How Can Deer Browsing Effect Forest Regeneration and Water Resources?

The white-tailed deer (*Odocoileus virginianus*) has played a major role in shaping our forests in the 20th century and will continue to do so as this century unfolds. The white-tailed deer is the most abundant wild ungulate on the North American continent and because of their strong interaction with plants can greatly affect whole ecosystems, and as such are termed keystone herbivores. Even though white-tailed deer are managed in many areas, deer populations are above pre-settlement densities. Pre-European estimates of deer densities across its "most favorable habitat" range from 3.1 to 7.7 deer/km^2. During the early European settlement period, commercial and private consumption of white-tailed deer led to its near extirpation in much of the eastern U.S. Due to extensive clearing of forests increasing the amount of forage, extirpation of predators, and enactment of laws to protect the deer, the deer population has dramatically increased. White-tailed deer populations have also increased due to their ability to occupy a wide range of sites and to reproduce rapidly. Recent estimates of deer density range from 7.7 to 14.8 deer/km^2 in heavily forested areas to >60 deer/km^2 in areas with mixed forests and agriculture land. One acute example of the explosive potential of the species is in Sharon Woods Metro Park in Ohio where over 150 vascular plant species were extirpated when the deer population reached over 110 deer/km^2. With the absence of the wolf, hunting is the primary means of controlling the deer population.

In addition to their intensive browsing, deer also disperse parasites and seeds, and mechanically damage vegetation by trampling and bedding. In the winter, deer depend on woody browse, while in the summer they depend on nutrient-rich herbaceous plants and the herbaceous portions of woody plants. The height threshold considered to be out of the reach of deer is a height greater than 6 feet or 1.8 meters.

Composition and Structure

On a watershed protection forest, deer can wreck havoc with management plans that desire a mixed species multi-layer forest by profoundly effecting the composition and structure at a local and landscape level. Deer browsing can lead to a lack of regeneration of preferred species and a dominance of unpreferred and browse-resistant species. The vegetative result will depend on deer density, regeneration characteristics, abundance of food, hierarchy in deer preference, the amount of light available in the forest understory, and topography. In general, the length of time for relationships between deer density and species composition to develop happens sooner with increases in overstory disturbance. Deer can cause changes to the regeneration dynamics of a forest. Over time, selective browsing leads to a reduction in species richness/diversity and species composition and unpreferred browse resistant species. As a result of selective browsing, deer can push a forest towards an alternative successional route with a makeup of different species by changing the environmental conditions and competitive interactions. Shade tolerant species that typically mature slowly and favor conditions that are disturbed infrequently can have their advanced regeneration suppresses by browsing and thus prevent their replacement of mature trees. Some tree species can overcome browse damage, e.g. sugar maple, whereas others are less capable, e.g. hemlock. Forest management efforts to thin a stand to increase light and promote tree seedling growth can be thwarted with high deer densities. As deer browsing increases, regeneration failures begin, understory herb diversity declines while ferns and graminoids-grasses, sedges, and rushes, become more dominant.

As herbaceous diversity declines as a result of habitat destruction by deer, so can the diversity of wildlife that depends on it. Declines in insect diversity, especially among pollinators, can result from the decline of herbaceous cover. Deer also compete with mast-dependent small mammals for acorns and high deer densities can negatively effect these small mammal populations. Because ferns and graminoids have relatively few insect herbivores and are not a nectar source, their increase can cause invertebrate species to decline. As deer densities increase, the understory is also becoming less hospitable to the deer themselves.

Browsing which reduces understory vegetation can affect the microclimate of the forest floor. Soil moisture and humidity can decline, while temperature and light can increase. Thus, the vertical complexity of the forest is reduced. Changes in species composition brought on by deer browsing, such an increase in more browse-tolerant species, can cause changes to the nitrogen mineralization rate thus destabilizing the soil for other understory and canopy species.

Ferns

Typically, the growth of woody plant species generally occurs faster than the expansion of ferns. However, with intensive deer browsing eliminating or greatly reducing most woody plants, and deer's avoidance of ferns, a dense fern understory can develop. Within highly dense deer populated areas, ferns can expand and form understory monocultures that dominate the forest floor. An overstory thinning intended to stimulate tree seedling growth will increase light and aid in the formation of a thick fern understory when the failure of desired tree regeneration has occurred. The dense fern layer that results can significantly reduce light levels at the forest floor (<2% of full sun in one study), and thus reduce the photosynthetic rates of seedlings. The thick organic mat that results from the dense fern layer and the accumulation of tree litter further reduces germination for tree seedlings. A dense fern cover can have a differential effect among seedling species. For example, some species such as black birch and white pine are able to grow through a hay-scented fern cover following a reduction in the deer population, while other species such as oaks, maples, white ash, and black cherry cannot. These dense fern understories can continue to influence the germination and growth of seedlings even after deer populations have been reduced. Research indicates that 70% of the area beneath a stand needs to be free of ferns for 3 to 4 years to insure sufficient seedling regeneration after a reproduction cutting method, e.g. shelterwood. Also, spreading species of ferns such as bracken, hay-scented, and New York pose a greater concern than ferns that have a clump pattern.

