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ABSTRACT: Principal methods being used to alleviate browsing damage to Douglas-fir (Pseudotsuga menziesii) seedlings by black-tailed deer (Odocoileus hemionus columbianus) in the Pacific Northwest are animal repellents applied to foilage and plastic mesh cylinders around individual seedlings. As an alternate method, we demonstrated that prompt establishment of highly palatable native forbs reduced summer browsing on planted seedlings to the point that black-tailed deer were no longer a factor limiting Douglas-fir regeneration. We believe that establishing native forbs is a sound ecological approach to deer-reforestation problems; furthermore, it should have wide utility because it integrates forest- and wildlife-management objectives by promoting prompt regeneration of conifers and enhancing wildlife habitat.

INTRODUCTION

The Denver Wildlife Research Center's field station at Olympia, Washington is charged with developing safe and selective methods to reduce wildlife damage to forests as part of the responsibility of animal damage control delegated by Congress to the U.S. Fish and Wildlife Service (Evans, 1974). Barnes (1976), Campbell and Evans (1977), Lindsey (1977), and Anthony et al. (see Anthony, Barnes, and Evans in these Proceedings) describe the various methods being studied to cope with animal damage problems in western forests; many of these methods can be used elsewhere. This paper describes a method of improving wildlife habitat as an approach to reducing browsing damage to Douglas-fir (Pseudotsuga menziesii) seedlings by black-tailed deer (Odocoileus hemionus columbianus). The method was evaluated in western Washington but can be used for black-tailed deer throughout their coastal range from British Columbia into northern California.

BACKGROUND

Browsing damage to Douglas-fir seedlings by black-tailed deer is the most common type of animal damage in coastal forests of Washington and Oregon. Although deer feed on dormant seedlings (winter browsing), most feeding is on actively growing seedlings (summer browsing) mainly during the early growing season in May and June. This summer browsing is generally light the first year after outplanting when seedling growth is slow; thereafter, browsing is normally heavy until seedlings "escape" from the deer. Protecting the terminals of seedlings for the first 3 or 4 years after planting or until seedlings are about 100 cm (40 inches) tall minimizes browsing damage and provides this "escape". This protection can be achieved with mechanical devices like "Vexar" [1]/ seedling protectors (Campbell and Evans, 1975b) or various chemical repellents (Rochelle et al., 1974; Campbell and Evans, 1977); habitat modification, planting genetically resistant Douglas-fir and increasing the deer harvest on problem areas are other control methods that have been tried or proposed (Campbell and Evans, 1975a). All methods have damage reduction potential and all have economical/political/biological constraints tied to their use.

Since 1972, studies at Olympia have included introducing native forbs preferred by black-tailed deer in new clearcuts in western Washington as an ecological approach to reducing summer browsing on planted Douglas-fir. The philosophy of this approach has been explained (Campbell, 1974; Campbell and Evans, 1975a). Stated simply, timber-oriented land management programs--namely clearcutting, site preparation by burning or machine scarification, and periodic brush control--have provided and maintained habitat conditions that have favored the growth and expansion of black-tailed deer populations (Brown, 1961). Palatable foods, however, are not always present during early plant succession in clearcuts, or if present, they are not always abundantly available particularly during the peak summer browsing damage period in May and June. Early observations revealed that up to 40 percent of the Douglas-fir seedlings in a plantation had to be browsed before the plantation began showing significant height growth losses. When certain natural occurring forage plants were abundant in early stages of plantation development, browsing damage to Douglas-fir was generally below 40 percent. Conversely, in plantations lacking these plants, browsing damage was generally high (up to 80%). Our objective, then, was to find out if direct seeding for early establishment of these preferred plants kept deer damage in Douglas-fir plantations at tolerable levels of 40 percent or less.

We began our study by finding out that preferred forbs could be collected, seeded, and established in small study units in various forest clearcuts in western Washington (Campbell, 1974; Campbell and Evans, 1975a). We then seeded larger units to evaluate if use of these plants by deer minimized summer damage to Douglas-fir. This report summarizes this evaluation.

[1]Trademark of E.I. DuPont de Nemours & Co., Inc. Reference to trade names does not imply U.S. Government endorsement of commercial products.

MATERIALS AND METHODS

We designed our study to partially seed and entirely seed clearcuts and compare treated (land seeded) with untreated (natural, unseeded, control) areas. By doing this, we also planned to document the effect of natural abundance of preferred forbs on browsing damage in the control areas.

