REP 1997-070
997-068

New Developments in Wildlife Damage Management

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Background

The NWRC Olympia Field Station is part of the United States Department of Agriculture (USDA), Animal and Plant Health Inspection Service (APHIS), Wildlife Service (WS), National Wildlife Research Center (NWRC). The NWRC functions as the research arm of WS by providing information on the development of socially acceptable methods for wildlife damage management. The NWRC Olympia Field Station investigates methods to reduce wildlife damage to forest resources. At present, the research at the Field Station includes studies with bears (*Ursus americanus*), beavers (*Castor canadensis*), deer (*Odocoileus hemionus*), deer mice (*Peromyscus maniculatus*), elk (*Cervus elaphus*), house mice (*Mus musculus*), mountain beaver (*Aplodontia rufa*), pocket gophers (*Thomomys* spp.), and porcupines (*Erethizon dorsatum*). The focus is placed on developing nonlethal measures. Ongoing research includes chemosensory studies and repellent development, physical deterrents, and efforts to learn more regarding means to modify habitat or animal behavior to reduce damage.

OVERVIEW

A brief overview of 5 studies is provided. These studies include: 1) primary hazards of strychnine baiting to reduce pocket gopher populations; 2) habitat manipulation to reduce mountain beaver damage to seedlings; 3) impacts of silvicultural practices on bear damage; 4) textural repellents to reduce beaver gnawing; and 5) efficacy of repellents to inhibit deer browsing.

PRIMARY HAZARDS OF STRYCHNINE BAITING

Pocket gophers (*Thomomys* spp.) are an impediment to reforestation efforts in the Pacific Northwest. Efforts to establish tree seedlings on sites infested with pocket gophers can be futile unless population reduction measures are implemented.

Procedures

The study was implemented on the Rogue River National Forest in Klamath County approximately 50 km west of Ashland, Oregon. Two experimental plots were established on each of 2 reforestation units targeted for pocket gopher population reduction. Each plot was 2.8 ha (140 x 200 m) with a 20 x 20 m (quad) grid system established across it to ease mapping of

1997. Pages 134-141 in Wildlife Damage Management for Natural Resource Managers. Western Forestry and Conservation Association, Portland, OR. (A workshop held Oct 1-2 in Olympia, WA. Compiled by Dale L. Nolte & Kimberly K. Wagner).

captured animals. One plot from each unit was randomly selected for strychnine application. The other plot served as an untreated control to monitor temporal effects not related to strychnine baiting. A minimum of 200 m separated all study plots.

Steam-rolled oats with 0.5% strychnine was applied by U.S. Forest Service contractors. This operation consisted of applying bait twice, first on August 28 (0.45 kg/ha) and again on September 4 (0.05 kg/ha). Open hole monitoring of pocket gopher activity was then conducted and it was determined that a third treatment was required to meet contract stipulations. This bait was applied on September 30 (0.4 kg/ha).

A capture and release program was used to measure the presence of small mammals. During the capture and release effort, 2 traps to capture small mammals were set on each of the 70 quads per plot. Trapping was conducted once prior to baiting, then 3 times at 2-week intervals after treatment, with a follow-up trapping period the next spring, shortly after snow melt, and then twice the next fall at 2-week intervals that reflected the pretreatment and the first posttreatment trapping periods.

Captured animals were marked with an AVID micro-chip for subsequent identification. The species, weight, and sex along with the location and time of capture were recorded for each animal. Any animal carcass encountered during the study was examined to determine whether it had been previously marked with a micro-chip. When possible micro-chip numbers were recorded, if a micro-chip was not present then the species of the animal was recorded.

Impact of Strychnine Baiting

Pocket gopher populations were reduced to less than 10% of pre-treatment levels a few weeks post baiting. Though activity signs were significantly less on baited plots the next spring, populations had increased by the following fall.

Ground squirrel numbers declined immediately after baiting on treated plots relative to control plots. At 2 and 4 weeks post baiting there was a significant decline in populations. Few animals were active on either of the plots during the 3rd post bait monitoring, probably as a result of hibernation. Populations were similar to pretreatment levels the next spring and summer.

Chipmunk populations were not negatively impacted by the strychnine treatment. Their populations remained similar on treated and untreated plots throughout the fall after baiting. The next spring chipmunk populations were higher on the treated than the control plots baiting. Perhaps because chipmunks were invading areas vacated by the golden mantled ground squirrel. These two species may compete for resources.

Few predators or scavengers were encountered during the study, therefore, it was impossible to assess secondary hazards. Ground squirrel (15) and chipmunk (7) carcasses were found above-ground. A few with strychnine bait in their cheek pouches. Thus, the possibility existed for secondary exposure. As previously reported these carcasses were largely consumed by insects within 48 hours.

