Forest Regeneration Assessment Series

2 What's Getting in the Way of Your Woodland's Potential to Regenerate?

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Introduction

Why Your Forest May Not Be at a Point of Regeneration

This sugar maple seedling is an example of natural regeneration, which is essential to sustaining the state's hardwood forests.

In the *Forest Ecology: How a Forest Grows* publication, you were introduced to the process of stand development – stand initiation, stem exclusion, understory reinitiation, and complex/mature forest. Forests that are in the stand initiation or stem exclusion phases of development often don't have regeneration considerations – they are either already a young forest (stand initiation) or they are a closed canopy (stem exclusion) with little light reaching the forest floor. The latter condition can persist for decades. However, whether by natural forces or human-induced disturbance, at some point openings will occur in a closed canopy.

Examples of when you might need to be concerned about forest regeneration include:

- creating young forest for wildlife,
- preparation for overstory removal harvest,
- long-term income (planning for the next forest for sustainable forest management),
- risks associated with severe storms, ice damage, and fire.

Planning for establishing, or releasing already-established, regeneration is not without risks. Recognizing and addressing those risks benefits from assessing current conditions and threats and developing a plan that will increase the likelihood of success. This publication series will prove useful in conducting an assessment, finding assistance, and sustaining your woodland ownership values.

Regardless of where your forest is in its development, it is important to be aware of potential ecological threats that will not only compromise regeneration, but also overall health and resilience of existing forest: deer and competitive plants. Choosing the extent of current control/treatment directly connects to planned future practices. As you read this publication, be aware that your forest may not yet be at a place where you need to have concern about forest regeneration; however, if you intend to ensure a healthy, working forest continues for generations, at some point there needs to be concrete action taken to assess, plan, and act to create forest regeneration. This publication series will assist you in that process.

What's Getting in the Way of Your Woodland's Potential to Regenerate?

Natural regeneration is essential to sustaining Pennsylvania's hardwood forests and the many values they provide. Sustaining the state's forests, nearly 17 million acres, depends on the development of "the next forest" from the trees already growing and creating the high canopy seen across the landscape. This is not a planted forest. Rather, it is a forest that depends on trees naturally following trees. To have this happen, it is essential that the state's forests accumulate advance regeneration in the understory to ensure that the next forest is there and ready to grow. True, some seeds lay dormant in the forest leaf litter waiting to germinate under desirable conditions, but this is not as common as believed. As well, in the past, some species such as oak successfully contributed to regeneration through stump sprouts; however, larger trees are less likely to sprout, and white-tailed deer often prefer browsing sprouts. Our forest's future depends on ensuring that our management and use practices foster adequate advance regeneration.

US Forest Service forest inventory reports for Pennsylvania repeatedly find naturally occurring forest regeneration lacking across much of the state. Recognizing that light is a driving factor in initiating and sustaining forest regeneration, that research specifically focuses on stands where canopy disturbance (59% or less closed) from harvesting or natural events should encourage seedling development. The most recent report from 2014 found that 50% of the state's forests, public and private, have canopy density or openness that should favor regeneration.

However, under these canopies, things are not going well. The Forest Service inventory divides regeneration into three seedling and sapling species groups[1]: Desirable, Commercial, and All Woody[2]. If the evaluation includes all the species listed in the All Woody species group, 68% of the forest has sufficient regeneration to establish a new forest. Some of these species provide wildlife food and cover, and depending on landowner values and objectives, are acceptable in the forest; while other species suggest concerns about future forest composition. Stepping back to the Commercial species group, the projected capacity of forest replacing forest drops to 59%. This too might be acceptable to some woodland owners; although, several species offer little economic or wildlife value (e.g., birch, beech, elm, and black locust). Finally, for the Desirable species group (admittedly those more favored for economic value), only 40% of the forest has sufficient regeneration to replace the existing forest canopy.

Interpreting these findings, the Forest Service notes that species not listed as preferred white-tailed deer browse fare better than those favored for browse; more shade tolerant species are expanding over shade intolerant species as they respond better in small canopy gaps resulting from partial cutting. As well white-tailed deer browsing preference further influences species success in small openings. Specifically, deer do not preferentially browse sweet birch and beech, and both species respond well to small canopy gaps. Further the survey findings suggest that harvests often focus on removing specific species or trees in larger size classes. For example, harvests focused on oak species, which are difficult to regenerate, remove or greatly reduce desirable seed sources, and sweet birch and red maple then come to dominate these disturbed forests.

