Forest County Forest Regeneration 2020 CDAC Report

Wisconsin Department of Natural Resources - Forestry Division

December 1, 2020

Summary - Forest Regeneration

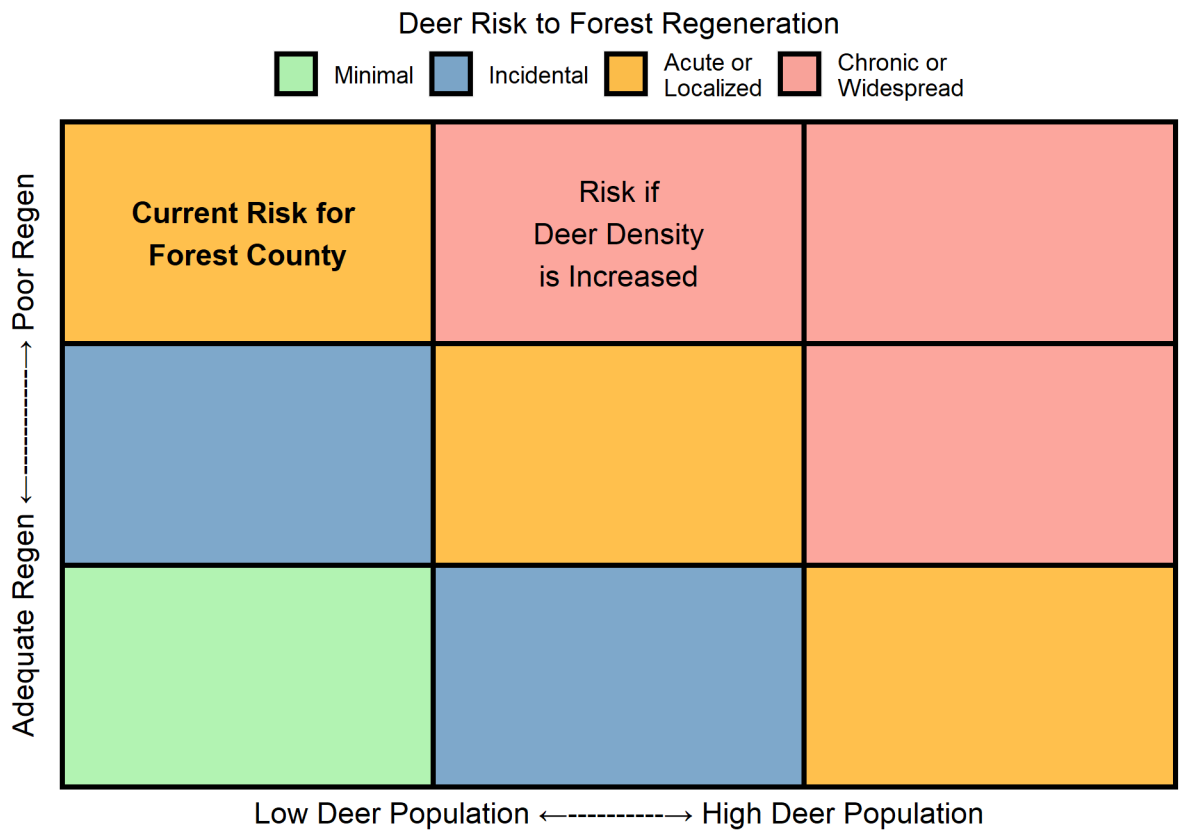
In Wisconsin, forest management relies on natural tree reproduction or regeneration to ensure the benefits of sustained outdoor recreation, wildlife habitat, and timber production. Natural regeneration is the process by which new tree seedlings become established through natural seeding, sprouting, suckering, or layering after trees are harvested or die from other causes. Successful regeneration is critical to forests reaching a stage of maturity where they can provide ecological and economic benefits to wildlife habitat, outdoor recreation, and timber production.

There are many factors that can affect forest regeneration such as the weather, interfering plant species, and forest management practices. Animal browse can also pose a significant impediment to forest regeneration, and in Wisconsin, white-tailed deer are the most common large animal that regularly eats tree leaves and stems. Research has regularly shown that high deer density often leads to increased browse impacts on forest regeneration.

Risk to Forest Regeneration in Forest County

Forest regeneration analysis conducted by the Forestry Division indicates that whitetail deer populations currently pose an **acute or localized** risk to forest regeneration in Forest County. This result is derived from regular observations of significant regeneration difficulties and relatively low deer populations by timber harvest.