HABITAT MANIPULATION TO REDUCE MOUNTAIN BEAVER DAMAGE

Food selection by foraging animals is relative and depends on the options available. Alternative forages may limit the amount of damage inflicted on trees. Factors that influence diet selection, however, also influence whether animals occur in a specific location. Thus, although alternative forage may reduce damage by the existing individuals, these alternatives may also attract additional animals to the area. Alternatively, a void of desirable habitat may limit the number of offending individuals in a protected area. This series of tests investigated the effects of habitat on mountain beaver damage to tree seedlings. Treatments were varied foraging opportunities. The freedom to move among habitat types and then population density were varied on subsequent tests.

Procedures

All habitat enclosures (11 x 16 m) contained 2 nest boxes located at opposite corners of the enclosure. Nest boxes consisted of a 125 l trash can buried in the soil with an exit to the surface via a 1.5 m corrugated pipe (10 cm dia.). Opposite the exit pipe was a .5 m corrugated pipe buried in the soil to facilitate natural burrowing by the animals. A common feed station and water bowl were centrally located. The feed station was an A-frame (.5 x .5 m) hut with a feed bowl that was filled daily with rodent pellets and apples cubes for food, and straw for bedding material. Alder branches were stacked behind the feed station to provide material for gnawing or nest material.

Three habitat regimes were developed for this study: 1) complex; 2) intermediate; and 3) barren. The complex habitat consisted of salal, sword fern, Oregon grape, cat's ear and huckleberry. Only cat's ear and huckleberry were established within the intermediate habitat enclosures No vegetation, except alder for shade, was established within the barren habitat enclosures.

Douglas-fir (*Pseudotsuga menziesii*) and western red-cedar seedlings (*Thuja plicata*) were planted after mountain beaver had been established within their respective enclosures for at least 4 weeks. Two age classes of seedlings were planted since size may influence clipping by mountain beaver.

Three tests were conducted on consecutive years to assess the impact of alternative forage on mountain beaver damage to tree seedlings. In the first test, 2 mountain beaver were established within each of the 3 habitats and barriers between enclosures restricted animal movements throughout the test. Likewise, 2 mountain beaver were established within each of the 3 habitats during the second test, but the barriers between enclosures within a block of habitat regimes were removed the day before seedlings were planted. For the third test, 2 mountain beaver were established only within the barren habitat. No animals were placed in the complex or intermediate habitats. As in the second test the barriers between enclosures within a block of habitat regimes were removed the day before seedlings were planted.

Tree seedlings were inspected for damage at weekly intervals for 12 weeks post planting. The number of seedlings damaged was recorded for each species and age class.

Throughout these tests all mountain beaver had free access to rodent pellets, apples and nesting materials. Mountain beaver in other pens do very well over extended periods when provided only these materials. They did not need to collect any other of the "natural" vegetation to survive. The amount of seedlings and habitat vegetation clipped probably would have been greater had these materials not been provided.

When confined to a single habitat regime mountain beaver inflicted the most damage in the enclosures with the barren habitat regime. The least amount of damage occurred in the enclosures with the complex habitat regime.

In the second test, damage was more evenly spread across treatments when population densities (6 animals) were as before but mountain beaver were permitted to roam among habitat regimes. Observations indicated that animals were crossing from the barren and intermediate habitats into the complex habitat areas. Though protective of burrows within the immediate vicinity of their nest, mountain beaver are less territorial outside their burrow systems (Nolte et al. 1993). Plants within the complex habitat enclosures were heavily utilized. This reduced availability of alternative choices may have caused the increased foraging on seedlings.

Not surprisingly, fewer seedlings were clipped during the test with reduced mountain beaver densities. Less expected, however, was the similarity in the number of seedlings clipped among habitat regimes. Mountain beaver were established in the barren enclosure when the study was started and they continued to persist or at least to return to this enclosure. Mountain beaver are adequately mobil to readily cross a block of habitat regimes (48 m). Results may have been different if the animals had been initially established in the complex enclosure.

These results indicate that foraging options impact the extent mountain beaver damage tree seedlings. Supplemental feed or planting "natural" forage can reduce damage but the success of these efforts depends on population densities and the mobility of target animals.

IMPACTS OF SILVICULTURAL PRACTICES ON BEAR DAMAGE

A Series of studies investigated: whether phytochemicals present in Douglas-fir vascular tissue mediate bear tree selection; 2) whether silvicultural management practices (thinning, urea fertilization, pruning) impact the allocation of these constituents; and 3) whether genetic selection affects the allocation of these same compounds.