Reasons for not attaining adequate regeneration are complex and may often include more than one impediment; however, frequently the problem involves 1) plant competition, 2) white-tailed deer, and 3) light-related conditions. Beyond these three obvious issues, there are site-related conditions (e.g., sites that are either too wet, dry, or stony) often reflecting site changes as a result of the canopy disturbance event.

Setting a course for successful forest regeneration or stand replacement is an often overlooked or a poorly understood forest stewardship goal. This publication will provide a tool for evaluating individual forest stands and provide basic insights into management options that may increase potential for developing conditions designed to foster successful regeneration.

[1] Seedlings and saplings include all trees from established seedlings to 5 inches DBH (i.e., Diameter at Breast Height).

[2] Desirable: Black cherry, Oak, Sugar maple, Red maple, Conifer, Hickory, Yellow-poplar, Ash, Basswood, Cucumber, Walnut, Butternut; Commercial (Desirable plus): Birch, Beech, Black gum, Elm, Black locust; Hackberry, Aspen; All Woody (Desirable and Commercial plus): Honey locust, Sassafras, Ironwood, Shadbush, Mountain ash, Blue beech, Hawthorn, Dogwood, Redbud, Pin cherry, Striped maple, Hercules club, Scrub oak, Chokecherry.

Openings in the canopy and a low deer population create good conditions for these young oaks to thrive.

What Do You Want?

What you want is an interesting question and it warrants consideration by every woodland owner, whether the ownership encompasses hundreds of acres or a wooded house lot. Research has repeatedly found that woodland owners want to do well by their land – they want to be stewards.

Taking care of a woods involves planning, developing more than a cursory understanding of forest ecology, investing time and resources in addressing management (i.e., care), which are driven by what you value about your woodland and what is important to you. Again, research finds that woodland owners express diverse values. Among the most frequently mentioned are solitude and privacy, wildlife, recreation, aesthetics, hunting, estate and legacy, and relatively far down the list is income production.

Attaining and sustaining any and all the common values expressed by woodland owners requires retaining desirable forest conditions. It is often difficult to appreciate how dynamic forests are and how they change slowly but continually. Individual trees die, which is obvious, but understanding the process through which trees replace trees and the time scale required involves thinking at spatial and temporal scales that extend over several human lifetimes, especially with the hardwood forests common across Pennsylvania.

If these ideas resonate with a woodland owner, the need for regeneration Is easily understood. More problematic is describing what is missing from a forest. It is important to assess and document regeneration conditions and to appreciate the interactions of competition among plants, the requirement for appropriate light conditions, and the role of white-tailed deer in shifting or sustaining plant communities.

Finally, attaining forest regeneration is a process. That is, it does not generally happen quickly or as the result of one decision. For example, harvesting does not mean regeneration will just appear; rather, creating appropriate light conditions, conserving desirable seed-producing tree species, managing competing vegetation, and keeping deer populations in balance with ecological conditions prior to a harvest, might result over time in successful regeneration – even then, there is no guarantee. Assessing conditions, regeneration development, and planning for management activities all contribute to successful outcomes. Failure to plan and assess conditions is more likely to result in poor outcomes.

Looking for Forest Regeneration: Assessing Your Woodland

Understanding the need to establish and foster adequate tree regeneration is the primary role of this publication. This understanding begs the question: “What conditions exist in my woodlands?” Answering this question depends on conducting a systematic evaluation or assessment of stand level conditions. Looking ahead, publication number 3 in this series, *Evaluating Stand Conditions: Implementing and Interpreting the Regeneration Assessment*, presents specific protocol and methods for collecting data and guides your understanding of existing conditions using a stand-level decision tree to determine what level of regeneration exists in your forest. At that point, before undertaking any actions, you should consult with a resource professional to thoroughly consider appropriate management actions.

The remainder of this publication will explore how the intersection of light, competition, and white-tailed deer set the stage for achieving successful

stand-level forest regeneration. This is important as success or failure sets the stage for forest development for many years into the future.

In each section that follows look for the reference to **PROTOCOL**. For those who wish to look ahead, these notes link to the specific guidelines in publication number 3 in this series. Alternatively, these provide an easy link back to this discussion and provide the reasoning behind collecting specific information.