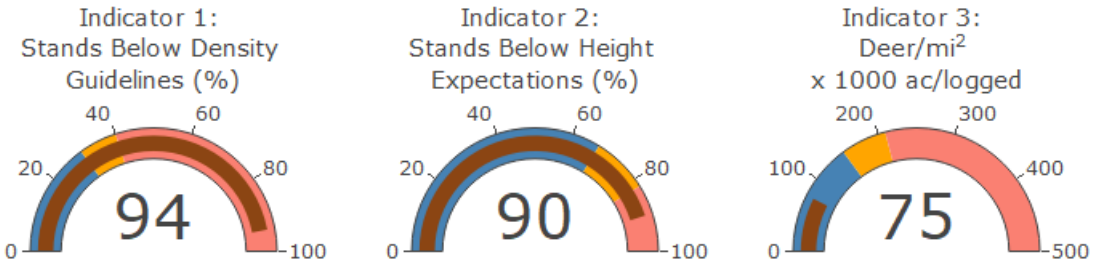
The Forestry Division concludes that reducing the deer population in Forest County may reduce the severity of current regeneration impacts. Likewise, increasing the deer population will likely increase current risk and intensify regeneration current impacts.



This risk table indicates the current risk that deer pose to forest regeneration in Forest County. It also demonstrates the likely consequences of increasing and/or decreasing deer densities. For example, an increase in deer density will move the current risk right whereas a decrease will move it left, unless already at the uper or lower limit. Over time, it is likely that an increase in the deer density will worsen regeneration moving risk up, where a decrease in density will improve regeneration moving risk down. Descriptions of the four risk categories can be found in Appendix C at the end of this report.

Forest Risk Metrics for Forest County

The Division of Forestry reports three metrics to identify risks to forest regeneration. These metrics contribute to our understanding of whether forest stands are meeting seedling and sapling density guidelines, whether seedling and sapling heights are meeting growth rate expectations, and whether timber harvest deer densities are at level where regeneration impacts are more likely. The total number of indicators in the red or orange determine the current risk to deer regeneration.



The dark brown dial line and number represent Forest County's performance on each indicator. For Indicator 1, the color shaded areas reflect the stocking standards from the Wisconsin Silviculture Handbook. For indicators 2 and 3, the color shaded areas represent the 33rd, 66th and 100th percentiles for that value.

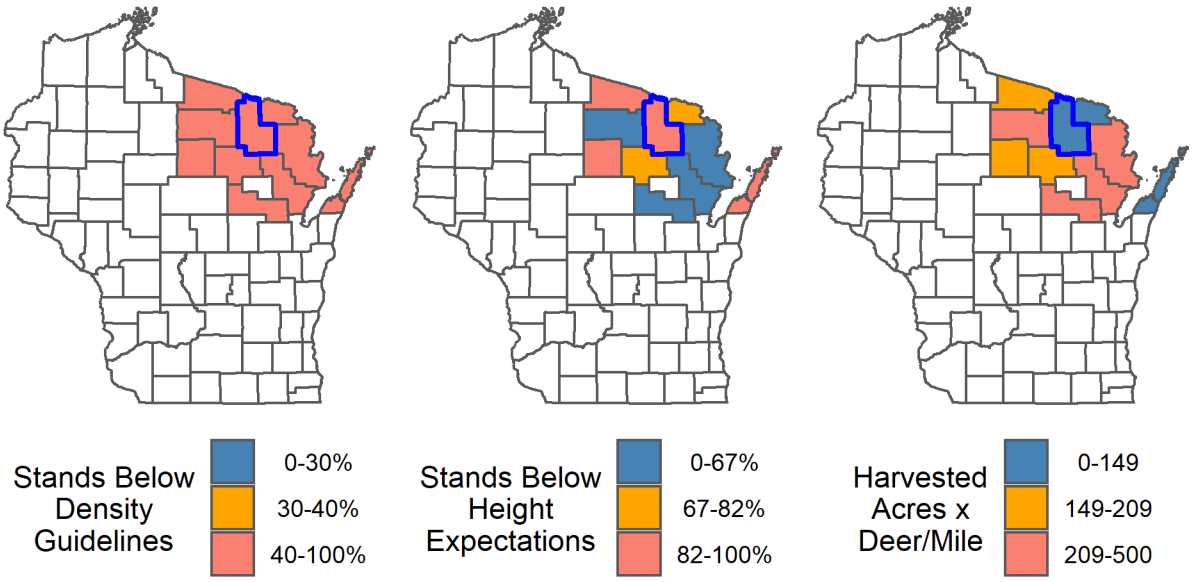
Indicator 1 - Forest regeneration monitoring from 2018-2020 indicates that **94**% of the observed recently harvested stands in Forest County are failing to meet regeneration guidelines. If a significant percentage of stands are failing to meet guidelines, this indicates that deer could be a factor impeding the overall regeneration of seedlings and saplings in Forest County.

