

2. **Plant experimental seedlings of additional species, including 1 shrub and 1–2 species each of spring and fall wildflowers.**
   - These can be planted in an array with red oaks to that each planting location will have several and monitoring can be done efficiently.
   - Final species mix will be determined by assessing species inventories for park natural areas to select species that are the most widespread, as they will form a standardized gauge.
   - Planting will be done in fall, with red oaks if possible, but may be done in spring for some species, depending on procedures recommended for each species.

(E.g., I have located ample Michigan genotype trillium that is ready to plant this fall, but the false Solomon's seal that is available would need to be grown in the greenhouse over the winter and planted when the ground thaws in the spring).
    - Time constraints for planting and monitoring may limit the number of individuals of each species that can be planted to less than the 400 for red oaks.
    - Consider whether to fence some plots with these other species to serve as experimental controls, since this suite of species has not been assessed before. Experimental seedlings of other species could be added to existing fences that now contain only oaks so that we can assess survival with and without deer browse damage.
    - ***Measurement metrics: Proportion of shrub and wildflower seedlings browsed; can also assess proportion blooming/fruiting and number of flowers/fruits.***

3. **Continue tracking browse damage and survival of seedlings from 2015–2016 study.**
    - Although proposed and designed as a one-year study, it would be helpful to track survival and browse damage of existing seedlings for one or more additional years to assess the 15% browse damage level proposed by Blossey (2014) and look at tree regeneration over time.

4. **Establish permanent monitoring plots and conduct additional surveys to assess growth and flowering success on species currently growing at each site.**
    - Rawinski (2016 unpublished) provides a quick method for establishing and tracking plots over time, which will provide necessary information about species currently growing in the sites to supplement the experimental browse data. This will be key for interpreting whether and how vegetation recovers following deer management.
    - ***Measurement metrics: Average height of 10 tallest individuals of species selected within and across sites (that is, particular species of concern on a site, or those that can be compared across several sites).***

ADDITIONAL STEPS (NOT INCLUDED IN THIS BUDGET)

- **Explore collaborating with Ann Arbor Public Schools to extend red oak seedling study to school natural areas; plant up to 80 additional seedlings.**
    - School-owned properties adjacent to Pioneer Woods, Eberwhite, Skyline, and Scarlett Mitchell are important natural areas in the city, including a part of Ward 4 (Pioneer Woods). I will work to find collaborators within the schools and funding sources to support planting experimental seedlings on these properties.

- **Explore collaborating with University of Michigan to continue the red oak seedling study in the Arboretum and extend it to other university properties.**
    - Continuing the red oak experimental study in the Arboretum and extending the same monitoring protocols to include more species and cover more UM properties in and near the Ann Arbor city limits (including Matthaei Botanical Gardens and Horner-McLaughlin Woods) can offer important information about how university properties fit into the mix.
    - Deer densities at the UM's fenced E.S. George Reserve, in Livingston County, are low enough to allow for oak regeneration at present, so conducting the red oak sapling study at this site will offer a look at the link between proportion of red oak seedlings browsed that can sustain tree regeneration. I am currently in talks about how to move forward with a study funded by the university to address this.