Plants

The plants we selected for seeding were evergreen forbs chosen principally because we knew that they: (1) provided early flowers and stems that were preferred by deer in late spring and early summer, (2) had a high reproductive and establishment potential, (3) did not compete with growth of Douglas-fir seedlings, and (4) were native to the Douglas-fir region. The plants were: catsear (Hypochaeris radicata)2/, fleabane (Erigeron strigosus septentrionalis), phacelia (Phacelia nemoralis), and hawksbeard (Crepis capillaris). All are normally considered as weeds of agricultural and forest lands. They appear in Douglas-fir plantations (sometimes immediately after site preparation), increase in abundance and gradually decline as tree stands develop.

We collected seeds by hand and in portable vacuum cleaners from plants growing along roadways, in fallow agricultural fields, and in forest clearcuts. All seeds were cleaned and separated by crude hand- and machine-methods, stored for less than 1 year, and tested for germination before use.

Study Units and Treatments

Our study units consisted of six newly logged clearcut areas in the coastal Douglas-fir forest type (U.S. Forest Service, 1973) west of the Cascade Range in Washington. All units were owned by the Washington State Department of Natural Resources and planted by them in late fall of 1973 and 1974 with nursery-grown, bare-root, Douglas-fir seedlings at the rate of about 1,250/ha (500/acre). We assumed that all units would receive summer browsing damage because nearby plantations were being damaged by black-tailed deer. For this study, we had seeded two of the units with preferred forbs and used the four remaining units as natural study areas. It cost us only $75/ha (about $30/acre) to seed our study units, however, additional seeding was not possible due to lack of available resources.

To evaluate partial seeding, we chose a 8-ha (20-acre) slash-burned clearcut (Gosnell) and seeded it in the fall of 1973 in a strip approximately 25 m (80 ft) wide; the strip was about 50 m (160 ft) inside the perimeter of the clearcut. Seeding rate was 1,422 g/ha (1.25 lb/acre). Catsear made up 90 percent of the seed, fleabane about 9 percent, and phacelia and hawksbeard about 0.9 and 0.1 percent, respectively. The inside and outside unseeded areas of the study unit served as the control.

In the fall of 1974, we entirely seeded one 16-ha (40-acre) slash-burned clearcut (Independence) with preferred forbs at the rate of 900 g/ha (0.8 lb/acre). Catsear made up 90 percent of the seed, fleabane 3 percent, phacelia 3 percent, hawksbeard 1 percent, and miscellaneous seed and trash 3 percent. Four other clearcuts near Independence served as control comparisons for this seeded unit. They were: one 16-ha (40-acre) slash-burned unit; one 8-ha (20-acre) slash-burned unit; one 8-ha (20-acre) unburned unit; and one 20-ha (50-acre) machine-sacrified unit.

Measurements

Measurements were taken weekly, monthly, quarterly, and annually depending on the data we needed to evaluate the abundance of plants and their use by deer to determine damage to Douglas-fir seedlings.

To obtain quantitative measurements of vegetation, we used the canopy-coverage technique described by Daubenmire (1959). For deer forage availability, we subsampled vegetative plots by clipping and weighing forage plants during the summer damage season. Deer use was determined by measuring incidence of browsing on plants and trees, by making daytime and nighttime observations of deer, and by taking track and pellet-group counts. Douglas-fir seedling heights and damage were sampled following methods described by Campbell and Evans (1977) and compared with seedlings protected from deer with "Vexar" protectors. Use by other animals was also measured but is not discussed in detail in this report. The study was scheduled to continue until Douglas-fir seedlings averaged 100 cm (40 inches) tall but for no more than four growing seasons.

RESULTS

We terminated our preferred forb-deer browsing damage study in fall of 1977 because "Vexar"-protected and undamaged Douglas-fir seedlings were about 100 cm (40 inches) or more tall at that time (Table 1), meeting our prescribed seedling height parameter to end the study. The study had allowed us to gather 4 years of data on the Gosnell partially seeded study unit and 3 years of data on the Independence units.

Measurements of the abundance of preferred forbs and summer browsing damage to Douglas-fir seedlings by black-tailed deer- are summarized in Figures 1 and 2. Browsing damage to Douglas-fir was consistantly below 40 percent in hand seeded areas (Figs. 1A and 2A) where the abundance of high

[2]Scientific names of forbs in this publication are from Hitchcock et al. (1955).