Indicator 2 - Forest regeneration monitoring from 2018-2020 indicates that **90%** of recently harvested stands in Forest are not meeting regeneration height expectations. When a forest stand is not progressing to maturity as quickly as expected, it indicates that deer browse may be restricting seedling and saplings growth so they do not mature as expected This impact can impede regeneration of forest stands even when minimum density guidelines are being met.

Indicator 3 - DNR Wildlife staff estimate that the 2017-2019 average post-harvest deer population is **15.3** deer per square mile of deer range in Forest County. Deer density alone does not necessarily mean that deer are impacting forest regeneration in part because the level of timber havest varies considerably. To estimate the overal risk that a deer density poses regenerating forests, the deer density is scaled by the average **4.9** thousand acres of annual timber harvest in Forest County. In total there are there are **75** deer per square mile scaled by the thousand acres of timber harvest in Forest County. For this metric, a higher number indicates greater overall risk, while a lower number indicates lower risk.

Taken alone, none of these indicators tell us for certain that deer browse is, or is not, having an impact on forest regeneration. When taken together, these indicators show the relative likelihood that deer browse is impacting forest regeneration and the ecological and economic risk it may pose to forests in Forest.

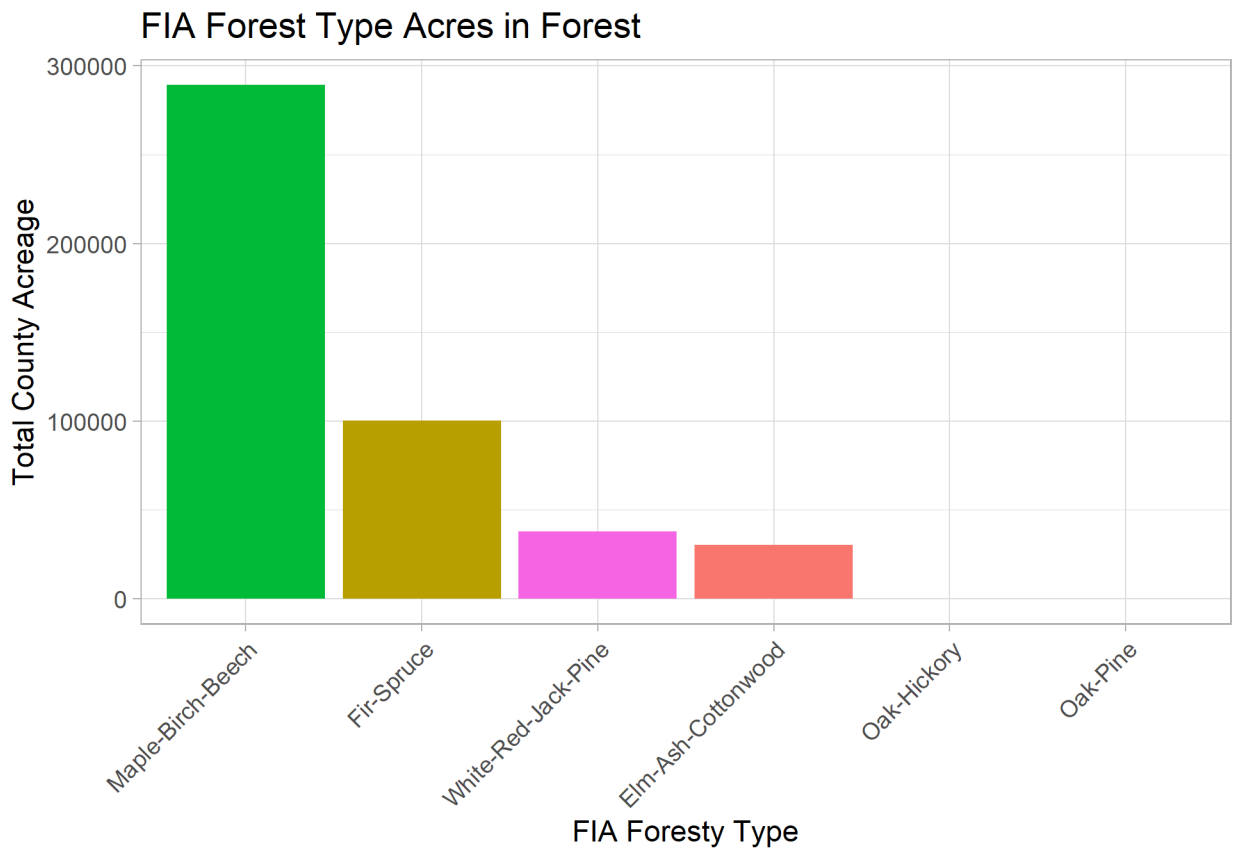
The following maps show the regeneration metric status for counties in the FIA Northeast Region which share similiar forest and land cover features.



