

# EFFICACY OF BLACK BEAR SUPPLEMENTAL FEEDING TO REDUCE CONIFER DAMAGE IN WESTERN WASHINGTON

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**Abstract:** While searching for food, 1 black bear (*Ursus americanus*) may girdle 60–70 coniferous trees in a day during the spring months in western Washington, USA. Tree-bark peeling and subsequent foraging on sapwood can result in substantial economic losses for forest landowners. The supplemental feeding program, a nonlethal approach to minimize black bear damage by providing an alternative food source, was developed by the Washington Forest Protection Association (WFPA) in 1986. From 1998 to 2002, I studied the efficacy of this supplemental feeding program on the Olympic Peninsula. I selected 14 conifer stands of approximately 20 ha each for study. Mean pretreatment conifer damage on these sites in 1998 was 26% of trees. In March 1999, 1,000 trees were marked on 4 transects throughout each stand. Two feeding stations were installed on each of 7 randomly chosen stands in April of 1999, while no supplemental feed was supplied on the remaining 7 control stands. I found that bears damaged significantly more trees on control sites than on treatment sites ( $P < 0.001$ ). To validate initial results, I removed feeding stations from 2 of the 7 feeding sites in July 2000. Damage increased by a factor of nearly 7 on 1 feeding site over the next 2 years. I concluded that the supplemental bear feeding program constituted a viable, nonlethal damage control tool.

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The black bear population in Washington state is estimated at 25,000–50,000 animals (Tirhi 1996). A significant segment of the bear population is associated with some 400,000 ha (Mitchell 2001) of 15–25-year-old industrial forests in western Washington. Bear damage to trees has a significant aggregate economic impact across these lands, estimated in millions of dollars annually (Nolte and Dykzeul 2002). The WFPA's Animal Damage Control Program (ADCP) attempts to control black bear damage in Washington state. In addition to lethal black bear control methods, the WFPA developed the supplemental black bear feeding program in 1986 as a potentially nonlethal damage-control alternative (Flowers 1986). I evaluated the efficacy of this feeding program from 1999 to 2002.

Black bears emerge from their winter dens in western Washington around mid-March, and natural foods at this time are limited. By the beginning of May, bears feed on skunk cabbage (*Lysichitum americanum*), false dandelion (*Hypochaeris radicata*), horsetail (*Equisetum arvense*), and cow parsnip (*Heracleum lanatum*; Poelker and Hartwell 1973, Partridge et al. 2000). Tree-bark peeling and subsequent foraging on sapwood (phloem tissue) by bears begin with initiation of tree growth around mid-April in the low elevations of the coastal ranges.

Feeding on newly forming vascular tissue can either kill or seriously damage trees (Poelker and Hartwell 1973). The primary targets of bears are 15–25-year-old stands with about 1,000 trees/ha and trees about 20–40 cm diameter at breast height (dbh). Bears often bite into the lower bole of a tree and then remove the outer bark around all or part of the base of the tree with their claws. The phloem is then removed with the incisor teeth in an up and down motion of the head, leaving clear vertical tooth marks on the xylem (Ziegler and Nolte 1996). Complete girdling is lethal to trees, while partial girdling reduces growth rates and provides avenues for subsequent insect and disease infestation. The severity of tree loss is compounded because bears typically select the most vigorous trees within the most productive stands (Kimball et al. 1998a). Stands with high growth potential can be entirely lost to bear foraging behavior within 5–6 years (Ziegler 1994).

Damage to trees frequently occurs after stand improvements, such as pre-commercial thinning and fertilization, have been implemented and when conifer growth is at its seasonal peak (Mason and Adams 1989, Nelson 1989). In May, the phloem may contain up to 3.5% soluble sugars on a fresh weight basis (Kimball et al. 1998a), which provides an incentive for bears to consistently feed on coniferous sapwood from mid-April to the end of June in the absence of similarly attractive food sources. Phloem provides

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fructose, sucrose, and glucose (Radwan 1969, Kimball et al. 1998b). These sugars are immediately available for a bear's energy needs after emergence from the winter den. Bears target western hemlock (*Tsuga heterophylla*), the dominant tree species of the coastal range, about 2 weeks earlier than Douglas-fir (*Pseudotsuga menziesii*) because of an earlier bud break and initiation of growth (personal observation). Damage to trees usually is severe and may result in 60 to 70 peeled trees by a single foraging bear in 1 day (Schmidt and Gourley 1992).

