What do pervasive ungulate browse impacts mean for forestry in New England and New York

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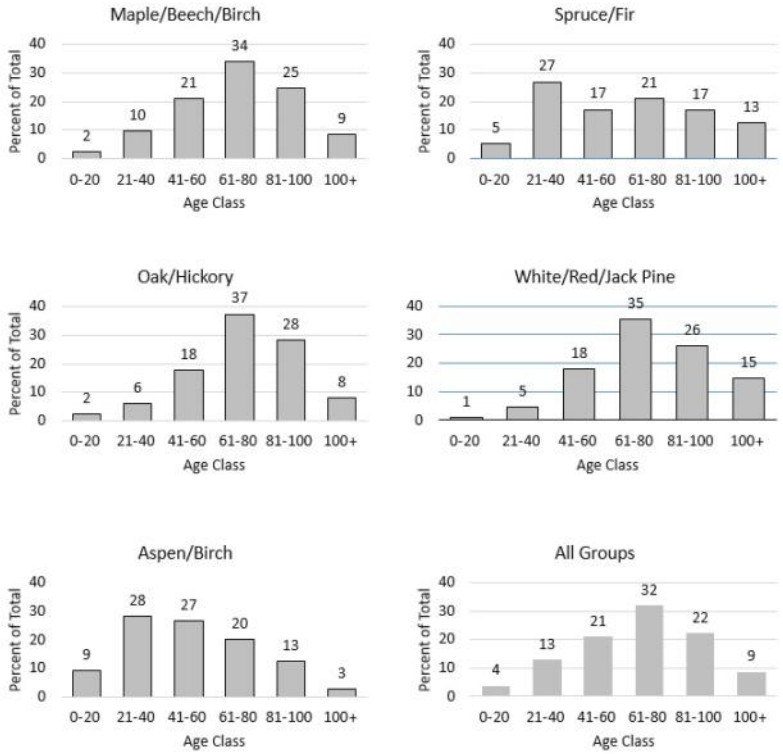

Figure 1: Area of forest land by age class and forest-type group for groups with at least 5 percent of the total forest land, New England and New York, 2017. Age class percentages may not sum to 100 due to rounding.

Background

Ungulates, invasive plants, climate variability, and other stressors are acting together to compound the challenges facing forest managers tasked with regenerating forests following stand-initiation disturbances, e.g., harvest or catastrophic mortality. The range expansion of large ungulates, primarily *white-tailed deer* (*Odocoileus virginianus*), and their browse impacts across the Midwest and Northeast have affected many aspects of the forest ecosystem (McWilliams and others 2018). This makes it nearly impossible to regenerate species that require advance regeneration and interferes with forest development in early stages of succession.

The principle objective of regeneration management is to develop healthy young forest habitat (YFH) and move the forest forward to the sapling and later stages of succession. The problem is that YFH has become rare in New England and New York forests (Figure 1). The New York Forest Owners Association recently concluded that deer browsing is the Number 1 problem threatening the future of New York's woodland (NYFOA 2018).

The scourge of large ungulate herbivory is not new. Seventy years ago, Aldo Leopold and others (1947) made projections about areas in the continental United States that were susceptible to overbrowsing of nutritive plants because of deer overpopulation (Figure 2). Leopold and his colleagues mapped areas of deer presence and absence and identified areas of expected deer overpopulation, where browse pressure would leave plants that have little or no nutritive value. The survey identified seven problem areas in the Midwest and Northeast: northern Wisconsin, the Upper Peninsula and northern Lower Peninsula of Michigan, most of Pennsylvania, the Adirondack region of New York, southwestern New York, and Vermont. The 1947 map showed that deer were absent or scarce in the rest of the region (Figure 2).

Browsing by ungulates is a challenge to sustaining young forest habitat. In addition to being the source of future forests, YFH supports a unique suite of ecological values. One example is habitat for wildlife such as the American woodcock (*Scolopax minor*) and golden-winged warbler (*Vermivora chrysoptera*), as well as the codependent bobcat (*Lynx rufus*) and snowshoe hare (*Lepus americanus*).