Report Detail for Forest County

County Overview

Forest County has a total of 669,326.1 acres of which 574,801 are forested. In terms of forested land cover, Forest County ranks #3 in Wisconsin at 86% forested. Forestry and logging in Forest yields approximately 12.04 million dollars per year in economic output.



Note - FIA Forest types are slightly different from the WDNR Forest Cover Types discussed in the remainder of this analysis.

Since forest regeneration monitoring began in Forest County, 1 stands with 2 plots were surveyed in 2018, 33 stands with 191 plots were surveyed in 2019, and 2 stands with 26 plots were surveyed in 2020.

Deer Densities and Timber Harvest in Forest County

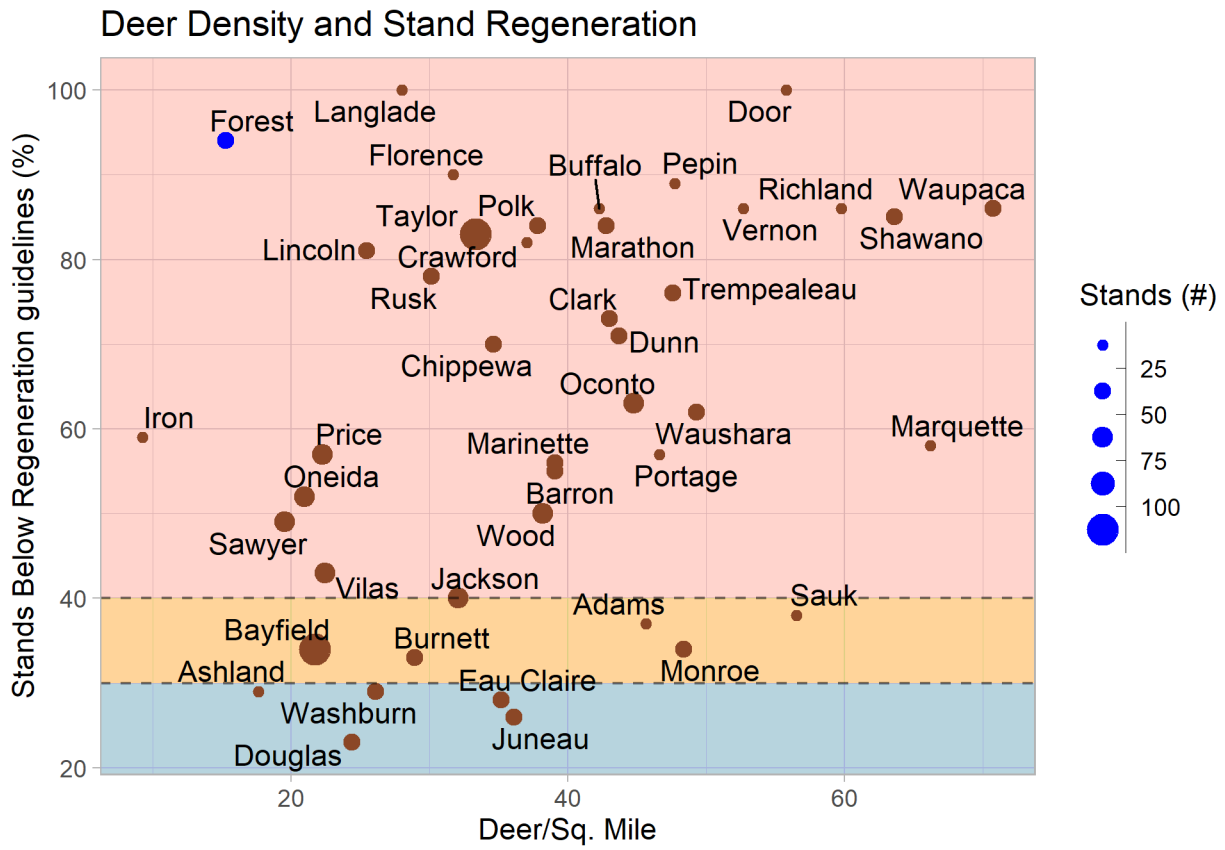
Following a timber harvest or other disturbance, tree seedlings are established that will eventually become the future forest. It is in these the early stages of regeneration that

