WILDLIFE IMPACTS ON FOREST RESOURCES

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Abstract: The negative impacts of wildlife on forest resources can be extensive. This paper provides some insight into the economic and environmental consequences of wildlife damage to forest resources and a brief overview of the damage inflicted by select wildlife species. Probably the most thorough measure of wildlife damage to forests in the Pacific Northwest was initiated in 1963 and 1964 by the Committee on Animal Damage Survey of the Western Forestry and Conservation Association. This study estimated that 30% of the tree seedlings planted would be damaged if no preventive practices were implemented; stocking rates on unprotected sites were 75% of those on protected sites; and trees protected from animal damage were 33% taller than unprotected trees after 5 years. Updating the economic numbers to reflect present day values, this damage results in an annual financial loss in Oregon of US$333 million. The total predicted reduction in value of the forest asset in Oregon, if no animal damage management was practiced, was estimated to be US$8.3 billion. Results from a recent survey conducted by the Oregon Forest Industry Council also provides insight into economic losses due to damage by select species: mountain beaver (US$6.8 million) and bear (US$11.5 million).

Key words: damage, economics, environmental, forest resources, wildlife

The negative impacts of wildlife on forest resources can be extensive. Although damage is most often considered in terms of reduced productivity or delayed harvest cycles, attempts to replace trees after a harvest or a fire can also be complete failures because of foraging wildlife. The full impact of wildlife on forest resources is frequently difficult to assess because of the complexity of the resource. This complexity is inherent because of the spatial and temporal scales of forests. Assessing impacts is further complicated by the diversity of wildlife species that forage on forest flora, and the varied management approaches employed by landowners. Further, wildlife species are considered to be integral and desirable components of forest ecosystems and thus eradicating problem species is not an acceptable option.

This paper provides some insight into the economic and environmental consequences of wildlife damage to forest resources and a brief overview of the damage inflicted by select wildlife species. Our estimates for probable economic losses if preventive measures were not implemented are based on a long-term study initiated in the 1960s and a recent survey conducted by the Oregon Forest Industry Council (OFIC). The OFIC survey also provided costs estimates for efforts employed by Oregon timber managers to prevent damage by a few select species.

ECONOMIC CONSEQUENCES

The most thorough measure of wildlife damage to forests in the Pacific Northwest was initiated in 1963 and 1964 by the Committee on Animal Damage Survey of the Western Forestry and Conservation Association. Black et al. (1979) summarized the intensity of damage revealed by survey results, and Brodie et al. (1979) provided an economic evaluation of the costs associated with this damage. Briefly, 165 Douglas-fir (*Pseudotsuga menziesii*) plots placed on newly established plantations in Oregon and Washington were monitored for animal damage for 5 years; subsequently 45 plots were selected and monitored for another 5 years. This study compared survival and growth of protected and unprotected seedlings. From this study, potential damage caused by wildlife was estimated. Potential damage is damage that would occur in the absence of damage reduction measures, i.e. management. Unfortunately, a considerable time has passed since the original survey and no additional surveys have been conducted. Nonetheless, we feel that the estimates of potential damage still accurately reflect present day circumstances, and we proceed with our analysis using these values to project values to present day estimates. Not surprisingly, the 1963-1964 survey revealed that the extent and severity of damage varied among regions, but was geographically widespread throughout both states (Black et al. 1979). Overall, 30% of the forest seedling stock was damaged by some animal. Vertebrate species inflicting the damage, ranked by plot frequency, were deer (96%), lagomorphs (75%), grouse (51%), mountain beavers (25%), elk (21%), microtine rodents (6%), pocket gophers (4%), domestic livestock (4%), and miscellaneous vertebrates (11%). Seedlings were not damaged by porcupines or bears during the first 5 years of the study. These numbers may not accurately portray current damage frequency because of changes in silvicultural practices. Deer and elk damage remains common, but planting larger seedling stock reduced but did not entirely eliminate problems associated with lagomorphs; while reduced site preparation, such as burning, has increased the potential for high mountain beaver populations and increased damage caused by this species. Thus, the estimate of 30% seedlings damaged if no preventive practices are implemented (e.g., baiting, trapping, repellents, barriers) may be high or low depending on the region and silvicultural techniques employed. Nevertheless, we consider the findings by Black et al. (1979) to remain valid. These authors found that stocking rates on unprotected sites were 75% of those on protected sites. We also consider the potential growth loss to trees reported by Black et al. (1979) to accurately reflect current impacts. Trees protected from animal damage were 33% taller than unprotected trees after 5 years.

