AVID

Assessing Vegetation Impacts from Deer

A Rapid Assessment Method for
Evaluating Deer Impacts to Forest Vegetation

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A Rapid Assessment Method for Evaluating Deer Impacts to Forest Vegetation

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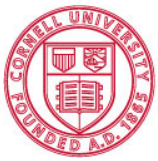
Cover photo credit: Haliburton Forest



Cornell University
Cooperative Extension

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Introduction

This document describes procedures used to measure vegetation to quantify the impacts deer are having on woodland vegetation. These field methods will be used by volunteers, landowners, foresters and other natural resource professionals. Field data collected by individuals and organizations across New York State, and submitted to a central database, will be used to track tree, shrub and wildflower response to deer browsing over time. Knowledge of how deer impacts change through time will help guide deer management decisions at local and state levels. Participants will document changes in forest plants on their own land, or land in their communities, and also will learn:

- To identify important spring wildflower and tree species
- To recognize evidence of deer impacts based on the presence or absence of key wildflower, shrub, and tree indicator species

The Effect of Deer on Forest Health and the Future of New York Forests

The white-tailed deer *(Odocoileus virginianus)* can significantly influence New York's forests. Deer impact their own habitat, the habitat resources available to other species, and the forest ecosystem overall. Low-intensity browsing can have positive effects by opening up a dense understory and fostering species diversity. However, in many areas of the state deer browsing has become intensive. Through selective and intensive browsing, deer affect the kinds and numbers of plants present in an area, impair the growth of new trees, and shape the overall look or structure of the forest, both present and future. The changes brought about by deer can affect the quality of the forest and reduce available food and habitat for other wildlife species. The abundance and number of different types of songbirds, for example, is lower in forests heavily browsed by deer.

As selective browsers, deer prefer to eat certain plant species more than other less desirable species. Many of the tree species deer prefer to consume are valued for timber, or as food-producing trees for wildlife (e.g., oak (*Quercus spp*.), maple (*Acer spp*.)). Deer also eat many wildflower and understory plants such as trillium (*Trillium spp*.), Canada mayflower (*Maianthemum canadense*), and lady slippers (*Cypripedium spp*.), but tend to avoid eating less palatable species such as hay-scented ferns (*Dennstaedtia punctilobula*) and many invasive plant species (e.g., garlic mustard (*Alliaria petiolata*), barberry (*Berberis spp*.). By preferentially eating some species and leaving others behind, deer will reduce the native biodiversity of a forest. Selective browsing is a negative force on the species deer prefer, and a positive force on the less palatable species. When the variety of species in the forest changes, so can change the way that forest ecosystem functions, its resilience to natural disturbance, and the quality of products and services provided to society.

In addition to changing the types of plants, deer can also change the structure (the number and sizes of trees and the layers of vegetation) of the forest. For example, over-browsing of tree seedlings and shrubs can eliminate those layers and create open, park-like stands with little or

no forest understory. Loss of forest understory affects other wildlife too, including small mammals, insects, and songbirds that rely on the forest understory to provide cover, nesting sites, and food. Some animal species may become less abundant in heavily browsed areas, while others may disappear completely.

The effects of deer browsing on the composition and structure of New York forests can have long-lasting effects (also called "legacy" effects) that persist for decades even after deer impacts are reduced. In areas with a history of deer overabundance, regeneration failure – the failure of new, young trees to grow – is having a detrimental effect on forests and the potential to keep areas in forest cover into the future.

Signs and Symptoms of Deer Impacts

When deer are having a substantial impact on the forest, recognizable signs can be detected by the trained eye. Many of these signs are described in Table 1.

Table 1. Common, recognizable signs of deer impacts.

A park-like understory with little vegetation growing in the shrub or understory layers. Browsing of any or all palatable plants that begin to grow can eliminate vegetation from the forest floor.	
An understory dominated by invasive shrubs such as barberry, multiflora rose, honeysuckle, or others. Invasive species can colonize and dominate when native vegetation is reduced or removed through deer browsing.	

An understory dominated by deer-resistant ferns. Ferns can dominate when other plants are removed through browsing. Once established, thick stands of fern shade the forest floor and can prevent seedlings from receiving sunlight necessary for growth.	
An understory dominated by native tree species less preferred by deer than other species in the forest. Examples include trees such as hop hornbeam, striped maple, and American beech. Deer browse other species, like sugar maple, ash and oaks, which allows the less preferred species to become established. American beech sprouts profusely when infected with beech bark disease and can block sunlight from reaching the forest floor. Once established, this condition can persist for decades.	
A “browse line”, a visual line created by a lack of vegetation growing at a height of 5-6 feet, indicates deer have eaten everything growing within their reach.	

Obvious signs of deer browsing to seedlings or understory plants can indicate deer impacts. Browsing on species are not typically preferred by deer may indicate substantial deer impacts, as more palatable species are usually eaten first.	
A woodland with low levels of deer impact is indicated when wildflower species highly preferred by deer are present in the forest, reach greater heights and flower, or when preferred tree seedlings are able to grow beyond the reach of deer (5-6 feet).	 