young seedlings and saplings are the most vulnerable to deer browse which can slow or prevent the forest from reaching a stage of maturity where it can provide ecological and economic benefits to wildlife habitat, outdoor recreation, and timber production. Furthermore, regeneration problems associated with deer will have a relatively larger impact in areas where more acreage is logged, even when deer densities are relatively low. By comparison, where deer densities are relatively high and forestry and logging is not widespread, deer browse poses a smaller total risk to future ecological and economic health of forests. In these areas, deer browse still presents a significant risk to the few stands that are harvested, but in absolute terms, the net effect of these impacts will be less than in areas where logging is more common.

To capture this effect, WDNR Forestry calculated a metric which scales the deer density in each county by the average acreage of forest harvested (1000's of acres rounded to the nearest 100) in that county each year. According to USDA Forest Service Forest Inventory and Analysis data, Forest County is **#20** in Wisconsin in terms of acres logged with an estimated average **4.9** thousand acres cut annually between 2013 and 2019. In addition, DNR Wildlife staff estimates the average post-harvest deer density over the last three years was **15.3** deer per square mile of deer range in Forest County. (Note that deer range includes only deer habitat which is all permanent forests, woodlots, brush-covered lands or marsh, that are least ten acres or more in size and adjacent farm fields.) By combining these two terms, there are **75** deer per acre scaled by the 1000 acres harvest in Forest County.

Regeneration Minimum Density Guidelines in Forest County

Statewide, there is a strong linear relationship between deer densities and the likelihood that recently harvested forest stands are meeting tree count guidelines for regeneration. This graph compares the deer population in each county (x axis) to the percentage of forest stands that are below minimum density guidelines (y axis). A deer density increase of 2 deer per square mile is related to about a 1% increase in the likelihood that forest stands in that county will not meet regeneration minimum density guidelines. On the graph, an increase in deer densities would be expected to move the county up and to the right. Conversely, a decrease in deer densities would be expected to move the county down and to the left.



This graph compares the deer population in each county (x axis) to the percentage of forest stands that are below minimum density guidelines (y axis). The blue point represents Forest County. The brown points represent the other counties in Wisconsin with FRM monitoring. The size of each point is proportional to the toal number of monitored stands in that county.

The Wisconsin Silviculture Handbook indicates that all forest cover types are fully stocked if 70% of sample plots are meeting regeneration guidelines and are inadequately stocked if fewer than 60% are meeting guidlines. These 60% and 70% thresholds are used here as a rough guide to identify counties that are systematically not meeting minimum density quidelines.

Forest regeneration monitoring indicates that recently harvested stands in Forest County are not meeting seedling and sapling regeneration guidelines on **94**% of the observed stands. In addition, DNR Wildlife staff estimate that there **15** deer per square mile of deer range in Forest County.

Minimum Density Guidelines by Forest Cover Type in Forest County

Different forest types regenerate differently in response to deer browsing preference and seedling and sapling growth patterns. In some cases, deer browse may prevent seedlings