In the initial study conducted in 1994 and 1995, chemical data was collected from Douglas-fir trees foraged by black bears. Chemical constituents (carbohydrates and terpenes) were correlated with the extent of tree damage. This was followed in 1996 with bioassays that confirmed the causal effects of these constituents on forage selection. Subsequently, the impacts of silvicultural practices on vascular tissue carbohydrates and terpenes were investigated.

Tree Selection

Foraging of vascular tissue is selective in that not all stands are damaged, and individual trees may be damaged while adjacent trees are not. Trees with minimal (ca. 20 cm^2) peeled bark were frequently found adjacent to trees with extensive (up to 15,500 cm^2) bark damage. We assumed that trees with minimal bark damage were less desirable forage then those with extensive bark removal. Multiple regression models were built using area of peeled bark as the response and the chemical variables as the predictors. The data indicate that carbohydrates and terpenes may be related to tree selection.

Results of the field bioassay demonstrated the casual effects of carbohydrates and terpenes on forage selection of bears. Free-ranging bears were offered the choice of four prepared test diets varying in carbohydrate and terpene concentrations. Bears preferred low terpene containing diets to high terpene diets. Bears also preferred diets with higher carbohydrate concentrations. These preferences may have resulted from prior foraging experiences. Generally, carbohydrates produce positive feedbacks from intake while terpenes can induce negative consequences. Thus, bears have learned to forage in a manner that maximizes carbohydrate intake while minimizing terpene intake.

Silvicultural Practices

The effects of thinning and urea fertilization on the allocation of carbohydrates and terpenes in vascular tissue were investigated in 1996. Samples were collected in 9 Stand Management Cooperative (SMC) installations located in Washington and Oregon. Tree diameter (DBH, a measure of cumulative growth) as well as vascular tissue (a measure of current growth) were increased by thinning. Furthermore, thinning significantly increased the carbohydrate concentration of the vascular tissue while having only minor impact on the terpene concentration. Thus, the net effect of thinning was an increase in the carbohydrate to terpene ratio of the vascular tissue. Previous data indicate that such an effect causes trees to be more highly preferred. This is supported by the observation that bears prefer to forage in thinned stands.

Fertilization had a positive effect on DBH and on carbohydrates the year after fertilizing, but did not effect terpenes. There was no difference in carbohydrates after the first year. The observed increase in tree diameter in the absence of increased vascular tissue mass suggests a growth spurt in the same year the treatment was applied.

The impact of live canopy pruning on the allocation of carbohydrates and terpenes in the vascular tissue was investigated on 3 Oregon Department of Forestry (ODF) sites. At each of these sites, every other tree was pruned by removing approximately 40% of the live canopy. Pruning treatments significantly decreased vascular tissue mass and carbohydrate concentration while having no impact on the terpene concentrations of vascular tissue. Thus, pruning decreased the carbohydrate to terpene ratio which may make pruned trees less preferred than unpruned trees.

Bear preference for unpruned trees was demonstrated in a survey of bear damage on a 50-

acre ODF site which was subjected to the same pruning treatment as described above. Statistical analysis revealed that unpruned Douglas-fir are four times more likely to be damaged than pruned Douglas-fir. Similarly, unpruned western hemlock are three times more likely to be damaged than pruned hemlock. These data are consistent with the hypothesis that bears will select trees to maximize carbohydrate intake and minimize terpene intake.

Genetic Effects

The impact of progeny selection on the allocation of carbohydrate and terpenes in the vascular tissue was investigated in a cooperative study with the USDA Forest Service and the Northwest Tree Improvement Center. Samples were collected from 6 known genetic families of Douglas-fir at 5 different progeny test sites. Initial chemical assays indicate that the amount of terpenes is not necessarily correlated with growth. This suggest that it may be possible to select for trees that are less palatable to bears without sacrificing growth potential.

TEXTURAL REPELLENTS TO REDUCE BEAVER GNAWING

Painting materials (e.g., boards, tree stems) with textural repellents may inhibit damage by beaver. The extent to which tree segments were gnawed by beavers in controlled pen trials was significantly reduced when the stems were painted with textural repellents. Textural repellents used in the study were a simple mixture of sand (silica, industrial quartz, 70 mil sand, mason sand, 30 mil sand, washed sand) and alkyd paint (140 g/1l). Untreated stems or stems painted with untreated paint were severely damaged during the 2 week trial, but treated stems received minor damage. Eight of 10 beavers completely avoided stems painted with a mixture of paint and 30 mil sand, and damage inflicted to stems treated with this treatment by the other 2 animals was slight. Sandpaper sheets can provide similar protection. Repeated destruction of beaver pens stopped when the frames and sides were covered with sandpaper.

