Implications of Reforestation: Controlling Mammalian Browsing and Competing Vegetation

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In recent years the number of reforestation projects have increased due to growing appreciation and concern for the ecological significance of forests. Benefits of forests include reducing soil erosion, maintaining biodiversity, reducing the effects of global warming, and providing recreation and educational places for people (Shea & Stange, 1998). Reforestation is an endeavor to improve the condition of land and to speed up natural succession by planting trees on old fields and cleared land. During the period between disturbance and reforestation, competitive vegetation, disease or pests, and drought are some of the factors that can influence natural succession and complicate reforestation projects. Not only do these factors influence tree establishment, some studies indicate that the presence of forage animals (such as mice, rabbits, and deer) can be a main obstacle to long term survival (Tierson et al. 1966; Alverson et al. 1988; Canham et al. 1993).

In most reforestation projects, many methods of establishment are used in conjunction to solve problems associated with competing vegetation and browsing. The purpose of this literature review is to gather and interpret the methods used in the past, in order to determine what is ideal for future practices. Although there are many techniques varying from location, desired outcome, and the type of forest, there was a definite pattern of failure and success in the experiments dealing with browsing and weed control.

Work with natural populations has shown that the effects of browsing by white tailed deer (*Odocoileus virginians*) can be severe enough to effect relative

density and regeneration of forests in the temperate North America (Heinen & Sharik, 1990). Many factors can effect the severity of browsing including tree species, season, deer population, environmental conditions, and proximity of existing forests (Healy et al. 1971; Alverson et al. 1988; Canham et al. 1993).

Vegetation surrounding reforestation projects, especially forest edges, often provides ideal habitat for white-tailed deer (Shea & Stange, 1998). Deer tend to browse the woody twigs of plants near forest edges and may be impediment to reforestation projects (Alverson et al. 1988; Inouye et al. 1994). Season, weather, herd size, available vegetation, and palatability of a species are important factors for determining the severity of browsing. White-tailed deer in the United States tend to browse in agricultural areas where vegetation and cover are high. They feed on leafy vegetation in agricultural fields and on understory growth in hardwood forests. After the crop in the fall is harvested deer feed mainly on woody plants. Ferns, grasses, and other herbs are important source of food before leaves appear on woody plants (Healy, 1971).

Extreme cold and snow can reduce the movement of deer and further intensify the browsing on seedlings in a small area. The effects of winter browsing on regrowth the following spring depends largely on the nature and distribution of the buds along a woody stem, and the ability of the lateral meristems to develop if the terminal meristem is removed (Canham et al. 1994). Some species, such as northern red oak, have concentrated carbohydrate reserves in the root system during the winter, and therefore are less sensitive to winter browsing (Gordon et al. 1994). Although one or two years of severe browsing may have a little effect on survival (Canham et al. 1994), the danger with repeated browsing is that it will eventually deplete seedling reserves and lead to seedling death (Shea & Stange, 1998).

Since reforestation depends greatly on the growth and survival of seedlings, devices such as tree shelters, fencing, and deer repellents have been tested in their ability to control mammalian browsing.

Tree shelters are tubes or fencing that wraps around a sapling in order to make the tree unavailable to the deer. Experiments have shown tree shelters to be extremely effective in reducing the browsing of deer, rabbit, and mice. 1990 Recently Shea and Stange (1998) determined that seedlings protected with white plastic tree shelters (five feet tall) were free from browsing and were significantly taller than the unprotected seedlings. By using tree shelters to allow the trees to grow above the range of deer browsing, experiments have shown increased growth and survival rates of seedlings within exclosures (Inouye et al. 1994; Tierson et al. 1996).

An experiment conducted by the Northeastern Forest Experiment Station indicated that protection with tree shelters varies with the diameter and the mesh covering used (plastic or wire). It was concluded that small mesh plastic and wire tubes were fully effective (over 90%) when used in a one-foot diameter, surrounding the tree. Both types need to be at least 5-feet tall in areas of high browsing. The plastic protectors were more expensive, but faster to fabricate and added an additional advantage of providing protection from rodents. Metal mesh lasted longer than the plastic, and wooden stakes were problems in longevity in each type of protection (Marquis, 1977).

Tree shelters are generally easy to install and take some maintenance, but they do have a few drawbacks. They are fairly expensive and maybe impractical for large reforestation projects, because they can be used only once and must stay in place for at least two years after the trees emerge from the top and develop sturdy stems (Kittredge et al 1992). Other possible alternatives for decreasing the intensity of browsing include electrical fences and topical repellents.