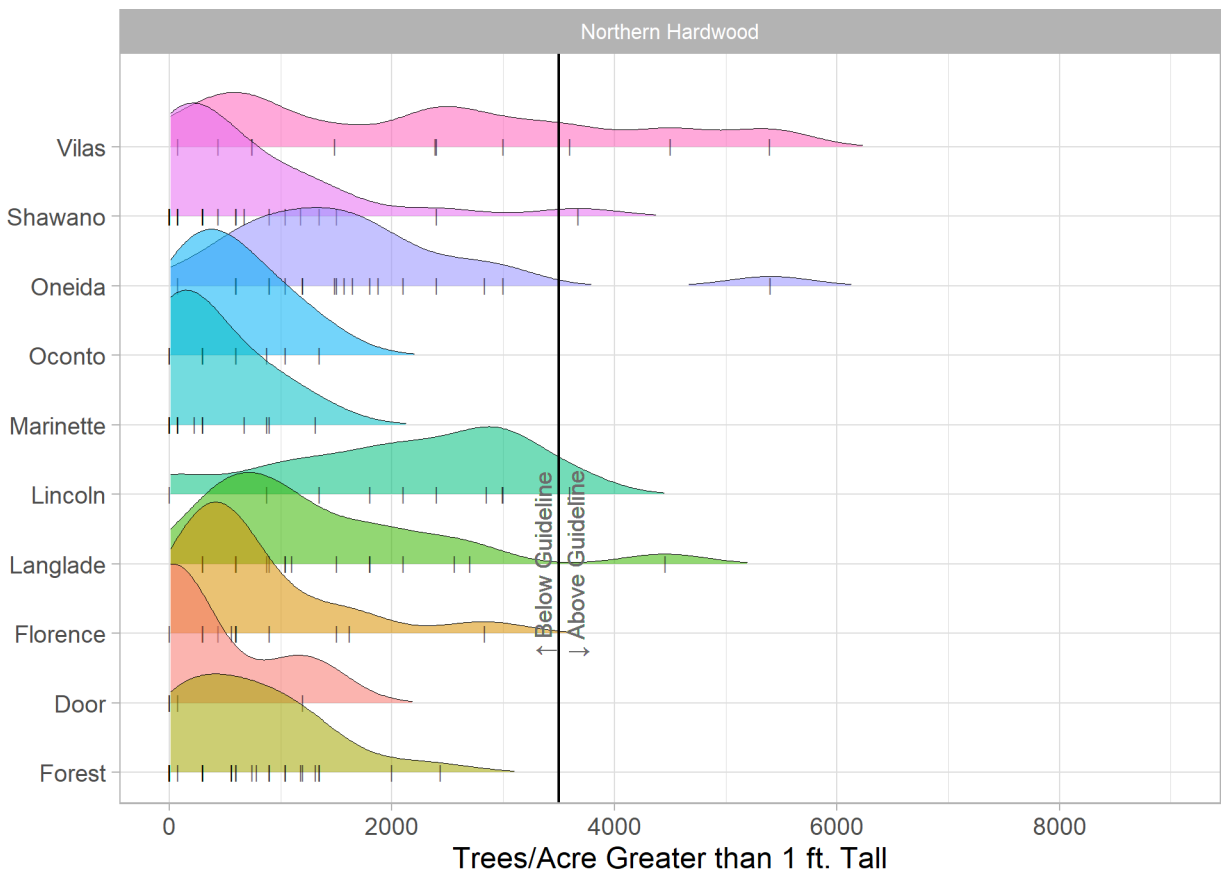
and saplings from reaching the minimum density needed for that forest ecosystem to develop into a mature, self-sustaining forest with marketable timber. This analysis is capable of determining the proportion of stands that are not meeting these minimum seedling and sapling counts. Statewide, regeneration of pine (Red, White, and Jack) is doing well in most counties. By comparison, a larger proportion of hardwood stands such as oak and maple are falling short of the regeneration guidelines in most counties.

There are 1 forest types in Forest County that have been surveyed more than three times since forest regeneration monitoring began. The below table compares regeneration between Forest County and the regional average for these forest types.

Table 1: Forest Regeneration in Forest by Forest Cover Type Compared to Region (types with less than 3 stands excluded)

Forest Type	County			Region		
	Total Stands	Seedlings/Acre	Below Guideline (%)	Total Stands	Seedlings/Acre	Below Guideline (%)
Northern Hardwood	30	680	100	160	1084	87

The plot compares the seedlings and saplings per acre greater than 1 foot tall observed for different forest cover types in counties within the FIA region.



On the above plot, each shaded area represents the tree densities on monitored stands for each county. The vertical line represents the regeneration guideline for that forest cover type. The more shaded area there is to the right of the line, the more stands are meeting regeneration guidelines.