Toward the beginning of July, as soon as wild salmonberry (*Rubus spectabilis*) is available, bear foraging on coniferous trees ceases (Ziegler et al. 1996). Red huckleberry (*Vaccinium parvifolium*), blackberry (*Rubus ursinus*), and elderberry (*Sambucus racemosa*) ripen in August and are the focus of foraging bears throughout the summer and fall months before bears return to their winter dens in November.

Unrestricted, lethal black bear removal by forest managers became less politically acceptable in Washington in the early 1980s, increasing the urgency for the development of nonlethal control methods (Partridge et al. 2000). The supplemental black bear feeding program was developed with the objective of providing an alternative food source to lure bears away from trees during the spring months. The ADCP avoided a year-round bear feeding program to decrease the likelihood of the supplemental feeding program contributing to bear population increase. The assumption was that bear foraging behavior during the rest of the year would not change and that bears will naturally wean off the supplemental food as soon as wild berries ripen in July.

After anecdotal initial success, the supplemental feeding program was quickly implemented in 1989. Demand for bear pellets grew to about 40,000 kg/season within the first 2 years. During 1996–2002, the ADCP distributed between 240 and 250 metric tons from April to June annually through 900 feeding stations established in vulnerable timber stands in western Washington (Ziegler et al. 2003).

The carbohydrate concentration of pellets is approximately 25%, which is about 8 times greater than the carbohydrate concentration in Douglas-fir sapwood (Kimball et al. 1998a). This high sugar content provides an incentive for bears to consistently feed on the pellets (Partridge et al. 2000). Fats, chicken protein, vitamins, blood concentrates, sugar beet, and miner-

als added to the pellets enhance palatability and the nutritional balance of the feed (Flowers 1986). The pellets are very hard and have a shelf-life of >1 year if stored under cool and dry conditions. The pellets are resistant to crumbling unless they become wet. Anecdotal field observations indicate that bears will not eat powdered, wet, or fermented feed.

My research tested 2 hypotheses: (1) providing bears with this alternative food source reduces damage to coniferous trees in western Washington; and (2) removal of feeding stations increases subsequent damage to trees.

## STUDY AREA

I conducted my study on mixed Douglas-fir and hemlock stands on the Olympic Peninsula in Washington State, USA. Eight test sites were located on the north side of the peninsula in Clallam County, along State Route 112, west of the town of Joyce. Six additional test sites were located on the west side of the peninsula along U.S. Route 101, near Kalaloch in Jefferson County. Ten test sites were on land managed by the Washington State Department of Natural Resources. Four sites, in Kalaloch, were located on land managed by the Northwest Forest Resources Timber Company (Rayonier, Washington, USA). All stands had bear activity, but no management efforts to reduce damage had been practiced on any of these sites prior to my study.

## METHODS

### Pretreatment Survey

I selected 14 research sites in the summer of 1998. I began pretreatment surveys in March 1999 to assess the existing characteristics and damage levels of each stand (Table 1). Tree age on the selected sites varied between 18 and 26 years, which is within the age range considered most vulnerable to bark-peeling by bears. All

Table 1. Mean number of black bear damaged conifers on 14 sites ( $n = 7$  pairs) with and without supplemental feeding in Clallam and Jefferson counties, Washington, USA, 1999–2002.

Year	$n$	Treatment		Control	
		$\bar{x}$	SE	$\bar{x}$	SE
1999	7	4.9	4.5	26.1	4.5
2000	7	10.3	4.5	21.6	4.5
2001 <sup>a</sup>	5	2.8	5.3	14.8	5.3
2002	5	3.4	5.3	16.0	5.3

<sup>a</sup> Feeders were removed from 2 sites in the summer of 2000.

stands had been pre-commercially thinned prior to the experiment's initiation. Stand sizes were between 16 and 20 ha, with similar timber stocking rates of approximately 1,000 trees/ha of Douglas-fir and hemlock. Existing bear damage in these stands served as an indicator of bear presence, although bear densities on these sites were unknown.