At the request of the Oregon Forest Industry Council, Dr. Brodie, Forest Economist, Oregon State University, separated the Oregon portion of the data collected during the above study and translated the economic damage into year 2000 US$ values to project current potential timber value loss in Oregon attributable to wildlife. He offered the following projections:

- Animal damage reduced board foot growth by 9% over a normal rotation or 92 board feet/acre/year.
- 134 thousand acres were planted in Oregon in 1997.
- At a stumpage price of US$450/thousand board feet, the annual reduction in yield is US$41.40/acre/year or US$2,484 per acre at the end of a 60-year rotation.
- Assuming a planting rate of 134 thousand acres/year and a 60-year rotation, annual financial loss in Oregon is US$333 million.
- Using a 4% real discount rate, the average losses justify a present net worth expenditure of US$236/acre on damage prevention, more in high hazard areas and less in low hazard areas.
- Growth loss/year is 740 million board feet, assuming a harvest of 8.2 billion board feet (This harvest assumes continued harvest on federal lands, the value would be reduced by half in a no federal harvest scenario).
- Total impact of above resource value at 4% real discount rate is $8.3 billion, which is the total predicted reduction in value of the forest asset if no animal damage management is practiced.

Potential revenue loss because of animal damage to timber resources also was projected in an unpublished survey report conducted in 2000 by the Oregon Forest Industry Council, Salem, Oregon. Respondents to the survey held approximately 3.7 million acres of private industrial timber lands, or 62% of the total acres owned by industrial forestry organizations in Oregon. Annual losses, if no preventive measures were taken, were estimated for mountain beaver (*Aplodontia rufa*) and bear (*Ursus americanus*). Assuming a plantation survival at 75%, then an equivalent of 8,000 acres of the 32,000 acres currently being treated for mountain beaver damage would be lost. Using a bare land value of US$500 per acre, plus the capital investment of planting and site preparation at US$350 per acre, the first year loss is US$6.8 million. The report emphasized that this estimate pertained only to the first year as damage levels could be expected to increase substantially over time as mountain beaver populations increased in the absence of control measures.

Bear damage occurs predominately in western Oregon. Aerial surveys show that approximately 34,000 acres are affected annually by bear damage in northwest Oregon, and projected losses in southwestern Oregon include another 30,000 acres. Assuming a stocking rate of 300 trees per acre and using previous ground truthing results indicating active peeling of tree bark to be inflicted on 4% of the total area, then 768,000 trees (300 trees per acre x 64,000 ac x .04) are estimated to be killed annually by bears. Assigning a value of US$15 per tree, and an average tree age of 25 years, the annual loss is estimated to be approximately US$11.5 million. Again these estimates are projected to increase significantly over time and because of increasing bear numbers if population control measures were halted.

Costs outlays to prevent damage are another measure of the economic consequences of wildlife damage. The OFIC survey revealed that timber managers in western Oregon are spending US$1,880,000 annually to reduce wildlife damage on 4,520,000 acres of timberland, or approximately US$0.42 per acre. The majority of these funds (68%) are spent to reduce mountain beaver damage, with bear (25%), beaver (*Castor canadensis*; 4%), pocket gopher (*Thomomys* spp.; 2%) and porcupine (*Erethizon dorsatum*; 1%) damage accounting for the remainder. These costs are anticipated to increase significantly if current lethal damage preventive practices become unavailable. For example, mountain beaver damage is generally prevented through population reduction using the conibear trap at a cost of approximately US$40 per acre. The most viable nonlethal alternative is tubing. Placing tubes on trees and maintaining the tubes for 2 years would cost approximately US$1 per tree. Thus, to protect the current 32,000 acres vulnerable to mountain beaver damage, using 400 trees per acre, the cost would jump to US$12.8 million per year, or a 900% increase over current expenditures. OFIC calculated similar cost increases to protect timber resources from bears (332 - 400%) and beaver (400%) if control measures are restricted. Unfortunately, although alternative control measures cost more, the level of protection most likely would decrease, particularly over time as populations of these species increased.

ENVIRONMENTAL CONSEQUENCES

Although they are an integral and desirable component of forest ecosystems, some species can be detrimental to the other native components of the ecosystem. Moreover, while the environmental consequences of the adverse effects to the ecosystem can be examined, it is difficult to assign a monetary value to these impacts. Species targeted for control may contribute to the destruction of habitat necessary for the survival of endangered or threatened fauna, or they may more directly impact those species, i.e., act as predators or herbivores.

Considerable resources are expended annually to establish native plants to increase forest diversity, improve riparian areas, revegetate disturbed sites, restore endangered or threatened plants, or to create or improve wildlife habitat (Rose and Haase 1998). Regardless of the original objective of the project, wildlife species ultimately benefit through improved cover or increased forage availability. Whether these benefits are long-term via established stands or merely a single meal, is often uncertain.