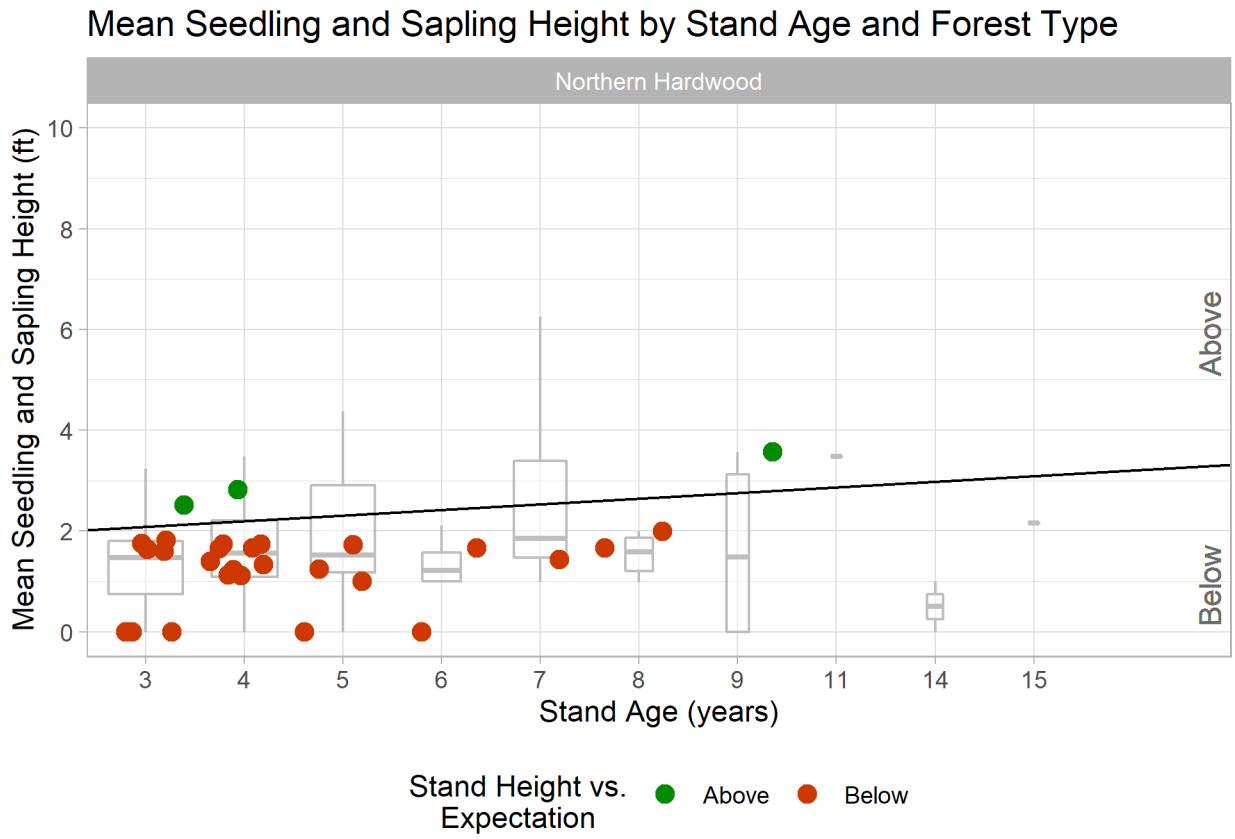
The small vertical tick marks are the observed tree density values for individual stands. The more tick marks there are, the more accurate the shaded area can be taken to be. If a county does not have a shaded area for that cover type, it indicates that no monitoring was done for that forest type in that county.

Regeneration Height Expectations in Forest County

In addition to affecting the total amount of trees per acre, deer browse can also affect the height distribution of a regenerating forest. For example, deer may repeatedly browse on seedlings and saplings in a manner that does not kill them but slows or stalls their growth. In this case, the minimum density guideline may be met according tothe total seedling and sapling count, but over time the seedlings and saplings may never become established trees.

Forest regeneration monitoring began in 2018 and revisits stands every three years. Therefore, this analysis cannot at this time identify individual stands that are failing to mature.

However, some forest cover types (Northern Hardwood, Oak, Red Maple, Central Hardwood, and Pine) can be compared to a modeled expected growth rate using statewide data for each forest type. Compared to the expected mean height for the stand's age, forest regeneration monitoring indicates that recently harvested stands **90**% of stands in Forest are below growth rate expectations.



The above graph shows each stand in the county as a point representing average seedling and sapling heights relative to expectations for different forest cover types. The x-axis represents the age of the stand in the number of years since its last harvest. The y-axis is the mean height of seedlings and saplings in that stand. The black line represents expected mean height at that age (black line). Stands above the black line (green points) are above expectations at that age. Stands below the expected growth rate (red points) may be failing to adequately develop into mature forest stands. Boxplots of the regional distribution are shown behind the points to reference Forest County against other counties in the Northeast FIA region.

Note that this metric is only used as a rough guide to determine growth rate expectation. Closer investigation of the data for individual stands is needed to asses that stand's actual progression as would be expected for its age and harvest type.

Appendices

Appendix A - Forest Regeneration Monitoring Methods

Forest regeneration monitoring on recently harvested stands began in 2018 in Wisconsin. This effort is limited to the 45 (out of 72) counties with more than 30% forest cover. The goal of this monitoring is to determine if forest stands are regenerating at a rate that will support ecological purposes such as wildlife habitat and future economic benefits such as timber harvest. In addition, this monitoring attempts to identify factors that might be preventing or slowing regeneration of the forest. This is done by recording the count, height, species of all seedlings and saplings that have not grown large enough where they are free to grow without interference from other plants or animals browsing on them. In addition, other measures are recorded such as visible deer browse, canopy coverage, ground cover, and the type of recent harvest that was conducted.