I divided each stand into 4 sections and extended a 10-m-wide belt transect into the stand perpendicular from the edge, starting at a random location within each quarter. Transect placement was stratified to ensure that transects ranged across different areas of stands. A team of 8 people worked simultaneously in 1 stand. Two surveyors on a given compass line surveyed the first 250 live trees encountered within 1 belt transect and documented existing bear damage. Often, 1 or more of the 4 transects went through large, wet, or rocky areas without any coniferous trees. Therefore, since 250 trees/transect were necessary, transect lengths varied.

Fourteen thousand trees were marked and examined on the 14 sites (1,000 trees/site). Trees with bear damage were marked with red tree paint, and undamaged trees were marked with blue tree paint. Dead trees were excluded from the survey. Annual post-treatment surveys over the next 4 years examined the same 1,000 marked trees on each site.

### Post-treatment Surveys

Stands with similar levels of damage were paired for analysis ( $n = 7$  pairs). I randomly assigned treatment and control within these pairs. Two feeding stations were placed in each of the 7 treatment stands in April 1999 before bears began to forage on tree sapwood. In the first year, beaver (*Castor canadensis*) carcasses were initially hung in the trees next to the feeding stations to lure bears quickly to the supplemental food, and thus minimize initial learning time. Feeding stations were stocked with pellets by the ADCP personnel on a weekly basis throughout the damage period at a rate of 100 kg/feeding station. No other bear damage management control tools were applied on feeding sites or control sites.

Black bear feeding stations were constructed from plastic drums holding about 90 kg of pellets. Two cables, at the top and bottom of the drum, held the feeder tightly attached to a tree. An opening in the front enabled bears to access the pellets inside the feeder. A simple self-replenishing mechanism in the form of a slanted plywood

sheet inside the barrel restricted bears from playing with the pellets and from spilling excessive amounts of food. Feeding stations were placed near a road, providing easy access for personnel.

The first post-treatment surveys were conducted in July of 1999. The 1,000 trees marked previously were surveyed for bear damage and received 2 additional orange dots of paint. We conducted the second post-treatment surveys in July 2000 and recorded new damage from the spring of 2000. Marked trees received 2 yellow dots of paint on opposite sides of the tree. We randomly replaced dead trees within each transect if the tree count was <1,000 trees/stand. After the bear damage surveys in July 2000, I randomly selected 2 treatment units in the Joyce area (J1 and J3) for discontinuation of the feeding program. The last surveys were completed in July 2002, and we recorded new bear damage from the spring of 2001 and 2002.

### Data Analyses

I used a *t*-test to compare pretreatment counts of damaged trees on treatment and control sites. I used analysis of variance to evaluate changes in numbers of damaged trees between treatment and control sites and among years from spring 1999 to spring 2002. I analyzed 14 sites (7 pairs) during the first 2 years ( $n = 7$  pairs) and 10 sites ( $n = 5$  pairs) after the second year, since feeding stations were removed from 2 sites in summer of 2000.

## RESULTS

Pretreatment damage surveys showed means of 235.7 (range = 84–498) damaged trees per 1,000 trees sampled on treatment sites and 256.9 (range = 151–527) on control sites. I found no statistically significant difference between the number of damaged trees on treatment and control sites ( $P = 0.60$ ).

The number of newly damaged trees was greater on control sites than on treatment sites in each year of my study (Table 1). Analysis of variance indicated no effect of year ( $F_{3,1} = 1.17, P = 0.33$ ) on the number of trees damaged. During 1999–2002, bears damaged significantly more trees on control sites than on treatment sites ( $F_{3,1} = 16.98, P < 0.001$ ).

Treatment was discontinued after 2 years in treatment sites J1 and J3. Bears damaged 6 trees during the first 2 post-treatment surveys on treatment site J1. After feeding stations were removed, bears damaged an additional 40 trees over the next 2 seasons, increasing damage by a factor of

7. Treatment site J3 was eliminated from the test because feeding stations on this unit were not maintained during 2000, and 55 trees were girdled on transect 4.