Assessment Methods

Deer browsing affects many different components of our forests. Plants are a primary component and the basis for an index to assess and document changes in deer population levels and associated impacts. An index of deer impact should respond quickly to changes in the population, be based on scientific evidence, and be easily and accurately applied by volunteers in different conditions. The methods supported by this protocol emphasize either spring wildflowers, or tree and shrub seedlings in some circumstances.

For the method (or methods) you select, plan to collect and record **all** of the relevant information. The data collected will be used to track vegetation changes over time. Therefore, try to visit the plots and collect data on your established plots each year, or every other year at a minimum. In subsequent years following the initial plot establishment, re-measurement should happen within one week of the original date of measurement.

Spring wildflowers, also called spring ephemerals because they occur for a short period of time, have been found to respond quickly to changes in deer pressure, and are effective indicators under a variety of forest conditions. As ephemerals, wildflowers will not be apparent for much of the year and thus seasonally restricted in use. Woody seedlings are available year round, but they tend not to respond as quickly as wildflowers, and seedling identification can be more challenging, especially when leaves are not present.

This protocol includes two methods:

- Method #1 - identifying, counting, and measuring spring wildflowers
- Method #2 – tagging and measuring the height of 20-50 individual seedlings each of two or more species

Having enough information to make management decisions at a local or the state level will require a sufficient amount of data from the same method. A concern with offering multiple assessment methods is that each is diluted, and an insufficient database is accumulated when volunteer efforts are spread across multiple methods. For this reason, volunteers are strongly encouraged to implement the Wildflower Method (#1). If seasonal access or ecological conditions preclude the Wildflower Method, use the Seedling Height Method (#2). If time, energy and ecological conditions permit, collect data on multiple properties or use both methods on one property.

There is similarity among the methods and their implementation is fairly simple. All methods involve selecting a wooded area (details are below). In these areas circular plots with a 6 foot radius are located, and plants are measured or counted (Table 2).

Table 2. Summary of attributes of assessment methods. See text for full details.

Attribute	**Method 1- Spring Wildflower**	**Method 2- Woody Seedlings**
What's measured (simplified)	Count number of stems of specific wildflowers Record percentage of stems of those species that are flowering	Height method - Tag 30 seedlings each of one or two species and record the heights
Sensitive to canopy or sub-canopy shading	Can work in shaded conditions	May be unreliable in shaded conditions
Seasonality	Mid-May to late June	June-early October (before leaf-off), or fall and winter with adequate skill.
Standard equipment (details below)	6-ft long rope or staff Smart phone with app or tally sheet Compass Hammer Center and quadrant stakes or flags Tape measure Yard stick to record plant height	Same
Unique equipment	Horticultural tags to mark individual stems Wildflower identification guide (see Appendix)	Horticultural tags to mark individual seedlings for height measurements Stick with 6-in, 3-ft and 5-ft heights marked Tree seedling identification guide

Selecting a Property

The property where you take measurements will be a woodland or forest site. The property could be your own land, public forest land, properties owned by a local land trust or other community-owned or private land. If you don't own the land, be sure to ask permission of the owner and explain the long-term nature of the monitoring project. Some public or private agencies, organizations, or individuals may welcome your involvement.

These assessment methods are intended to measure vegetative response to a change in deer browsing pressure, and an associated increase or a decrease in deer impacts. If the availability of sunlight or soil conditions limit plant growth, then the methods will not accurately detect changes in deer impact. Therefore, select a location that would allow a vegetation response when deer abundance changes.

At any property there will be a range of conditions among different areas. Think about the environmental differences you might expect in a steep-sided ravine with a dark hemlock canopy versus a mature hardwood woodland with scattered wind-thrown trees versus a recently harvested oak-pine forest. Light levels and soil conditions will be quite different. These areas of distinctly different conditions are called "stands." A forest stand is analogous to a farmer's field; and there are obvious difference between a corn field, pumpkin field, or pasture.

At the property you select, **avoid** areas (stands) that have any of these characteristics (see site selection illustration guide below):

- Permanent standing water such as wetlands although woodland around the wetland may be suitable
- More than 65% cover of exposed rock
- High densities of interfering plant species (ferns, grasses, invasive herbs, invasive shrubs, etc.)
- Slope greater than 40%
- Canopy > 50% closed, but some flexibility permitted (Wildflower method preferred under these conditions)
- Subcanopy > 50% closed, but some flexibility permitted (Wildflower method preferred under these conditions)

Sunlight is essential for plant growth. Although the methods may be implemented in forests with any amount of canopy closure (shading from overstory trees), a closed upper canopy or closed mid-story canopy prevents light from reaching the forest floor. Without adequate sunlight woody and herbaceous seedling growth is limited. Therefore, try to select stands for your measurements where on average less than half the sky is shaded by overstory trees when looking up. Remember, your perspective on the amount of sunlight is your view skyward from ground level.