The forest regeneration monitoring program will attempt to revisit most stand every three years. With repeated measurement, Forestry staff will be able to identify specific stands that are not progressing toward maturity and determine what factors are impacting its growth. However, since the monitoring program is only three years old, no stands have been revisited yet and this analysis will not be possible for several years. For now, Forestry staff have compiled indicators based on statewide statistical analysis to identify potential problems. These indicators are not capable of definitively connecting deer browse to impacts on forest regeneration, but instead indicate the level of risk deer pose to forest regeneration in a county.

The first forest regeneration indicator identifies the percentage of stands in a county meeting regeneration guidelines. When regeneration monitoring measurements are completed on a stand, WDNR staff calculate the number of desirable seedlings and saplings per acre taller than one foot and compare them to regeneration guidelines for that forest type as defined in the Wisconsin Silviculture Handbook. If the tree density is above the minimum density in the handbook, the stand is considered to be meeting the regeneration standard. If the tree density is below the minimum density in the handbook, the stand is considered not meeting the standard. This calculation is done when the forest is in the regeneration period for its forest cover type. These periods are 1-2 years after harvest for aspen and birch and 3+ years for all other forests. Eventually, Forestry staff will be able to use regeneration monitoring to refine the current guidelines.

The second forest regeneration indicator identifies the percentage of stands that are meeting expected growth rates. Expected growth rate curves were determined from the forest regeneration monitoring dataset by calculating the mean seedling and sapling height for each forest cover type at each year post harvest. Linear regression models were then used to calculate the annual expected growth for the forest cover types had a statistically significant relationship between year and height. Notably, this modeling likely includes forest stands that have substantial regeneration problems. Therefore, the growth rate curves are likely too low for what would be expected from a healthy stand. At this time there is little to no research that prescribes a target growth rate for different forest cover

types. However, Forestry staff will use forest regeneration monitoring data to calculate growth rate curves that can be used by forestry staff, the timber industry, and landowners to assess the health of their stands as they regenerate after harvest.

Appendix B - Risk Category Assignments

Risk categories were assigned to each county based on the number of regeneration metric indicators it has. For each indicator, a value of 1 was assigned if the county was in the 25th percentile, a value of 2 was assigned if it was in the 25-50th percentile, and a value of 3 was assigned if the county was in the 50-100th percentile. Deer indicators were placed on the x-axis of the risk matrix. The two regeneration metrics were summed and placed on the y-axis. A result of this is that a county could be assigned to the category of poor regeneration if it had one regeneration indicator in the 50-100th percentile or two in the 25-50th percentile.

A limitation of this current approach is that the indicator assignments are based on how a county compares to all other counties in Wisconsin. It would be preferable to compare each county to a static performace standard. Although, those static standards do not yet exist, further research and continued analysis of this these data will be used to eventually create these static standards.

Appendix C - Risk Category Descriptions

Widespread or Chronic Risk - Widespread or chronic risk is the most severe risk category. It indicates that there are currently multiple and/or severe regeneration problems coupled with moderate to high deer populations by timber harvest. There are likely to be county-wide impacts from deer browse and/or severe impacts where deer populations are the highest. Reducing deer populations county-wide will likely decrease risk and improve forest regeneration in the long-term.

Acute or Localized Risk - Acute or localized risk indicates either a) severe or multiple regeneration problems have been identified in the county or b) that deer populations are high enough to represent a potential risk to forest regeneration. This risk may be focused on specific tree species, specific forest cover types, and/or specific parts of the county where the deer population is highest. Reducing the deer population, especially where populations are the highest would likely reduce this risk.

Incidental Risk - Incidental risk indicates that either a) some regeneration problems have been observed but that deer populations are low enough that do not pose a widespread risk, or b) regeneration is adequate but deer populations are high enough that they represent an increased risk. It is likely that deer will still periodically impact forest regeneration

to some degree, particularly in areas with the densest population. Reducing deer populations will likely have limited impact on reducing risk, whereas a higher deer population could dramatically increase the risk to forest regeneration.

Minimal Risk - Minimal risk is the lowest risk category and indicates that deer populations are low and few if any regeneration problems have been observed. Reduction of the deer population is unlikely to reduce risk significantly whereas an increase might increase risk, especially in the long-term.