## DISCUSSION

After emerging from their winter dens, bears will eat the most palatable foods available first. If bears are given a choice between tree sapwood and ADCP pellets, bears seem to opt for the pellets to a substantial extent. If given a choice among sapwood, pellets, and berries, bears prefer berries. In July, bears quickly wean off the man-made feed.

The ADCP experience indicated that maintenance problems, empty feeding stations, or wet pellets are main reasons for failure of the black bear feeding program. In the J3 unit in Clallam County, 1 feeding station was accidentally not stocked for 1 week. As a result, we counted 55 girdled trees during the spring of 2000 along the transect where the feeding station was located, while the other 3 transects showed no damage. The ratio of damaged trees between treatment and control sites would have been higher without this avoidable mistake. Past feeding program failures also invariably occurred on sites with high bear densities (Ziegler 1994). Clallam County had historically high sport harvest success, which indicates high bear densities. Sport hunting was encouraged in areas with high bear population densities and where damage was unacceptable. Past experience has shown that population reduction, whether by sport hunters or through control programs, reduces bear damage. Therefore, reduced bear numbers likely equates to fewer damaged trees in general. Also, when damage was reduced through the feeding program, fewer bears needed to be removed from areas of vulnerable timber stands.

The K2 control unit near Kalaloch showed no bear damage in 2001 and 2002 but had normal activity and damage during the first 2 years. The Washington State Department of Fish and Wildlife and the land manager revealed that bears were killed around this research unit by sport hunters during the regular bear hunting season in 2000, which likely was responsible for the lack of damage.

Pretreatment surveys indicated the potentially high losses in timber production if no bear damage management practices are implemented. At least 25% of the pretreatment surveyed trees had suffered some damage inflicted by bears. This

damage is compounded because these stands had already been thinned to pre-commercial stocking levels of about 1,000 stems/ha. Damage also usually occurs in pockets, often resulting in the complete loss of trees on several hectares in 1 area. Kimball et al. (1998a) suggested that openings allow sunlight to penetrate the canopy and shade-intolerant trees, such as Douglas-firs, respond with higher photosynthesis rates. The higher carbohydrate concentrations in the phloem probably increase the attractiveness of these trees to bears.

Survey results from the first year extrapolated to a 20-ha stand suggest that 769 of 20,000 trees (1,000 trees/ha) on untreated stands would suffer bear damage annually. These figures, applied across a 15-year vulnerable period, suggest anticipated damage to 11,535 trees. Damage estimates for the stands with feeding stations across the same 15-year period, using the same calculation, would be only 2,100 trees or approximately 10%.

Before feeding on pellets consistently, bears must learn that feeding stations do not present immediate danger from hunters. We often observed bears waiting at the previous year's feeding locations in early April, before feeding stations were installed. This suggests that longer-term feeding may reduce damage to a further extent over time as a function of learned behavior.

Nolte et al. (2001) indicated minimum competition among bears at feeding stations placed at the same site for several years. I speculate this lack of competition may occur because bears have learned that feeding stations provide an unlimited resource of food, unlike an animal carcass that provides only a short-term resource. If true, this response would require time for bears to learn, and competition for the pellets would be the greatest the first year that feeders are installed. If competition restricts bears' access to feeding stations, then excluded bears likely would peel trees in an attempt to meet their dietary demands.

## MANAGEMENT IMPLICATIONS

My study supports the anecdotal experience of Washington's foresters that the supplemental feeding program is a viable tool to alleviate bear damage to trees. Further, this study also indicates, as observed in the past, that removing feeding stations in established feeding areas may increase bears' tree-girdling behavior.

Future studies are needed to understand the economic efficacy side of the black bear supplemental feeding program. Our experience cur-

rently is based on 900 feeding stations maintained by the ADCP in western Washington in 2002. One feeding station costs \$110. The price for pellets delivered to land managers last year was \$495/ton. Little information is available on the total labor costs to maintain the feeding stations for 3 months, and I am currently investigating the costs and benefits associated with a supplemental feeding program.

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