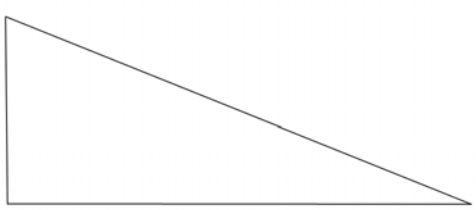
Stands with recent timber harvests, even where much of the tree canopy has been removed, are acceptable. However, stands where broadcast herbicides have been used to control

competing vegetation or that have been grazed should be avoided for a period of two years. If you are aware of a stand on your property where wildflowers are present or abundant and you plan to implement the spring wildflower element of the protocol, then choose that stand for sampling. The key below will help guide your site selection.

Key to Aid in Site Selection

Slope

Is slope > 40%? This is not a suitable site
Is slope ≤ 40%? This is a suitable site



This drawing depicts a slope of 40%. Any slope steeper than this would not be an appropriate site.

Rock cover

Is the site ≥65% covered by exposed rock? This is not a suitable site
Is the site <65% covered by exposed rock? This is a suitable site

Canopy closure

Do the overstory trees at this site block your view of more than 50% of the sky when looking up in most locations? If yes, then all methods could be implemented at this site, however shading from the tree canopy will limit seedling growth and dampen seedling height growth response to changes in deer browsing. Focus on spring wildflower methods in this site if possible.

Are there openings between the overstory trees that allow you to see more than half of the sky when looking up in most locations? If so, you can implement any or all methods at this site.

The pictures below can help you decide how closed the canopy is at potential locations and can help you check the correct canopy percentage on your form (s).

0-10% canopy closure

10-20% canopy closure

20-30% canopy closure

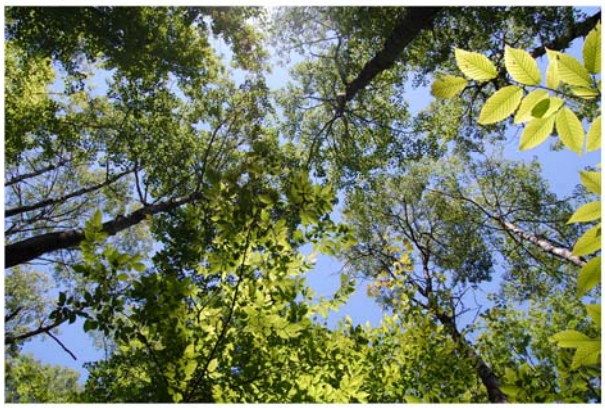
30-40% canopy closure

40-50% canopy closure

50-60% canopy closure

60-70% canopy closure

70-80% canopy closure



80-90% canopy closure

90-100% canopy closure

Understory canopy closure

Is there dense subcanopy of trees or shrubs below the main canopy that blocks sunlight from over half of the sky? If yes, shading will limit seedling growth. Focus on spring wildflower methods at this site if possible.

Pictures showing dense cover of American beech (left) and barberry (right) in the subcanopy and shrub layers of the forest. In these stands, the wildflower method is most likely to respond to changes in browsing impacts.

Are there openings between the understory trees and shrubs that allow sunlight to reach more than half of the forest floor in most locations? If yes, you can implement any or all methods at this site.

Fern, grass, sedge and invasive herb cover

Do ferns, grasses, sedges, or invasive herbs cover significant amounts of ground within the stand? Wildflowers that occur within fern patches can be measured. Only select woody seedlings if they are taller than the fern patch.

Plot Selection and Set-up

Equipment needed:

- Compass
- 2 yardsticks, or a stick or string cut to 2 yards in length
- 2 strings cut to 12 feet in length (to help lay out quadrants for wildflower methods only)
- Permanent marker
- Smart phone with app, or data sheets with pen or pencil
- PVC (2-ft x 1-inch), wood, or rebar stakes for marking plot center
- Hammer or mallet for pounding stakes into ground
- Brightly colored paint, brightly colored duct tape, or surveyors flagging for marking stakes
- GPS unit or phone with GPS capability
- Numbered tags (provided by Cornell University Department of Natural Resources, contact Kristi Sullivan at KLS20@cornell.edu)

The objective of these methods is to measure changes in vegetation in response to changes in deer browsing pressure. If your property's woodland is small (<10 acres), you will establish a minimum of six plots for each method you plan to implement. Locate the plots within the same "stand" in your woods. Because the vegetation in one stand will react differently to changes in deer numbers and browsing intensity than the vegetation response in another stand, the data need to be collected by stand. If you have a larger property and are able to devote more time to the assessment, consider establishing sets of six or more plots in multiple stands. If more than one stand type is present on your property, you may choose to establish one complete set of plots in two or more different stand types to capture the variability in deer impacts. For instance, if you have had a recent timber harvest in one area but not in another, you could set up monitoring plots in each of those areas. If you have woods of different ages, or dominated by different tree species (oak trees versus sugar maple, etc.) these different stands would allow for multiple clusters of 6+ plots each.