Table 1. Means and confidence intervals (P = 0.95) for heights of undamaged and deer damaged Douglas-fir seedlings in western Washington clearcuts seeded with high preference forbs to evaluate partial seeding (Gosnell) and total area seeding (Independence) as a means of reducing deer damage.*

Study units	"Vexar" protected	Unprotected	
	Controls	Undamaged	Damaged
Gosnell (4 years)			
Seeded area	116.9 ± 14.2	113.0 ± 19.2	98.5 ± 8.2
Natural area	111.2 ± 14.6	102.0 ± 18.9	92.5 ± 7.0
Independence (3 years)			
Hand seeded	90.9 ± 7.0	84.8 ± 10.3	74.0 ± 10.3
Natural seeded	106.3 ± 10.3	97.8 ± 8.1	91.4 ± 7.0
Natural	--	91.3 ± 9.3	56.6 ± 9.4

*Heights are in centimeters. Damage is defined as browsing injury to seedling terminal buds and stems.

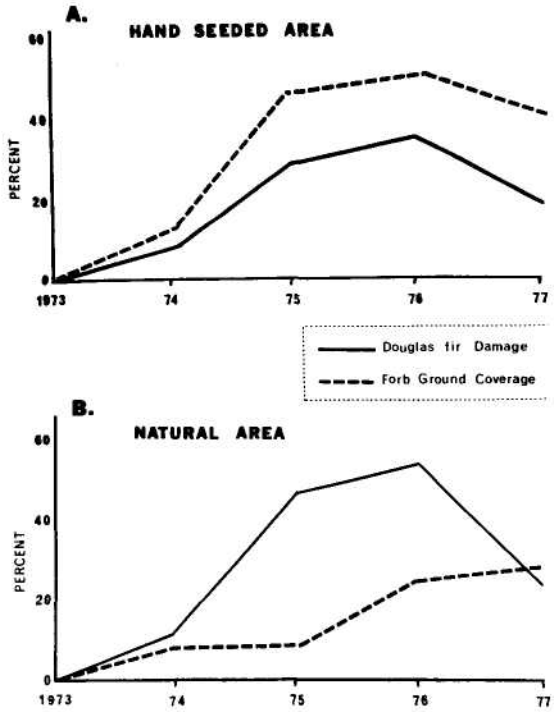

Figure 1. Patterns of summer browsing damage on planted Douglas-fir seedlings by black-tailed deer and abundance (percent ground coverage) of preferred forbs in the Gosnell partially-seeded, slash-burned clearcut study unit in western Washington where forbs were hand seeded (A), and where forbs established naturally (B).

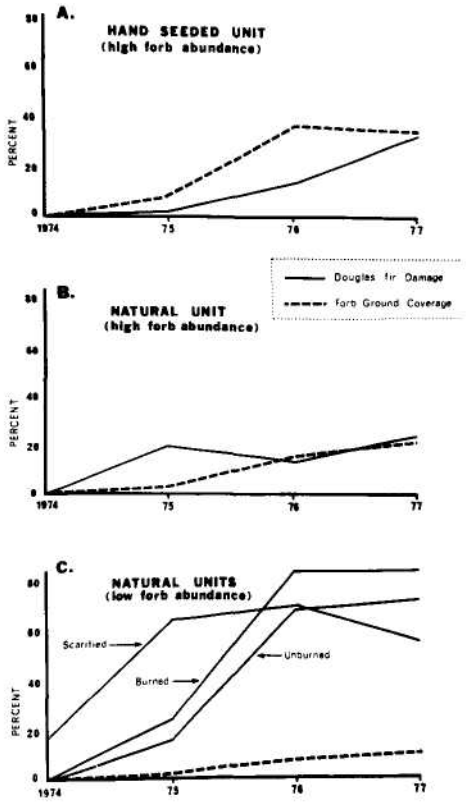

Figure 2. Patterns of summer browsing damage on planted Douglas-fir seedlings by black-tailed deer and abundance (percent ground coverage) of preferred forbs in western Washington (Independence) clear-cut study units that included (A) a slash-burned unit where forbs preferred as browse by deer were artificially established over the entire unit; (B) a slash-burned unit that had a rapid, natural increase of high preference forbs, and (C) three natural units with sites prepared in different ways that had slow natural increases of preferred forbs.

preference forbs exceeded 15 percent ground coverage. Weights of vegetation sampled to indicate deer forage availability (Fig. 3) showed that there was about twice as much forage available in seeded areas compared to natural areas.