Initial Assessment

Forest Ecology: How a Forest Grows, the first publication in this series, introduced several terms and concepts important for beginning to assess forest conditions. Recall that a "stand" is a contiguous, distinguishable group of trees of similar age distribution, species, structure, site, and history such that it is recognized as a unit. A landowner might even recognize and name these areas as the hemlocks, the old orchard, the oak ridge. Taking the time to outline your stands on a property sketch or aerial photograph printed from the internet starts the process of assessing woodland conditions.

Deciding on preliminary stand boundaries is challenging. For smaller properties, there is a tendency to define many small units; while, on larger properties, the opposite is often true. In the latter case there is the risk of large stands overwhelming an owner's capacity to embark on necessary management activities. Know, though, that work within larger stands can target activities and result in sub-stand units.

> **PROTOCOL:** Mapping assists with identifying important or valued woodland places. Stand Area guides sample size selection (i.e., number of plots to estimate existing conditions).

Do not lose track of the point that this assessment activity focuses on regeneration conditions. The development stage informs stand level understanding about the need for regeneration. Therefore, it is a good starting point. See Table 1 for a refresher on stand development stages. Clearly under ideal conditions there is seldom need for regeneration in the Stem Exclusion stage of stand development; however, this is not always the case. It is relatively easy to find situations where some competitive and/or invasive plant species are present in this development stage and this does not bode well for normal stand development. This is a condition to be aware of in the assessment. A second situation may occur where canopy gaps have developed because of cutting or invasive vines killing desirable saplings and larger trees. The role of competitive plants in stand development is a major concern even in the Stem Exclusion stage. Either while drawing the stand map or during an early visit to each stand, predetermine the stand development stage.

> **PROTOCOL:** Stand Development stage assists in categorizing stand-level conditions that aid in understanding if regeneration is important at this time.

Assessing Light

As noted several times before, light is the principle concern driving plant recruitment during forest stand development in Northeastern forests. A critical threshold appears where canopy structure is such that about 40 to 50 percent of the canopy is open. Said another way, if about half of the canopy has "blue sky," this should lead to understory plant development. At this level, sufficient light

Table 1. Stand Development Stages and What You May See

Stage	What you may see	What is happening
Stand Initiation Stage	Herbaceous plants, young shrubs, and young trees densely packed, brushy appearance. "Legacy trees" from the past stand may remain (for example, large individual trees, low quality trees often called "culls."	A disturbance (natural, or from a harvest) occurred recently, creating new growing space for seedling establishment or for release of advance regeneration. Growth will continue until all growing space is occupied resulting in a low canopy without gaps.
Stem Exclusion Stage	Heavy or full understory shade, no new shrub or herbaceous growth. Trees crowns small, canopy closed. Competition among small crowns, overtopped trees dying beneath same-age taller trees.	This development stage is long – 15 or more years. Trees from 5 to 12 inches relentlessly compete for light, space, and other resources. Some individual trees grow taller, faster, and thrive; less competitive trees die. Surviving trees expand crowns into the now-vacant space.
Understory Reinitiation Stage	Some small gaps in the canopy. Herbaceous plants, shrubs, and tree seedlings may appear. Some standing dead trees, uprooted trees, or large woody debris.	Some larger trees are gradually dying, leaving canopy gaps. Limited light resources initiate understory development, which may include tree seedlings. Shade tolerance may limit species diversity and success.
Complex Stage (Mature)	Large diameter living and dead trees. Groups of seedlings and saplings present. Foliage is continuous from the ground to upper canopy/ may be across the stand.	Individual tree death continues, leaves scattered larger openings spurring understory tree release or recruitment of more shade tolerant species, depending upon opening size. Seedling and sapling competition select for strongest individuals. This mature woodland stage has the most complex structural features, with plants of various heights and gaps in the canopy.

Adapted from:
Oliver, C.D. and Larson, B.A. 1996. "Forest Stand Dynamics, Update Edition." Y*ale School of Forestry & Environmental Studies Other Publications*. **https://elischolar.library.yale.edu/fes_pubs/1/**

consistently reaches the forest floor to initiate plant development. The second stand-related assessment variable is a determination of canopy openness.