Management

For watershed forest management, diversity in both species composition and structure is crucial to bring a higher level of resistance to disturbances such as hurricanes, ice storms, and insect outbreaks and resilience in the recovery of such disturbances. One aspect of this multi-layer protection is having regeneration available. The regeneration is the next class waiting to be released in the event of a major disturbance that will help in stabilizing the forest. A planned disturbance to bring about the formation of a new cohort may not occur within a high deer density area. For recovery of diversity, the reduction in deer density needs to be maintained long enough to allow the establishment of advanced regeneration before the next disturbance. Other considerations are the presence of ferns and the amount of overstory removal in any proposed harvest. In thinned and uncut areas, as opposed to clearcuts, the remaining or existing trees can provide a natural seed source which can be used for restoration of species diversity once deer densities have been lowered. Management decisions also need to take into account the composition of the surrounding landscape. Deer populations have a smaller effect on forest vegetation within a stand situated close to an agricultural land use then a stand within a continuous forest.

An early precursor of deer impacting a forest is the reduction of *Rubus*, a highly preferred species. Rates of deer browsing on *Rubus* have been used in Europe to monitor deer impact.

Herbicides can be effective treatments for reducing fern cover. For places that are not inclined to use herbicides, near drinking water supplies, mowing of the fern dominated understory can be an alternative solution. Based on studies of hay-scented fern in the Quabbin Reservation (MA), two mowings in 1 year was shown to be the most efficient for controlling the fern layer. Repeated mowing will control ferns but for uneven terrain or in stands with spacing issues, it may be impractical.

Many are divided on how to manage deer. Some argue that nature should take its course in regulating the population, whereas others believe today's landscapes have been altered to the point that a natural crash in the population is not likely and that deer must be managed by directly removing (killing), the animal. As the fragmentation of the northeast's forests continue,

the opportunity for public hunting also decreases. Animal rights advocates have also been vocal with their opposition of any sort of man induced reduction of the population.

For Further Reading

Campbell, T.A., B. R. Laseter, W.M. Ford, R.O. Odom, and K. V. Miller. 2006. Abiotic factors Influencing deer browsing in West Virginia. Northern Journal of Applied Forestry 23(1):20-26.

De La Cretaz, A.L., and M.J. Kelty. 2002. Development of tree regeneration in fern-dominated forest understories after reduction of deer browsing. Restoration Ecology 10(2):416-426.

De La Cretaz, A.L., and M.J. Kelty. 2006. Control of Hay-scented fern by mowing. Northern Journal of Applied Forestry 23(3):149-154.

Engelman, H.M., and R.D. Nyland. 2006. Interference to hardwood regeneration in northern North America: assessing and countering ferns in northern hardwood forests. Northern Journal of Applied Forestry 23(3):166-175.

Horsley, S. B., S.L. Stout, and D.S. DeCalestra. 2003. White-tailed deer impact on the vegetation dynamics of a northern hardwood forest. Ecological Applications 13(1):98-118.

Kraft, L.S., T.R. Crow, D.S. Buckley, E.A. Nauertz, and J.C. Zasada. 2004. Effects of harvesting and deer browsing on attributes of understory plants in northern hardwood forests, Upper Michigan, USA. Forest Ecology and Management 199:219-230.

Oswalt, C.M., W.K. Clatterbuck, A.E. Houston, and S.E. Schlarbaum. 2006. Implications of large oak seedlings on problematic deer herbivory. USDA Forest Service General Technical Report SRS-92. Southern Research Station, Asheville, NC, USA.

Rooney, T.P., and D.M. Waller. 2003. Direct and indirect effects of white-tailed deer in forest ecosystems. Forest Ecology and Management 181:165-176.

Tremblay, F., J. Huot, and F. Potvin. 2007. Density-related effects of deer browsing on the regeneration dynamics of boreal forests. Journal of Applied Ecology 44:552-562.

Web Resources

Deer Management Simulator
http://lutra.tamu.edu/dms/dms.htm

White-tailed Deer in Pennsylvania's Forest
http://www.dcnr.state.pa.us/forestry/deer/index.aspx

Version 1
May, 2008