For either of the two methods it is necessary to have an adequate number of plants present to measure and monitor. Before choosing plot locations, spend 20 to 30 minutes walking the stand you plan to sample. Each plot is located subjectively to ensure there are adequate numbers of plants to measure. Because this type of sampling assesses deer impacts, the selection of plants does not need to be random. Rather selection of plants needs to ensure that plants will reflect increasing or decreasing changes in deer browsing intensity. The goal is to measure at least 30 plants total of one species from the six or more plots. Each plot can have a different number of plants. All plots should be located at least 50 feet from the forest edge where the trees meet an open field, shrubland, wetland, or other non-forest habitat type, and at least 50 feet from human disturbance (skid trail, old home site, hiking trail, road, etc.). If you are conducting the Wildflower method, look for areas where the target species (Appendix A) are growing. Likewise, if you plan to implement the Woody Seedling method, look for areas with an abundance of woody seedlings (trees or shrubs) between 6 inches and 4 feet tall.

Set Up Sampling Plots

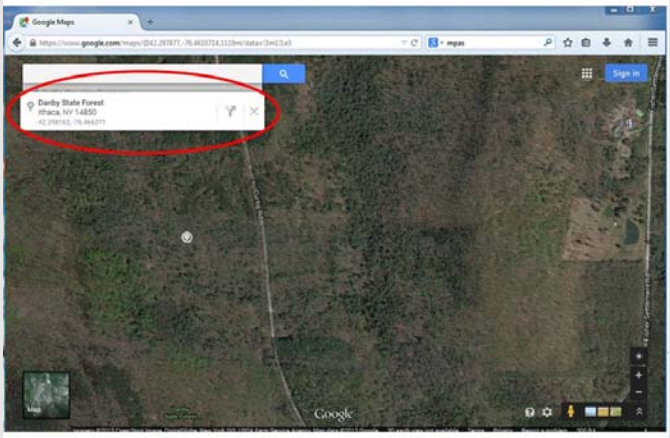
For either method, participants will establish plots with a six-foot radius. Establish as many plots as needed to include 30 or more plants of each species you select. Each plot center should be located at least 25 feet from the center of any another plot. Select a location and mark the plot center using a 2-foot long piece of pvc pipe that is 1 inch in diameter, or a short wood or metal rebar stake (Figure 1). PVC is inexpensive and lightweight to carry. You can paint the top of the stake with tree-marking (or other) paint to make it more visible, or wrap it in brightly colored duct tape. If possible, record the GPS location of each plot center with latitude and longitude or UTM coordinates and write the plot numbers on your stakes using a metal tag, permanent marker or another long-lasting method. It is also a good idea to draw a map of your plots on your data sheet and write the numbers on the map in case the numbering in the field fades or is lost. Marking an access trail with surveyors flagging or other material is helpful (and sometimes essential) for relocating plots.

Pacing to Measure Distance

Pacing is a reasonably easy and quick method of measuring distance in the field. One pace is defined as **two** footsteps walking at a natural pace. Twelve paces should cover 50 feet even for individuals with a very short stride. Therefore, if you don't have a long measuring tape or do not wish to carry one afield, you can walk 12 paces from any forest edge or disturbance. Six paces would represent an adequate distance between plot centers.

Using Google Maps to Find Latitude and Longitude – An Alternative to a GPS

If you do not own a GPS unit there is another easy way to find the coordinates for your site location. If you search the internet for Google Maps, you can zoom into the location where your site is located. Clicking the spot on the map will show the coordinates (latitude and longitude) in the box that appears underneath the search bar. You can then copy the latitude and longitude onto your data form.



Plots will have a 6-foot (2 yard) radius (Figure 2). You can use two yard sticks, or cut any stick to a 6-foot length. The plot edge can be marked with small sticks or other objects around the edge to help you visualize the outer limits of the plot. **It is important to avoid trampling the vegetation within the plots you establish**. These plots will be resampled over time and plants can be damaged by trampling, affecting the validity of your results.

Figure 1. Mark your plot centers with pvc pipe, a wooden stake or rebar. Mark the stake using brightly colored paint, surveyors flagging or brightly colored duct tape to make it easy to relocate.

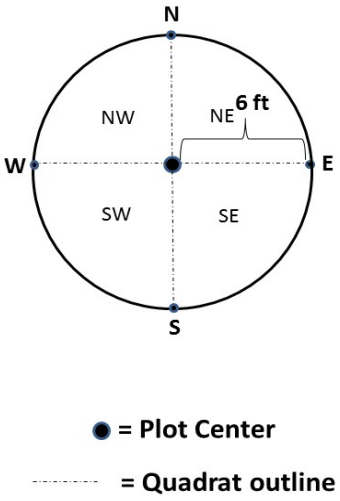


Figure 2. Schematic and picture of one plot showing 6-foot radius and four quadrants. Each quadrant is established by measuring two yards to the edge of the plot and marking the plot edge at each of the four cardinal directions.