> **PROTOCOL:** Estimate canopy openness to preliminarily prioritize stands for assessment. Measure actual closure using plot protocol

Competition: Assessing Species

In many forest stands, competition with regeneration occurs at various levels in the stand – from the canopy to the vegetation covering the forest floor. Start with the plants that comprise the canopy: do they represent expected species diversity? Do you have species that you do or do not want in the future forest? It is common in developing forest stands to lack species diversity, which subsequently may affect forest resilience (i.e., the ability to withstand issues that specifically affect one species such as emerald ash borer (ash), gypsy moth (oak), hemlock woolly adelgid (hemlock)) or stands may have undesirable species present (e.g., tree of heaven (*Ailanthus*), buckthorn, striped maple).

Simply, competitive plants compete for resources, especially light. Some plants, though, have the capacity to limit competition for light and other resources using chemical inhibitors through a process called allelopathy. Examples of species found in woodlands are black walnut and tree of heaven, which use exudates to inhibit development of other plants. Other plants, such as native hayscented, New York, and bracken ferns create dense shade layers close to the ground. Forestry research has found that shade within 25 feet of the forest floor is especially problematic; therefore, many woody native plants can create light-constrained situations. The species listing of All Woody regeneration contains numerous examples: sassafras, ironwood, shadbush, blue beech, striped maple as well as mountain laurel, spicebush, and American beech root suckers. With the exception of *Ailanthus*, all of these species are native and often become problematic because of preferential browsing by white-tailed deer.

PROTOCOL: Estimate mid-canopy percent cover and list composition.

Competitive plants from other places, often called exotic invasive species, are often more problematic than most of the competitive native species as they have several competitive advantages. First, they tend to leaf out sooner in the spring and retain their capacity to photosynthesize later in the autumn than native plants. These extended growing seasons provide a significant edge. Second, native herbivores, most notably white-tailed deer tend not to browse on many exotic invasive species. There are a few notable exceptions such as multiflora rose; however, browsing tends to focus only on succulent young shoots. Finally, many of these exotic invasive species are prolific seeders and readily dispersed by wind, water, and songbirds. The scenario that develops from these advantages easily gives many of them the ability to germinate in understory conditions and to then expand their foothold. See Appendix A for a listing of many common exotic competitive plants found in Pennsylvania.

PROTOCOL: Identify native and exotic woody plants. Identify native and exotic herbaceous plants.

Assessing White-tailed Deer Impact

Some woodland owners and hunters fail to recognize that white-tailed deer can adversely affect forest composition and development. Deer numbers have in places and at various times exceeded cultural carrying capacity and have, through selective and intensive browsing, shifted plant species composition. These changes have and continue to affect wildlife habitat quality for deer as well as other species.

The presence of wildflowers in the understory, such as this Canadian mayflower, can indicate low deer pressure.

Deer clearly prefer specific tree species. Browsing may contribute to problems regenerating all oak species and maple, especially sugar maple. As well, selective deer browsing may greatly reduce or even eliminate some wildflower species such as Canadian mayflower, trillium, Indian cucumber, and lady slippers. Some ecologists consider the lack of some of these wildflowers as important indicators of excessive browsing. On the other hand, predominance of some native (e.g., New York, hayscented, and bracken ferns, American beech root suckers, striped maple) and exotic invasive plants (See Appendix A) are an additional indicator as deer reduce some species to the benefit of those they choose not to browse.

Forest structure and appearance also provide insights into sustained or past deer impacts. Park-like appearances across a stand, where little understory develops is one example as browsing eliminates understory structure. Do not confuse the profusion of non-preferred species as a positive indicator of low deer impact.

Non-preferred tree species seedlings cropped by repeated browsing is another good indicator (e.g., American beech, black birch, red maple stump sprouts). Clear and evident browse lines where vegetation below five feet in height is eliminated or heavily browsed is another indicator. This is often very evident along woodland edges.

The below referenced Aviddeer website provides an excellent summary of deer impacts assessment.

- No Impact – only in well-maintained exclosures
- Low Impact – preferred woody regeneration abundant with varied height. Spring indicator wildflowers present, flowering, producing seeds
- Medium Impact – preferred woody regeneration present, all one height, herbaceous plants rare, non-preferred plants noticeably common.
- High Impact – preferred woody regeneration absent. Any seedlings heavily browsed. Wildflowers heavily browsed or absent. Ferns and invasive plants may be common.
- Very High Impact – even non-preferred seedlings reduced or heavily browsed. Ferns and competitive or invasive plants common and dominate forest floor or forest floor bare.