Some wildlife can be extremely detrimental to a plant restoration project, particularly if animals consume or damage the plantings before the seedlings are well established, or if their impact on the resource is particularly intense (Nolte 1998, 1999). For example, beaver also can significantly affect habitat composition (Ingel-Sidorwoicz 1982, Barnes and Dibble 1986, Johnston and Naiman 1990). Habitat modified by beaver is often beneficial to at least some of the forest ecosystem species (Harris and Aldous 1946, Gard 1961, Hason and Campbell 1963, Ingel-Sidorwicz 1982, Naiman and Melilo 1984, Naiman et al. 1986, Nickelson et al. 1992). However, flooding or reduced water flow can negatively impact other species. High beaver populations concentrated within some areas can reduce native flora so much that fauna survival is jeopardized, particularly where disturbed sites are rapidly invaded by highly competitive non-native plants. Beaver have contributed to the difficulties in establishing favorable riparian habitat for salmon in the Pacific Northwest (DuBow 2000).

Natural ecosystems also are being altered by high populations of ungulates (Stromayer and Warren 1997). Overbrowsing by herbivores can severely reduce seed production, plant establishment, and plant vigor and survival (Case and Kauffman 1997). Deer browsing has significantly impacted wildlife habitat in some northeastern forests by inhibiting regeneration of stands or by altering the tree species composition of regenerating stands (Curtis and Rushmore 1958, Brehand et al. 1970, Horsley and Marquis 1983). Understory habitat changes have affected the presence of some bird species (DeGraaf et al. 1991). Foraging by wild ungulates has delayed the recovery of some riparian species following the removal of cattle (Case and Kauffman 1997). Ungulates also are reported to be responsible for changing forest regeneration in Europe (Ammer 1996, Motta 1996). There is increasing concern regarding the impact of expanding deer populations on British woodland vegetation (Mitchell and Kirby 1990, Ratcliffe 1992, Kay 1993), and the concurrent indirect influences on invertebrates (Pollard and Cooke 1994). Habitat responses to grazing and browsing pressures also directly and indirectly affect other vertebrates and, ultimately, the future survival of ungulates themselves (Putman 1996).

DAMAGE INFLICTED BY SELECT SPECIES

The temporal and spatial scales of forests ensure varied habitats, and wildlife species change with the habitat. For example, high populations of pocket gophers may occur in young stands but are unlikely to be present in mature stands, and mountain beavers exist in high numbers in stands along the coast of Oregon and Washington, but are never found in inland forests. Vulnerability to damage also depends on stand age. For example, deer may inflict significant and repeated damage to young seedlings, but rubbing damage to older stems is rarely detrimental to the tree. Conversely, bear rarely damage trees less than 15 years of age. Therefore, whether calculating potential damage losses or figuring costs to implement preventive measures to protect forest resources the estimates must be based on the current state of the forest, reflecting the species present which, in turn, affects the potential type and the extent of damage and future controls that might be needed as the nature of the resource changes and becomes vulnerable to a new suite of wildlife capable of inflicting damage.

A brief overview of the type and extent of damage inflicted by a few select wildlife species is provided below. The reader is referred to Black (1992, 1994), Hyngstrom et al. (1994), Nolte et al. (1996) for more complete descriptions. We selected these species because of the severity or frequency which they inflict damage to forest resources.

Bear (Ursus americanus). – Bears feed on the vascular tissue of trees by removing the bark with their claws and scraping the sapwood from the heartwood with their incisors. Bears generally feed on the lower bole of trees in stands between 15 and 30 years old. Any age tree, however, is vulnerable, and bears occasionally strip an entire tree. Damage within a stand can be extensive as a single foraging bear may peel bark from as many as 70 trees per day. Damage inflicted through this behavior can be extremely detrimental to the health and economic value of a timber stand. The severity of timber loss is compounded because bears tend to select for the most vigorous trees within the most productive stands or where stand improvements (e.g., thinning) have been implemented.

Beaver (Castor canadensis). – Beaver activity can have severe negative impacts on agricultural resources and infrastructure developments. In the southeastern United States alone, economic losses attributed to beaver have been estimated to exceed US$40 billion over a 40-year period. Most of the damage is a result of flooding and the subsequent losses of timber, crops, roadways, and other resources. Less, but substantial damage occurs through bank burrowing, and tree cutting or girdling. Conical-shaped stumps and large wood chips at the base of stumps are prime indicators of beaver damage. Peeled sticks with uniform horizontal tooth marks also are generally found in the vicinity of beaver activity.

Deer (Odocoileus spp.) and Elk (Cervus spp.). – Browsing by big game species, such as elk and deer, inflicts the most widespread form of damage to forest resources. The similarity of deer and elk damage often prevents specific assignment of cause of damage. However, the wider distribution of deer suggests they are probably the most prevalent cause. Although lateral branches are browsed, damage to the terminal leader causes the most problems. Repeated annual browsing of terminal shoots distorts growth, suppressing tree height and converting seedlings into a bushy growth. Delayed growth lengthens the rotation period for timber stands. Extensive browsing can cause mortality. Unlike elk, deer rarely trample seedlings or pull them from the ground and most deer damage occurs below 6 feet. Elk, on the other hand, can pull seedlings without well-established root systems out of the ground, and elk traveling in herds can severely trample new stands. Additionally, stems browsed by elk are often splintered, and during the spring the bark below the break may be stripped from the stem.