Set Up Sampling Quadrants

Dividing each plot into quarters, or quadrants, can be helpful for keeping track of, and relocating, individually marked flowers or seedlings. Four quadrants can be established by marking the plot edge at each of the four cardinal directions (north, south, east, and west) (Figure 3). A stake, brightly colored pin flag, or PVC pipe can be pounded into the ground to denote each of the cardinal directions. Use a ¾ inch or 1 inch PVC pipe cut to 24" lengths. Stakes should be labelled N, S, E and W. This will create 4 quadrants for sampling – the northeast quadrant, northwest quadrant, southeast quadrant and southwest quadrant. Permanently marking the cardinal directions will make re-measuring easier in future visits. Two 12-foot strings can be laid out from north to south and east to west to help you visualize the

individual quadrants as you sample (Figure 3). Data should be collected first in the northeast quadrant and should continue in a clockwise direction. Remove the strings when finished sampling.

Figure 3. Schematic and picture of one plot showing 6-foot radius and four quadrants. Each quadrant is established by measuring two yards to the edge of the plot and marking the plot edge at each of the four cardinal directions.

Collecting Data

A smart phone application (AKA "app") will be used to enter the data you collect. The app needs to be downloaded before going into the field, and activated where a cell signal exists. The app will store the data and automatically upload the data to a central computer server when a signal is available. Real time comparisons to other data is possible via the app. Paper data sheets (Appendix B) are available and match the data collected via the app. If paper data sheets are used, the data will be uploaded to an online database at www.BillHubbard.com

Plot Description

Use the app or data sheet to collect information on variables that describe the plot. These data will allow for analysis and interpretation among plots and locations that vary in the growing conditions for plants. The plot description variables document factors that influence the potential for plant growth. Because excessively rocky or wet soils were not sampled, only data on sunlight needs to be recorded. The extent of openness is reported at each of three levels or strata. The extent of canopy openness is reported for the following strata or levels:

- Canopy (the tallest layer, but usually > 30 ft tall)
- Subcanopy (midstory) (the layer below the overstory, but usually 8 ft to 29 ft tall)
- Ground/shrub layer (the layer closest to the ground, but usually < 8 ft tall)

Details and pictures of canopy closure for each strata were provided previously. Some stands will have plants that occupy all three strata, in other cases one or two strata.

Some native and non-native species can be problematic. They may form subcanopy or ground layer cover that is inhospitable to wildflowers and woody seedlings. Some establish dense monocultures and in doing so prevent light from reaching the forest floor. Other species form dense mats of roots that prevent plants from becoming established. These monocultures may persist indefinitely without management and reduce the potential for other flowers, shrubs and trees to grow. Examples include some native ferns, grasses and sedges, rhododendron (*Rhododendron spp*.), mountain laurel (*Kalmia latifolia*), blueberry (*Vaccinium spp*.), American beech, hop hornbeam, briars, and others. Many exotic invasive plants may also become established and persist in this way, including Japanese stiltgrass (*Microstegium vimineum*), barberry (*Berberis spp.*), honeysuckle (*Lonicera spp.*), mutiflora rose (*Rosa multiflora*), buckthorn (*Rhamnus cathartica*), tree-of-heaven (*Ailanthus altissima*), swallowwort (*Vincetoxicum spp.)*, oriental bittersweet *(Celastrus orbiculatus)* and others. To assess the degree to which interfering vegetation is preventing regeneration now and into the future, please check the approximate percent cover provided on the datasheet (Appendix A page 24) for each level of competing vegetation. If you know the name(s) of the species present, please list them in the comments section. This will help to assess the degree to which interfering vegetation is preventing regeneration now and into the future. If you are uncertain of the species name, you can take a picture and upload it using the app for identification.

Method 1. Spring Wildflower Method

The spring wildflower protocol will include measurements of Trillium. Canada mayflower, Indian cucumber (*Medeola virginiana*), Jack in the pulpit (*Arisaema triphyllum*) and possibly others. These species are fairly common and decline in abundance, show reduced height, or show reduced flowering when browsed by deer. In the absence of these species, Solomon's seal (*Polygonatum* spp.) and False Solomon's seal (*Maianthemum racemosum*) as well as other Solomon's seal species can be monitored instead. The goal is to select areas that allow you to monitor at least 20 stems of a species. Secondary species can be included if at least 15 to 20 stems are present.

Wildflowers exhibit patchy distribution in any forest and not all of these species will occur at every site. However, any or all of these species may be monitored when present. Picture guides to help you identify these flowers are provided (Appendix B). These guides are included in the app, or can be printed and taken afield as references.