Admitting that deer are an issue is challenging for many woodland owners. For the purpose of this assessment, use two scales: Low and High. Low would be as stated above, and High is anything above that threshold as intervention is necessary to increase forest and regeneration resiliency. If deer impact is Low, you would need a weighted average count of 15 seedlings on the 1/1000th acre plot to adequately regenerate. If deer impact is High, you would need a weighted average count of 50 seedlings on the 1/1000th acre plot to adequately regenerate.

PROTOCOL: Assess if deer impact is Low or High.

Further Reading:

http://aviddeer.com/ - Cornell University - Assessing Vegetation Impacts from Deer

Summary

Obviously, understanding and assessing forest conditions and their effect on regeneration is complicated. At this point, three conditions serve as the basis for conducting an assessment: Light, Competition, and White-tailed Deer. The intent in this publication is to frame the rationale for addressing the regeneration challenge and encourage landowners to undertake an assessment by considering their individual stands. The next step in this process is to conduct detailed data collection to arrive at specific impediments to achieving desired future conditions. Once this is done, the hope is that an informed landowner will prioritize activities and seek assistance in developing a plan to ensure successful stewardship of their woodlands – at least as it relates to achieving forest regeneration.

Appendix A

Common Invasive Plants

To help you identify what is in your woodland, pictures of some common invasive plants of Pennsylvania are shown below. For more information about identifying and controlling invasive plants, go to **extension.psu.edu** and search for "invasive forest plants."

Trees

"Tree of Heaven"—*Ailanthus altissima*


Jan Samanek, Phytosanitary Administration; bugwood.org


James H. Miller, USDA Forest Service, bugwood.org


Paul Wray, Iowa State University, bugwood.org

European (Common) Buckthorn—*Rhamnus cathartica*


Chris Evans, University of Illinois, bugwood.org


Chris Evans, University of Illinois, bugwood.org


Chris Evans, University of Illinois, bugwood.org

Glossy Buckthorn—*Frangula alnus*


Leslie J. Mehrhoff, University of Connecticut, bugwood.org


Chris Evans, University of Illinois, bugwood.org


Leslie J. Mehrhoff, University of Connecticut, bugwood.org

Norway Maple—*Acer platanoides*


Leslie A. Horner, Penn State Extension


John M. Randall, The Nature Conservancy, bugwood.org


Jan Samanek, Phytosantary Administration, bugwood.org

Shrubs

Japanese Barberry—*Berberis thunbergii*


Richard Gardner, bugwood.org


Leslie J. Mehrhoff, University of Connecticut, bugwood.org


Chris Evans, University of Illinois, bugwood.org

Bush Honeysuckle—(Amur honeysuckle) *Lonicera maackii*


Richard Gardner, bugwood.org


John M. Randall, The Nature Conservancy, bugwood.org


Ryan Armbrust, Kansas Forest Service, bugwood.org

Autumn and Russian Olive—*Elaeagnus umbellate* and *Elaeagnus angustifolia*


Nancy Loewenstein, Auburn University, bugwood.org


James H. Miller, USDA Forest Service, bugwood.org


Pennsylvania DCNR-Forestry, bugwood.org

Multiflora Rose—*Rosa multiflora*


Rob Routledge, Sault College, bugwood.org


Richard Gardner, bugwood.org


Chris Evans, University of Illinois, bugwood.org

<u>Herbaceous plants</u>

Garlic Mustard—*Alliaria petiolata*


David Cappaert, bugwood.org


Tom Heutte, USDA Forest Service, bugwood.org


Chris Evans, University of Illinois, bugwood.org

Japanese Stiltgrass—*Microstegium vimineum*


Bruce Ackley, The Ohio State University, bugwood.org


Bruce Ackley, The Ohio State University, bugwood.org


Leslie J. Mehrhoff, University of Connecticut, bugwood.org

Japanese Knotweed—*Polygonum cuspidatum*


Jan Samanek, Phytosanitary Administration, bugwood.org


Ansel Oommen, bugwood.org


Tom Huette, USDA Forest Service, bugwood.org

Vines

Oriental Bittersweet—*Celastrus orbiculatus*


Chris Evans, University of Illinois, bugwood.org


Chris Evans, University of Illinois, bugwood.org


Leslie J. Mehrhoff, University of Connecticut, bugwood.org

Japanese Honeysuckle—*Lonicera japonica*


Leslie J. Mehrhoff, University of Connecticut, bugwood.org


Leslie J. Mehrhoff, University of Connecticut, bugwood.org


James H. Miller & Ted Bodner, Southern Weed Science Society, bugwood.org

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