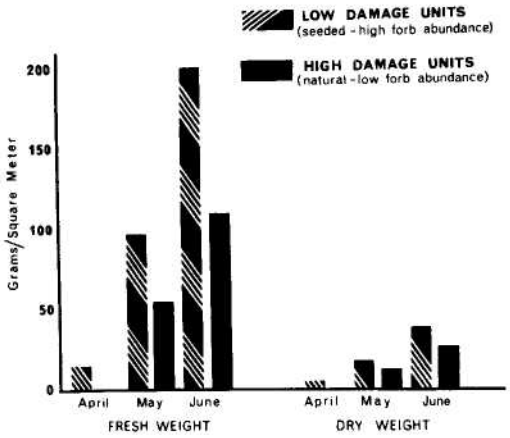

Figure 3. Total browse (excluding Douglas-fir) available to black-tailed deer in early summer in western Washington clearcuts where browsing damage to Douglas-fir seedlings was low and where it was high. Measurements include all plant parts normally eaten by deer.

Hand seeding resulted in a rapid increase of preferred forbs on the Gosnell (Fig. 1A) and Independence (Fig. 2A) study areas. The 16-ha (40-acre), slash-burned Independence natural unit (Fig. 2B) had good natural distribution and abundance of preferred forbs by the second summer, but the remaining control units (Fig. 2C) and natural portions of Gosnell (Fig. IB) did not--they had a more normal, gradual increase in abundance and variety of high preference forbs. The principal species of highly preferred, highly utilized forbs that occurred in these units were: catsear, fleabane, phacelia, and hawksbeard, of course, but also red stem fireweed (Epilobium watsonii watsonii), sow thistle (Sonchus asper), hawkweed (Hieracium albiflorum), and miners lettuce (Montia siberica). Miners lettuce was commonly abundant and used the first year after site disturbance but thereafter declined rapidly in both abundance and use by deer; red stem fireweed was fairly abundant and highly utilized on the Independence natural unit (Fig. 2B); catsear was the most abundant and most used preferred forb throughout the study.

In spite of an immediate increase in abundance of highly palatable deer food, our data and observations did not show a corresponding increase in relative numbers of deer or deer use in our Independence study units (Table 2). In addition, daylight observations at Gosnell showed that 27 deer fed 40 percent of their time in the seeded area of the unit and 39 percent of their time in unseeded areas of the unit; the remainder of their time in the unit was spent resting or on other nonfeeding activities. Observations also revealed that deer fed more on preferred forbs and less on Douglas-fir in the seeded area.

The forbs we seeded did not appear to directly affect the vigor of Douglas-fir seedlings; this is best exemplified in the comparisons of heights of undamaged, unprotected seedlings and "Vexar"-protected seedlings in hand seeded and unseeded portions of the Gosnell study unit (Table 1).

DISCUSSION AND CONCLUSIONS

In the Douglas-fir region, there is still great reliance on clearcutting and burning to create favorable habitat (forage and cover) for black-tailed deer. As shown in our study, clearcutting and slash-burning (plus other site preparation methods) do not immediately create favorable forage and that it can take several years until good forage is readily available and abundant for deer. Furthermore, current practices to increase timber productivity and wildlife habitat may have an adverse, rather than beneficial, effect on black-tailed deer. To increase timber productivity, for example, practices such as clean-tree farming by controlling brush and weeds in plantations, and rehabilitation of vast areas of brushfields in coastal forests are destroying deer habitat. For wildlife habitat, the trend to preserve stands of mature timber, especially at high elevations, may favor many wildlife species but does not necessarily favor black-tailed deer. There is some planned habitat management during reforestation such as seeding grasses, legumes, and shrubs, but these plants are not used sufficiently by deer during May and June to affect browsing damage to confiers. Basically, there are many clearcuts being reforested each year in western Washington and Oregon that lack good deer food for several years and there is little being done to correct this deficiency.

From this study, we now know that we can promptly enhance availability of prime summer deer food by direct seeding. By providing forbs preferred more than Douglas-fir by black-tailed deer we reduced summer browsing damage to Douglas-fir and enhanced regeneration. Based on observations by Crouch (1968). The preferred forb approach should also work in Oregon where Hines and Land (1974) reported that an

Table 2. Mean numbers* and confidence intervals (P=0.95) of black-tailed deer observed per night on Douglas-fir plantations (Independence study units) that were hand seeded with preferred forbs or left natural.