The use of fencing has proved to be a very effective way to exclude deer from plantings, increasing growth and survival of trees and other herbaceous plants (Tierson et al. 1966; Marquis & Grisez 1978; Palmer et al 1985; Alverson et al. 1988; Canhan et al. 1993; Inouye et al 1994). Tierson et al (1966) fenced in two areas with a heavy gage, measure wire fence, 10 feet high. After nine

years, the two-acre plot fenced in resulted in growth of three important hardwoods (sugar maple, birch, and white ash). Inside the exclosure there were 5,290 stems of these three species per acre, 3 feet and over in height. Outside the exclosure, there was a completely inadequate stocking in this height class. Where trees were unprotected, there were no yellow birches over 3 feet recorded, and only 167 stems per acre of sugar maple and ash. 1990

As an alternative to the traditional woven wire barrier fence (considered to be deer proof but too expensive for agricultural uses), electrical fences may provide a more cost effective way of repelling deer; but they may also need more maintenance (Palmer et al 1985). Many fences are available to exclude deer, but the importance lies with the wiring spacing and configuration of an effective fence and must prevent deer from crawling under and going through the fencing structure. The must successful electrical fence tested by Palmer et al (1985) ("The Penn State Vertical Electric Deer Fence") has five wires spaced approximately 11 inches apart, with the lowest wire spaced smaller to prevent deer from going under the fence. The more traditional agricultural fences, generally 8 feet tall with woven wire, and high-tensile fences (which have high voltages, but higher wire tension than traditional electrical fencing), varying in design, but have been proven effective (Palmer et al. 1985).

In areas where other forms of control such as shelters and fencing are impractical, chemical repellents are often used. However, the majority of chemicals repellents are either ineffective or reduce damage slightly. Repellents with biological bases, such as predator urines (bobcat, coyote, and human), have been tested in their ability to decrease browsing by white-tailed deer (Swihart et al. 1991). Results indicated that out of three predator urines used (topical sprays reapplied at weekly intervals during the winter season), bobcat urine was the most effective (possible due to the styles of hunting and the predator and prey relationship). Even when using a very palatable species, browsing percentage were below 40%, and with less palatable species browsing was not

significant. Because deer did not react with non-predator urines (such as rabbit, used in this study), this suggests that herbivorous mammals can distinguish predator odors and therefore adjust their behavior. Since the urine was applied as a spray, it may also function as a taste repellent. 1990

Because biological methods are not always acceptable or easily obtained, organic compounds have been identified and synthesis. Synthetic repellent made from an amino acid found in the urine of domestic cats and from lion feces have been manufactured, but documentation of their repellency was not found. Further research in this area would be benefited by the identification and synthesize of actively repellent compounds found in glandular secretions of predators and the development of slow release devices to enhance the long term effectiveness of the compound. Fermented eggs, containing amines and volatile fatty acids that are found in anal gland secretions of canines are also available to use for deer repellency (Swihart et al. 1991).

Not only is herbivory a concern, but detrimental effects of competing vegetation have been reported in the North America forestry literature over a long period and has been controlled in many ways throughout time and place. Techniques have ranged from physical (plowing, fire, mulching), to cultural (crop rotation, living mulches), biological, and chemical control (herbicides). Each technique has its own advantages and disadvantages. Some are not as effective because of constraints on time, money, labor, or local regulations. Some techniques work better in some sites compared to others, but an optimum situation would encompass more than one method of suppression.

In reforestation, experimental designs using the combinations of fertilizer, herbicides, and mulches to reduce competing vegetation have been successful with growth and survival rates (Francis 1977; Inouye et al. 1994; Gordon et al. 1995; Windell & Haywood 1996). Many environmental factors on a planting site affect seedling establishment. These include moisture, temperature, light, and mechanical damage. Mulches lessen the negative effects of these environmental factors of seedling development. Mulches also can suppress the surrounding

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vegetation. Mulch can include natural material such as straw, paper, leaf material or it can be synthetic such as plastics and cloths. Many commercial mulches are available in mat form for convenient handling and installation in reforestation. Because mulches should be in use for a few growing seasons (until seedlings root system becomes established), mulches that differ in degradability may fit specific situations better than others. 1990

Natural material may have to be replaced, depending on the site and conditions (Windell & Haywood 1996), while synthetic mulch must be staked down and eventually removed. Mulch mats that are staked may also be a problem for use in high populations of deer. Manufactured mats provide the benefits of natural mulch, and also allow controlled released fertilizers, animal repellents, and herbicides that are selectively incorporated into the matting. The use of chemicals and mulching material based on silvicultural procedures ensure seedling survival and early development on sites where nutritional deficiencies, animal damage, and weed problems are expected to be severe (Windell & Haywood 1996).

Herbicides allow the control of weeds where tillage may not be possible or desirable. Herbicides reduce the need for money and use less labor when compared to more conventional methods, and are more effective. Herbicides can be more efficient in areas where weeds have been allowed to constitute a large percentage of land, as abandoned agricultural fields and clear cut forest where trees may have a hard time becoming established. But because of the pressures to reduce herbicides for environmental reasons, an initial use of herbicides followed by another method, such as mulching, is recommended (Windell & Haywood 1996).

Use of herbicide in controlling competing vegetation has generally resulted in an increase in tree diameter and height. Also, tree growth rates increase with soil nitrogen and drought stress may also be reduced where soil organic matter is higher (Inouyle et al. 1994). Excessive herbaceous removal has resulted in a

reduced stem height, due to the exposure to deer and decrease food available to deer (Gordon et al. 1995; Shea & Stange 1998).

There are many ways to solve reforestation problems concerning mammalian browsing and competing vegetation. A review of the previous studies provides a basis for selecting the most efficient methods for forest establishment. Many procedures are site specific depending on soil and weather conditions. However, overall, the impact of browsing can be decreased with tree shelters, repellents, and fencing. Competitive vegetation can be controlled with an initial herbicide treatment and mulch materials appropriate to the site conditions. The implementation and monitoring of several methods will provide additional knowledge for further reforestation projects.

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