When selecting which wildflower species to monitor, search your stand for species with at least 20 (but ideally 30 or more) individual plants of that species that are four inches or taller. Canada mayflower may be less than 4 inches tall. Place plots where the tallest plants of your chosen indicator species are growing. Deer tend to forage selectively on taller plants as they are more accessible. Therefore, the taller plants are more likely to be impacted by deer and will show the greatest response to changes in deer browsing intensity. Trillium and jack-in-the-pulpit begin as 1-flowered plants but do not flower until reaching the 3-leaved plant for several years. When monitoring these species, select 3-leaved individuals if they are available. Likewise, Indian cucumber does not flower until it has 2 whorls of leaves. When possible, select Indian

cucumber plants with 2 whorls. However, if 2-whorled individuals are not present, 1-whorled plants can be selected. Plant height will not be measured for Canada mayflower.

Try to locate your plots to include three to seven or more individual flowers of the species you plan to monitor in each. Canada mayflower is the exception, as it tends to grow in dense clusters. For Canada mayflower, ensure that each of your six plots includes a cluster of 10 or more stems. If you wish to monitor more than one species it may be possible to capture enough individuals of more than one species within the same six plots, or you may need to establish additional plots.

Once you have chosen your target species and created your plots, mark each plant you will monitor with a numbered plastic or wooden plant marker 5-6 inches in height (Figure 4). Number the marker so the plant can be identified individually and place it in the soil directly behind the plants to which it refers. Be careful not to insert the stake so close to the stem that the roots are severed. These markers will be helpful for relocating and tracking each plant. However, markers can sometimes be disturbed by animals and in plots where many wildflowers are present, it may be unclear exactly which plant the marker refers. To help relocate the exact plant stems you are monitoring, each plant can also be marked with a colored twist tie (Figure 4). Wind the twist tie around the base of the stem, leaving a wide loop at the bottom so the stem is not disturbed. The ties can get buried by newly fallen leaf litter on the forest floor and should be uncovered each year but they generally stay associated with the plants.

Figure 4. Wildflowers can be marked with 5 or 6-inch plant markers numbered with a permanent marker. A twist tie affixed loosely around the base of the stem can help to relocate the plants in the event that the marker is disturbed.

Measure and record the height of each plant from the litter surface to the base of the leaf whorl (Figure 5). Record the height as “natural height” (do not manually extend the plant to make it more upright), measuring straight up from the ground as if measured along a plumb-bob line from the ground to the point where the stem intersects the leaf whorl. For plants with multiple stems, choose the tallest stem to measure. Indian cucumber will often grow two sets

of leaf whorls (Figure 5). If two sets of leaf whorls are present, measure to the base of the highest whorl. For each plant you are monitoring, record whether it is flowering or shows evidence that it has flowered or will flower this season (bud, flower stems still attached, opened seed pod, etc.).

Figure 5. Indian cucumber (pictured left) should be measured from the ground to the base of the second leaf whorl, if available, or the first whorl if only one is present. Trillium (pictured right) and jack-in-the-pulpit will only have one leaf whorl and should be measured from the ground to the base of the whorl.

For Canada mayflower, which often grows in dense patches, rather than mark individual plants you will count and record all individual stems until 10 stems have been counted, after which you may estimate by groups of 10. Count carefully and note the total number of stems and the number of flowering stems.

Method 2. Woody Seedling Heights

Spend 20 to 30 minutes walking the stand you plan to sample. This method focuses on identifying one to several common woody species in your stand and tracking seedling growth until seedlings grow beyond the reach of deer (five feet tall). Look for areas with an abundance of woody seedlings, trees or shrubs, less than five feet tall, and ideally between six inches and three feet tall. When choosing the kind of tree or shrub to monitor, select species that allow you to measure at least 20 (but ideally 30-50) stems. If there are not enough seedlings in that height range, you may include individuals in the 3-4 foot height range as well. You should continue monitoring the individual seedlings you select until they reach 5 feet in height (the height at which deer will no longer affect their ability to grow into mature trees). Once the number of seedlings of a given species drops below 20 because of height growth beyond 5 feet, you should select new stems or establish new plots containing that species to continue monitoring.

By measuring one or more species of differing browse preference levels (Table 3) you can learn a great deal about deer impacts in your woodland. If seedlings of a variety of species and preference levels are growing in your forest and are able to grow past the reach of deer, then deer impacts are likely low. If you have only species which are not preferred by deer, this may

indicate that your forest is heavily browsed by deer, or has been historically. If you observe deer browsing on seedlings of preferred species, such as sugar maple, but not on American beech, which is less preferred, then deer impacts may be moderate. However, if deer are browsing on both preferred and non-preferred species (essentially any or all available woody seedlings) then deer impacts likely are substantial.

To quantify these impacts, select seedlings of the target species that are as tall as or taller than the approximate average height of that species in that plot. Try to locate your six plots so that each includes 5 or more individuals of your target species in each plot. If possible, select at least two species to monitor - 1 species that is highly preferred by deer and 1 species that is less preferred by deer (Table 3). If you must choose only a species from the less preferred category because other species are not available, please specify that in the box provided on the data sheet.