	1975	1976	1977
Observation Nights	20	20	21
Damage Period			
(May 15 - June 30)			
Natural	6.2 ± 1.6	5.8 ± 1.8	4.6 ± 1.8
Seeded	4.1 ± 1.1	4.7 ± 1.6	6.2 ± 1.8
Post-Damage Period			
(July 1 - August 15)			
Natural	5.7 ± 1.6	4.0 ± 2.3	3.9 ± 1.1
Seeded	4.1 ± 1.4	4.3 ± 2.3	5.5 ± 1.8
Total Period			
(May 15 - August 15)			
Natural	6.0 ± 1.1	4.9 ± 1.3	4.3 ± 1.0
Seeded	4.1 ± 0.8	4.5 ± 1.3	5.9 ± 1.3

* These are relative numbers of deer equalling 31 deer per km^2 (range 24 to 38/km^2) or 80 deer (range 62-99) per square mile.

abundance of preferred food, namely trailing blackberry (Rubus ursinus), reduced winter browsing damage to Douglas-fir by black-tailed deer. On our study units, winter browsing of Douglas-fir was not a problem because of a combined use by deer of trailing blackberry and high preference, evergreen forbs.

Habitat improvement in our study did not have a positive or negative effect on damage to Douglas-fir by other animals such as snowshoe hare (Lepus americanus washingtonii) and mountain beaver (Aplodontia rufa) during the first 3 to 4 years after seeding forbs! (The study units are now beyond the hare and deer damage stage but we still monitor them for possible long-term affects on mountain beavers.) We did not cause an obvious effect on deer numbers but, as reported by Hines and Land (1974), it can take years for local populations of black-tailed deer to respond to immediate habitat improvement.

Our study was not without problems. Seeds of preferred forbs discussed in this paper were not commercially available; they had to be collected from the wild by hand or by vacuum. During some of our collections, seed purity was not enforced resulting in the establishment of velvet grass (Holcus lanatus) on the Independence hand seeded unit; the grass was not used in summer by deer, competed with abundance of preferred forbs, physically covered the forbs reducing their availability, and, as indicated in Table 1, affected growth of undamaged and "Vexar" control seedlings. Once the demand for seeds is great enough, we believe that private collectors will supply seeds at a reasonable price and unwanted seeds will be minimized by specification and enforcement of seed purity.

We were not able to predict natural abundance and distribution of preferred forbs based on site preparation or sampling methods used in our study. All untreated areas had localized patches of preferred forbs but they were not distributed sufficiently to affect browsing damage. We surmise that seed sampling techniques could be included with the system described by Hall (1974) to predict abundance and distribution of preferred forbs.

On Gosnell, while percent browsing damage to Douglas-fir seedlings was high on the natural area (Fig. 1B), the browsing intensity—-the amount of foliage deer remove from a seedling in one season and from one year to the next--was low. We believe that this was due to the gradual spread and increase in availability of the preferred forbs from the seeded areas, but we are not sure. Although the impact of browsing damage on seedling height growth was reduced (see Table 1, Gosnell unit, damaged vs undamaged seedlings), we do not particularly recommend partial seeding at this time.

To insure a rapid abundance and favorable variety of high preference forbs for deer and reforestation, we suggest direct seeding entire slash-burned or machine-scarified clearcuts in the fall with the following forb seed mixture at the rate of 1.2 to 1.7 kg of seed per ha (1 to 1-1/2 lb/acre): catsear (70%), hawkweed (2%), and not more than 1% miscellaneous seed and impurities. (To aid land managers and seed collectors, a bulletin is being prepared to identify these species and to explain where, when, and how to harvest, clean, store, and disseminate seeds from these forbs.)

The Washington State Game Department (Taylor and Johnson, 1976) has already recommended that our preferred forb habitat improvement technique be used for deer in Douglas-fir plantations. We feel that the technique is on target with U.S. Forest Service goals to improve management of timber and wildlife on national forests. The preferred forb approach also fits private industry needs but may have to be integrated with repellents, animal resistant seedlings (Dimock, 1974; Radwan, 1974) or other damage control techniques to keep browsing at low levels set by industry for high yield forests.

In conclusion, we believe that seeding for early establishment of forbs in clearcuts in coastal Washington and Oregon is a sound approach to deer-reforestation problems. Because it blends two conflicting forest- and wildlife-management objectives, namely to enhance timber and wildlife values, forb seeding should have high utility on public and private forest lands in these two states. The technique also has implications for use for other forest-wildlife needs.

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