

LONG-TERM IMPACT OF CLEARCUTTING, DEER BROWSING, AND DEFOLIATION ON STAND DEVELOPMENT IN A PENNSYLVANIA MIXED-OAK FOREST

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ABSTRACT

Introduction

The long-term impacts of even-age forest management and excessive browsing by white-tailed deer (*Odocoileus virginianus*) on regeneration are unknown for hardwood forests in the eastern United States. In 1965, Gene Wood, a graduate student at Pennsylvania State University, initiated a study in a mixed-oak forest in central Pennsylvania to examine changes in forest composition in response to clearcutting and deer browsing (Wood 1971). After the study ended in 1972, no other management was implemented, thus presenting a unique opportunity to collect long-term data on stand development. The primary objectives of our study were to examine forest composition after clearcutting with or without fencing by comparing present-day conditions to those observed in 1965.

Methods

The study area was a 5.4-ha portion of a mixed-oak forest in the Quehanna Wild Area, Moshannon State Forest, in central Pennsylvania. When the stand was first inventoried in 1965, black (*Quercus velutina*), white (*Q. alba*), and red (*Q. rubra*) oaks were dominant and trees were fairly uniform in age at 55-60 years (Wood 1971). Common woody understory species were witch-hazel (*Hamamelis virginiana*) and serviceberry (*Amelanchier arborea*). Tree seedlings and woody shrubs including blueberry (*Vaccinium* spp.), huckleberry (*Gaylussacia* spp.), and sweet-fern (*Comptonia peregrina*) were present, but sparse. Hummer (1970) measured deer density at more than 15 deer per km², a density exceeding the local carrying capacity based on the presence of a severe browse line.

An interior 2.6-ha portion of the stand was clearcut in fall 1966 with no woody vegetation >1 m in height left standing. Shortly after the cutting was completed, eight sampling plots 40 m by 40 m (0.16 ha) in size were established with permanent metal stakes marking the corners. Four plots were located in the 2.6-ha clearcut portion, and four plots were located in the surrounding uncut portion of the 5.4-ha stand to serve as controls. Woven wire fences 2.4 m in height were constructed to exclude deer from one-half (0.08 ha) of each plot, which created four replications of each treatment combination: clearcut with fencing, clearcut with no fencing, control (no cutting) with fencing, and control with no fencing.

We found the original study plots in 2012 and tallied all trees ≥10 cm in diameter at breast height (d.b.h.) rooted inside the 0.08-ha subplot. Additionally, we visually estimated percentage cover of woody shrubs in two 1.8-m-radius nested plots per 0.08-ha subplot. From the inventory data, we calculated the total density of each tree species present and percentage shrub cover for each treatment combination and compared these to Wood's data collected before clearcutting and fencing in 1965.

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Results and Discussion

As of spring 2012 (45 growing seasons after clearcutting), all of the unfenced clearcuts had failed to regenerate with trees. In fact, we found only two trees growing among the four unfenced clearcut plots; both were red maples (*Acer rubrum*) and in the same plot. Instead of regenerating with trees, a dense, continuous layer of woody shrubs covered >50 percent of the ground surface, on average. Apparently in the unfenced clearcuts, excessive browsing of tree regeneration by white-tailed deer allowed the woody shrubs and grasses to spread and capture the new growing space (Horsley et al. 2003). The deer and shrubs together have prevented forest regeneration for nearly half a century.

Fenced clearcuts successfully regenerated, but dominance shifted from oak (72 percent relative density in 1965 to 26 percent in 2012) to red maple (28 percent in 1965 to 69 percent in 2012). This shift from oak to maple may be due, in part, to poor sprouting potential of the larger oaks (Weigel and Peng 2002). Woody shrub cover was <1 percent in these areas, on average.

Fenced and unfenced control plots also shifted in composition, from largely oak (72 percent relative density in 1965 to 26 percent in 2012) to red maple (28 percent in 1965 to 78 percent in 2012). This shift likely resulted from multiple defoliations by oak leaf roller (*Archips semiferanus*) between 1969 and 1972, followed by gypsy moth (*Lymantria dispar*) in the early 1980s and 1990s, which caused many residual oaks to die, thereby releasing the red maples. Total tree density in 2012 in unfenced controls (395 trees/ha) was markedly lower than that in fenced controls (566 trees/ha), likely due to deer browsing of regeneration after insect-related mortality of overstory oaks.

Conclusions

Results from this study provide information concerning the potential long-term influence of clearcutting, excessive deer browsing, and repeated defoliations by insects on stand development in mixed oak forests. Future work should focus on blueberry-huckleberry-sweet-fern as interfering vegetation and methods for reforesting these areas.

Literature Cited

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