Seedlings need to be vigorous and healthy. The height of 5 or more seedlings in the plot will be recorded and each seedling will be identified with an individually numbered tag. Record the height as "natural height" not extended height, measure straight up from the ground as if measured along a plumb-bob line from the ground to the highest location on a twig (not the tip of a leaf). Attempt to distribute 2 or 3 seedlings in each quadrant, ideally with some seedlings located close to the center of the plot and others close to the edge of the plot. Record the quadrant and the height, to the nearest 0.5 inch, for each tagged seedling. Additional species can be tagged and measured within a plot if there are at least 5 stems.

Each seedling should be identified with an individually numbered tag.

Additional species can be included, and some participants may choose to monitor 3 to 10 species. Typically one plot will have one or two species that are tagged and measured. You will establish 6 to 10 plots, each with a 6-ft radius. If you plan to implement both the Wildflower method and the Woody Seedling method, the same plots can be used for both provided that an adequate number of seedlings and wildflowers are present. Otherwise, additional plots should be established as needed.

Plots can be clustered or dispersed. Use stakes to mark the center and the four quadrants (see wildflower methods). Tags may be obtained from www.Forestry-Suppliers.com ("utility slip on tags" item # 79186) or other vendors. You may request tags from Cornell University Department of Natural Resources at KLS20@cornell.edu

In some stands, deer pressure will have been sufficiently severe that a 6-foot radius plot will not include a sufficient number of stems. In these circumstances, increase the number of plots until you have sufficient numbers of stems.

Table 3. Some low-preference and high-preference tree and shrub species in New York State

High Preference Species	Low Preference Species
Red maple (*Acer rubrum*)	American beech (*Fagus grandifolia*)
Sugar maple (*Acer saccharum*)	Hop hornbeam (Ostraya virginiana)
White ash (*Fraxinus americana*)	Striped maple (*Acer pensylvanicum*)
Aspen (*Populus* spp.)	White pine (*Pinus strobus*)
Oak (*Quercus* spp.)	Red pine (*Pinus resinosa*)
Basswood (*Tilia americana*)	Spruce (*Picea* spp.)
Eastern hemlock (*Tsuga canadensis*)	American hornbeam (*Carpinus carolinensis*)
Birch (*Betula* spp.)	Black cherry (*Prunus serotina*)
Maple–leaf viburnum (Viburnum acerifolium)	
Witch-hobble (*Viburnum lantanoides*)	
Red elderberry (*Sambucus racemosa*)	
Blackberry and raspberry (*Rubus* spp.)	

Mini Deer Exclosures – Establishing a Baseline for Your Woodland

Creating small deer exclosures in your woods can give an indication of what could possibly grow in your forest in the absence of deer browsing. By fencing a couple additional plots per stand, you will be able to see the potential wildflower, tree and shrub species that could be present. You can also observe the height of the seedlings and flowers inside versus outside the exclosures, as well as the wildflower flowering rates.

Ideally, you should establish deer exclosures to complement measurements of species performance outside the exclosures and to assess how a particular species will perform in the absence of deer browse. By excluding deer from some areas in the same stand, you can make a direct comparison between what you might expect to see versus what you are seeing.

Small exclosures can be constructed from various fencing and pole materials and are fairly easy to erect (Figure 6). Garden posts and welded wire fencing, or even deer netting and bamboo poles with the wire affixed by zip ties, can provide protection. Fences should be 4 to 5 feet high.

Figure 6. Deer exclosures can help establish a baseline for what vegetation you might expect to grow in your woodland if deer browsing was not a factor. This exclosure in a clover field, shows clearly that clover height is taller inside the fence than outside.

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Appendix A. Data Sheets

Data Sheet Instructions

Three separate data sheets are provided in this Appendix for those without the phone app, or those wanting to see the structure of the data. The first is a site data sheet which should be completed once for each overall site, or stand, where your plots are located each time you sample the site. The second data sheet is for the woody seedling data and should be used when conducting the Spring Wildflower method (Method #1). This sheet includes descriptive information for each plot. A third data sheet is provided for conducting the Woody Seedling method (Method #2). This sheet also includes descriptive information for each plot. If you use the data sheets, use a new sheet each year.

Spring Wildflower Data Sheet (Method #1)
AVID: Assessing Vegetation Impacts from Deer

Plot #	Date	Recorder Names	
GPS at Plot		Vegetative Layer	Use picture guides to estimate percent cover
		Ground Cover	_____ %
		Subcanopy	_____ %
Is plot enclosed or protected from deer: Yes No		Canopy	_____ %

Vegetative Data (note – for Canada Mayflower report the # of stems in "height" and # of flowers in "flower evidence"). If the plant is no longer alive and available to measure, enter "D" under height.