Mountain beaver (Aplodontia rufa). – Reforestation efforts can be difficult, or impossible, on sites occupied by high numbers of mountain beaver. Mountain beavers clip seedlings up to an inch in diameter. Their diagonal cut is typical of rodents, but multiple bites may create a serrated edge. Although, mountain beavers are most often associated with seedling damage, they also girdle the base and undermine the roots of larger trees. Mountain beaver girdling can be readily distinguished from bear girdling because the damage is lower on the bole and mountain beavers leave horizontal tooth marks and irregular claw marks. This damage generally occurs as the canopy begins to close and shading reduces the availability of forage more preferred by mountain beaver. Over time, as these trees suffer mortality, substantial meandering openings may appear across a forest stand. Prime indicators of mountain beaver activity are numerous shallow burrows and burrow entrances, along with fresh digging, or fresh vegetation and debris piled near burrow entrances.

Mouse (Peromyscus spp. and Mus spp.). – Mouse feeding is rarely a deterrent to the growth potential of established tree seedlings. However, mice can have a substantially negative impact on efforts to establish trees through direct seeding. High mouse populations can render direct seeding futile. Damage inflicted by mice and other seed predators often makes it necessary to plant seedlings, rather than seeds, on many reforestation sites. Where small rodent populations are low, direct seeding is an affordable alternative to planting, or as an appropriate supplement to natural regeneration where seedfall from parent trees is inadequate.

Pocket gopher (Thomomys spp.). – Reforestation efforts are often severely hindered on sites that contain high populations of pocket gophers. Efforts to establish tree seedlings on sites infested with pocket gophers can be futile unless protective measures are implemented. Pocket gophers commonly prune roots of seedlings and girdle or clip seedling stems. Small seedlings, <.25 inch in diameter, are the most vulnerable. The stems generally are clipped at or near ground level and pocket gophers may pull harvested seedlings into their burrows. Pocket gophers also prune the roots and girdle the stems of larger trees. Extensive above-ground girdling is fairly easy to detect. Damage to roots, however, may go unnoticed until seedlings tip over or become discolored. Nonlethal damage causes poor overall growth, shortened needles, reduced internodes, premature needle drop, and needle discoloration.

Porcupine (Erethizon dorsatum). – Porcupines feed on the bark and sapwood peeled from conifers of all age-classes. Damage to seedlings and saplings can occur at any point from the ground upward; complete basal girdling kills the tree. Repeated injuries to older saplings or trees frequently cause mortality to the crown. These injuries cause poor growth-form which results in reduced lumber yields. Horizontal and oblique tooth marks are characteristic signs of porcupine feeding. Prime indicators of porcupine activity are bark chips, clipped needles, quills, and fecal material at the base of trees. During the winter porcupines leave distinctive trails, as they drag their tail, in the snow when they move between trees.

Snowshoe hare (Lepus americanus). – Snowshoe hares may be found in all forest types throughout the Pacific Northwest. Local populations undergo periodic fluctuations and plantations planted with small seedling can be devastated when high numbers of hares are present. Seedlings clipped by snowshoe hares are often difficult to distinguish from those damaged by mountain beaver. An oblique, 45° angle cut is generally found on clipped seedlings. Snowshoe hares tend to prefer feeding on seedlings <.25 inch in diameter. The most conspicuous indicators of snowshoe hare activity are their tracks and fecal pellets left throughout a damaged site.

Vole (Microtus spp.). – Vole damage generally occurs when the voles feed on young seedlings, but voles may girdle large trees when their populations are high and resources are limited. Voles prefer to feed on grasses and forbs during the growing season. Thus, tree damage is more prevalent during the winter when they shift to bark and roots for nourishment. Characteristic signs of vole damage are pointed stems on clipped seedlings and small whorled or circular marks on girdled seedlings. Voles inflict similar damage to roots. Vole populations are periodically irruptive. However, these peaks are not sustainable and these high populations naturally crash. Distinct trails and intermittent open burrow entrances are visible in areas where voles are active.

In all of the above examples, the economic impact caused by a species is a function of the current damage plus future losses plus the costs associated with replacement. For mature trees, the loss must account for time to reestablish the tree to a harvestable age. Thus, in time, the resource loss is the monetary value anticipated at time of harvest plus the monetary value for protection up to the point of damage, plus the time-integrated costs associated with reestablishment to future harvest.

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