Control of browse impacts is clearly at the forefront of policy discussions on restoring high-canopy forest cover with native species. If forest managers cannot successfully regenerate forest land to create healthy YFH, New England and New York could lose the features that citizens have come to expect from all stages of forest succession. This article summarizes results of a regionwide study of browse impacts.

Figure 2: Areas in which overpopulations of deer now exist or have existed as of 1947 (Leopold et al. 1947). Numbers refer to case histories. Used with permission of Wiley Inc. with copyright retained by The Wildlife Society.

Methods

Beginning in 2012, new measurement protocols covering regeneration and browse were incorporated as part of the regionwide forest inventory conducted by the USDA Forest Service, Northern Research Station, Forest Inventory and Analysis program. These regeneration indicator (RI) protocols include browse-impact severity evaluation and detailed seedling measurements. The browse-impact severity evaluation indicates the amount of stress that herbivores are exerting on tree seedlings and other understory flora. Details of the protocols and study can be found in McWilliams and others 2015, and McWilliams and others 2018.

In a previous study, a coding system was developed for forest ecosystems under browse pressure from white-tailed deer in the Northeast (Brose and others 2008). Guidelines for assessing impacts of moose and other browsers are not available in the literature, but their impacts were evaluated if they met the following deer-browse impact definitions:

Low: Plot was inside a well-maintained fence or minimal browsing was observed, or vigorous seedlings were present and of varied height if no well-maintained fence was present. Herbaceous plants were present and were able to complete their life cycles.

Moderate: Evidence of browsing was observed but not common. Seedlings were common but with limited variability in height. Stump sprouts were heavily browsed or not present. Herbaceous plants showed a lack or inhibition of flowering and fruiting. There was little or no evidence of browsing on non-preferred plants.

High: Evidence of browsing was common on preferred vegetation. Preferred seedlings and herbaceous plants were rare or absent. Nonpreferred plants showed some evidence of browsing. Browse-resistant vegetation was limited in height growth. Evidence of browsing was everywhere. Nonpreferred, browse-resistant plants showed signs of heavy repeated browsing, and a browse line was present.

Results

The new browse data was used to map the probability of moderate or high impacts on regeneration to alert forest managers where they may need to consider site-specific conditions prior to making stand-regeneration prescriptions. The resulting map (Figure 3) shows broad regions where forest managers and others tasked with reforestation should consider browse impacts when planning for regeneration. Management prescriptions to minimize species loss and encourage regeneration of desirable tree species should be considered in areas when impacts are moderate or high and where tree reproduction may be absent or where healthy seedling development is unlikely without additional management inputs. The impact probability threshold of more than 70 percent is a somewhat arbitrary but is a useful and well-described minimum based broadly on research in the mid-Atlantic (Brose et al. 2008). Our survey found areas with probabilities greater than 70 percent for moderate or high impacts in the northern highlands of Wisconsin; the western Upper Peninsula and northern Lower Peninsula of Michigan; the Ozark Highlands of southwestern Missouri; the southern portions of Illinois, Indiana, and Ohio; the central and northern Appalachian Mountains from West Virginia through the Catskills, Adirondacks, and Greens to the southern Longfellows of Maine; southern New England; and western New Hampshire.