			Initial Measurement			Re-measure date:		Re-measure date:		Re-measure date:	
Species	Tag #	Quadrant	Height (inches)	Flower Evidence (Y/N)		Height	Flower Evidence	Height	Flower Evidence	Height	Flower Evidence

Woody Seedling Data Sheet (Method #2)
AVID: Assessing Vegetation Impacts from Deer

Plot #	Date	Recorder Names	
GPS at Plot		Vegetative Layer	Use picture guides to estimate percent cover
		Ground Cover	_____ %
		Subcanopy	_____ %
Is plot enclosed or protected from deer: Yes No		Canopy	_____ %

Vegetative Data

List the 4 most common woody species in the stand:

Seedling Height Data (If the plant is no longer alive and available to measure, enter "D" under height).

			Initial Measurement		Re-measurement date:		Re-measurement date:		Re-measurement date:	
Species	Tag#	Quad	Height (inches)		Height (inches)		Height (inches)		Height (inches)	

Appendix B. Wildflower and Seedling Identification Guides

Indian cucumber-root
(*Medeola virginiana*)
Habitat: moist woods
Height: approx 3 feet tall
Leaves: 1 or 2 whorls of 5-8 leaves
Flower: small, appears above top whorl, may be 2-3 flowers per plant
Flower color: yellowish
Flowering time: late May-early June
Fruit: a dark purple or black berry
Distinguishing characteristics: whorls of usually 5-8 leaves, stem usually fuzzy and wiry close to ground

Flowers hang from top whorl

Whorl may have 5-8 leaves

Berries atop whorl

Flower arises from top whorl

Potential Lookalike:

Star Flower (*Trientalis borealis*)
Similar whorl of leaves but no top whorl present
Habitat: frequent in moist woods
Height: approx 4-8 inches
Leaves: whorls of 5 to 10 leaves, leaves are narrow, unequal sized
Flower: 1-4 flowers per plant, petals, 1/2 inch across
Flower color: white
Flowering time: May-June
Fruit: small, dry brown globular capsule
Distinguishing characteristics: distinctive flowers, features based on sevens: seven leaves, seven petals and seven sepals

Flowering plant

Flower close-up

Trillium (*Trillium spp.*)
Habitat: moist woods
Height: 1 - 1.5 ft, except for Snow Trillium (6 in.)
Leaves: three, in a whorl
Flower: found at the center of the whorl of leaves
Flower color: white, maroon, pink, yellow or green
Flowering time: April- May
Fruit: a berry
Distinguishing Characteristics: whorl of three leaves, flower is made of three petals

Large-flowered trillium (*Trillium grandiflorum*)- white or maroon flowers

1, 2, and 3 leaved white trillium

Fruit

Leaves form an equilateral triangle shape

*Note flowers/fruit at top of plant, whorl of 3 leaves

Purple trillium (*Trillium erectum*) - maroon flower, leaves are stalk-less

Painted trillium (*Trillium undulatum*) - white with pink center, leaves are on petioles that come out of the center

Jack-in-the-Pulpit (*Arisaema triphyllum*)
Habitat: common in moist woods, swamps, bogs
Height: approx 3 feet
Leaves: 3 leaflets
Flower color: white, green or maroon, streaked
Flowering time: Late April-June
Fruit a cluster of red berries.
Distinguishing characteristics: Distinct flower shape

Entire plant, showing leaves

Flower

Fruit

More prominent mid-vein

*Note leaves in 3 may resemble trillium, especially if no flowers are obvious. Jack-in-the-Pulpit will have one prominent mid-vein. Trillium has less obvious mid-vein and rounder leaves.

Potential look-alike for Trillium and Jack-in-the-Pulpit:
Mayapple (*Podophyllum peltatum*)
Also has whorled leaves, but has more leaflets. Usually branched into two leaves. Distinct flower.

Canada Mayflower (*Maianthemum canadense*)
Also called "False Lily-of-the-Valley"
Habitat: common in dry to moist woods
Height: 3-6 inches
Leaves: 2-3, alternate, parallel veins
Flower size: 1/8th inch long
Flower color: white
Flowering time: May-early June
Fruit: a red berry
Distinguishing characteristics: leaves clasping at base and somewhat heart-shaped, flower in a raceme (flowers on a stalk). Rhizomatous (creeping), may form a mat.

Close-up of flower (raceme)

Note: parallel veins in leaves appear prominent

Berries

*Note: Canada Mayflower may also resemble young greenbriar leaves, but greenbriar will be more heart- shaped, and Canada Mayflower will usually be seen in mat.

Mat covering forest floor

Lookalike: **Lily of the Valley (*Convallaria majalis*)**
Habitat: occasionally naturalized in woods & disturbed ground
Height: 8 inches
Leaves: 2-3 alternate, parallel veins
Flower size: 1/4 inch across
Flower color: white
Flowering time: April-early June
Fruit: a red berry
Distinguishing characteristics: fragrant bell-shaped flowers on a raceme. native to Europe, may act invasively.

bell-shaped flowers