EFFICACY OF REPELLENTS TO INHIBIT DEER BROWSING

Several studies have been conducted at the NWRC Olympia Field Station to assess the efficacy of commercially available repellents to deter deer browsing of seedlings. Candidate repellents are generally selected for testing because the producer or potential users have requested efficacy data. Methods used in the studies are generally similar. However, comparisons across studies are not valid since they were conducted at different times and under varied conditions.

Test Procedure

Though procedures vary slightly among tests the general approach used to assess efficacy of repellents is described below.

A resident deer herd at the NWRC Olympia Field Station is equally divided among several enclosures. These enclosures then serve as replications to assess the response of deer to seedlings treated with selected repellents. Enclosures vary in size from .75 to 2 ha with natural habitat consisting of Douglas-fir and alder and associated under-story vegetation. Although natural forage is readily available, animals are also provided free access to deer pellets and water throughout the study.

Repellents are obtained directly from the manufacturer or purchased through a commercial dealer. All repellents are prepared and applied according to the label or directions provided with each product.

Seedlings are planted in test plots immediately prior to treatment. Number of seedlings within a block varies between 9 and 12. Western red-cedar, Douglas-fir and ponderosa pine have been used in trials. Western red-cedar is readily browsed by deer, thus it is good indicator of efficacy.

Seedlings are examined for browsing damage at 24 and 48 hours after treatment and then at 1 week intervals for the duration of the test. Damage to the terminal bud and the number of lateral bites is recorded for each seedling. Lateral bite counts are limited to a maximum of 25, because after 25 bites the seedings are virtually defoliated. Seedlings pulled out of the ground are regarded as completely defoliated and thereafter recorded as having terminal damage and greater than 25 bites. This evaluation criteria provides an accurate assessment of: 1) the number of damaged seedlings; 2) the number of seedlings with terminal damage; 3) the mean number of lateral bites taken; and 4) the number of completely defoliated seedlings (25 bites).

Efficacy test indicate that several of the products that contained active ingredients which probably produce sulfurous odors reduced deer browsing for several (10 to 14) weeks. A capsaicin product worked well initially but efficacy declined after 2 to 3 weeks. Bittering agents and garlic were less effective at inhibiting deer from browsing seedlings. These results are consistent with other experiments that tested the efficacy of similar active ingredients to repel herbivores (Dietz and Tegner 1968, Harris et al. 1983, Palmer et al. 1983, Melchoirs and Leslie 1985, Conover 1984, Connover 1987, Swihart and Conover 1990, Andelt et al. 1991, Andelt et al. 1992, Milunas et al. 1994).

REFERENCES

Andelt, W.F., K.P. Burnham, and J.A. Manning. 1991. Relative effectiveness of repellents for reducing mule deer damage. Journal of Wildlife Management. 55:341-347.

Andelt, W.F., D.L. Baker, and K.P. Burnham. 1992. Relative preference of captive cow elk for repellent-treated diets. Journal of Wildlife Management. 56:164-173.

Conover, M.R. 1984. Effectiveness of repellents in reducing deer damage in nurseries. Wildlife Society Bulletin. 12:399-404.

Conover, M.R. (1987). Comparison of two repellents for reducing deer damage to Japanese yews during winter. Wildlife Society Bulletin. 15:265-268.

Dietz, D.R. and J.R. Tigner. (1968). Evaluation of two mammal repellents applied to browse species in the Black Hills. Journal of Wildlife Management. 32:109-114.

Harris, M.T., W.L. Palmer, and J.L. George. (1983). Preliminary screening of white-tailed deer repellents. Journal of Wildlife Management. 47:516-519.

Melchoirs, M.A. and C.A. Leslie. (1985). Effectiveness of predator fecal odors as black-tailed deer repellents. Journal of Wildlife Management. 49:358-362.

Milunas, M.C., A.F. Roads, and J.R. Mason. (1994). Effectiveness of odour repellents for protecting ornamental shrubs from browsing by white-tailed deer. Crop Protection. 13:393-397.

Nolte, D.L., G. Epple, D.L. Campbell and J.R. Mason. 1993. Response of mountain beaver (Aplodontia rufa) to conspecifics in their burrow system. Journal of Northwest Science. 67:251-255.

Palmer, W.L., R.G. Wingard, and J.L. George. (1983). Evaluation of white-tailed deer repellents. Wildlife Society Bulletin. 11:164-166.

Swihart, R.K., and M.R. Conover. (1990). Reducing deer damage to yews and apple trees: testing Big Game Repellent, RoPel, and soap as repellents. Wildlife Society Bulletin. 18:156-162.