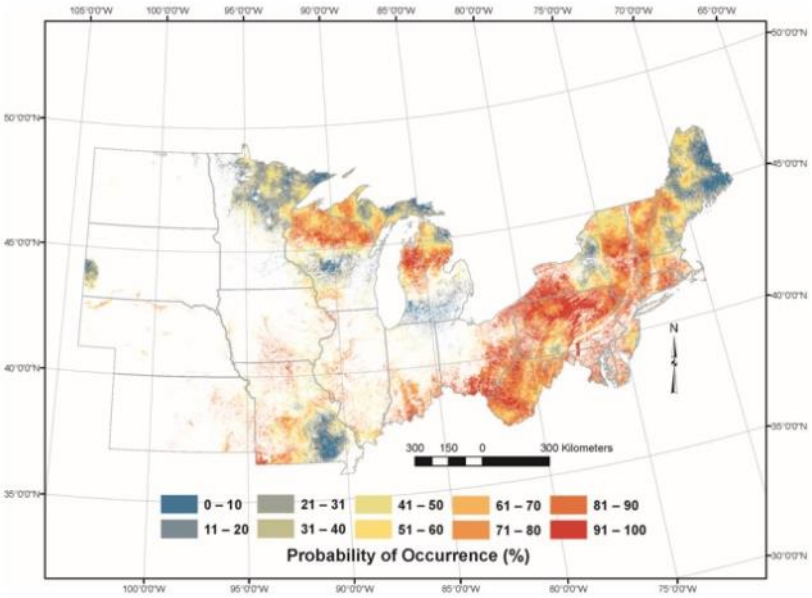

Figure 3: Probability of occurrence for moderate or high ungulate herbivory risk on forest land, Midwest and Northeast, 2017. Note: FIA does not take measurements in some urbanized areas and nonforest conditions where very high herbivory pressure is common. Other conditions where ungulates are typically concentrated that have few FIA samples are fragmented forests, smaller tracts, strip, and riparian forests.

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Probabilities from 31 percent to 70 percent provide a practical range for identifying areas where consideration of local browse conditions is advisable. Areas in this range are scattered throughout the eastern mid-Atlantic States; and the southern Adirondack Mountains, Mohawk River Valley, and Appalachian Plateau of New York. Areas with probabilities of 30 percent or less probably do not warrant measures to control ungulate pressure in management prescriptions. These areas are most common in the Ozark Highlands of southeastern Missouri and the Aroostook uplands and eastern interior of Maine.

Although Leopold's work is not directly comparable to the new browse-impact map, it is notable that the problem areas he and others described appear to have persisted and areas of concern have expanded to Midwest, mid-Atlantic, and the southern New England States. This survey did not find any areas where deer problem areas were reduced.

Overall, 59 percent of the forest land in the Midwest and Northeast had evidence of moderate or high impacts (Figure 4). The mid-Atlantic subdivision had the highest proportion of forest land with moderate or high browse (79 percent) followed by the Central/Plains (61 percent). The levels of moderate or high browse were below the regional average for the Lake (43 percent) and New England (45 percent) subdivisions.

The oak/hickory and maple/beech/birch forest-type groups had the greatest percentage of forest land with moderate or high browse impacts, at 69 percent and 65 percent, respectively (Figure 5). Elm/ash/cottonwood and other deciduous forest-type groups had percentages near the regional average. For spruce/fir, aspen/birch, white/red/jack pine, and other coniferous forest-type groups, the proportion was less than the regional average.

Conclusions

The results show that since Leopold's 1947 deer survey, browse problems have spread to most of New York, southern New England, New Hampshire, and the central southwest, central southeast, and southeast regions of Maine. These findings assert and affirm four realities of regeneration management for forests under herbivory stress:

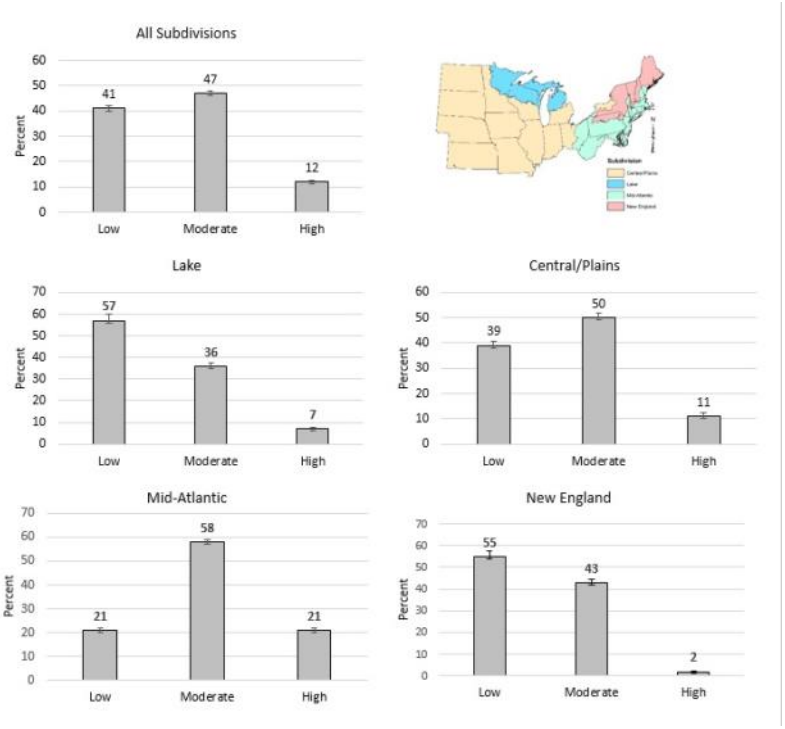

Figure 4: Percent of forest land by ecological subdivision and browse impact code, Midwest and Northeast, 2017.
Error bars represent 68 percent confidence intervals.

1. Large ungulates and their impacts on regeneration have become pervasive, widespread, and perennial requiring herbivory abatement management prescriptions in long-standing problem areas and new areas with at least moderate impacts.

2. Herbivory-resistant trees seedlings that are often different than the existing canopy dominants will continue to have a competitive advantage during the regeneration phase.

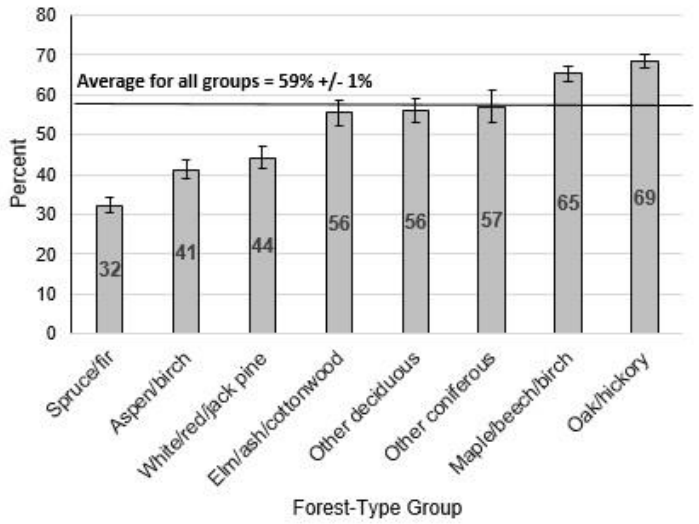

Figure 5: Percentage of forest land with moderate or high ungulate herbivory impacts by forest-type group, Midwest and Northeast, 2017.
Error bars represent 68 percent confidence intervals.

3. Although the reality that early stand management determines future forest condition is not new, it takes on a new dimension for forests under stress from herbivory and other anthropogenic factors.

4. Given the dearth of YFH across New England and New York, regeneration managers will have their hands full in coming decades as older forests undergo stand-initiation disturbances. The key to success will hinge on whether active regeneration management is planned or if regeneration is left to natural forces.

A review of the three forest-type groups with most of the region's forest land reveals prospective future trends. Maple/beech/birch is the most common forest-type group in New England and New York accounting for 47 percent of the forest land or 24.1 million acres. In addition to concern over abundance of desirable tree seedlings, there is concern over the future of American beech because of the effects of beech bark disease and the viability of root sprouts. Spruce/fir ranks second with 15 percent (7.5 million acres). Active management of spruce/fir should provide the potential for successful regeneration, particularly in Maine due to its economic importance, less browse pressure, and YFH habitat is more common there. The oak/hickory group has 14 percent of the region's forest land (6.9 million acres). Oak/hickory will likely be the most troublesome in terms of securing regeneration of oak because oak is a much preferred browse species and is most common in areas where browse impacts are heaviest.

The map (Figure 3) and underlying data presented here fill a critical information gap for policy makers and managers tasked with understanding where over-browsing has obliterated habitat for young forest obligate animal species and where regeneration needs to be better managed to restore high-canopy species. Opportunities for further research to better describe relationships between browse impacts, forest conditions, and regeneration security offer promise for helping to sustain forest values and services.

All of the data used in this study are publicly available from the FIA data portal: https://apps.fs.usda.gov/fia/datamart/CSV/datamart_csv.html.

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