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# Cost-Effectiveness of the Black Bear Supplemental Feeding Program in Western Washington

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## Abstract

*In 2004 I concluded that the black bear (*Ursus americanus*) supplemental feeding program was an effective, nonlethal damage control tool to protect conifers during the spring in western Washington, USA (Ziegltrum 2004). Consequently, I analyzed the costs of the supplemental feeding program, which is used for about 10 years from stand age 15 to 25 and the costs of accepting bear tree damage. One Douglas-fir (*Pseudotsuga menziesii*) stand with known yield data served as a model. I assumed 15, 25, and 35% tree damage by bears in this stand at age 15 and allowed the stand to grow to 35-, 40-, and 45-year rotations. I performed present value calculations (PV) for the costs of the feeding program to determine if it was the best expenditure for the Animal Damage Control Program (ADCP) in comparison. For the sensitivity analysis, I used 5, 6, and 7% interest rates. I found that the costs of feeding bears for 2.5 months annually were always lower than the costs of tree damage by bears. Therefore, I concluded that the supplemental feeding program was a cost-effective damage control tool.* (WILDLIFE SOCIETY BULLETIN 34(2):375–379; 2006)



## Key words

*black bear damage, cost-effectiveness analysis, future value, nonlethal damage control, Pacific Northwest, present value, supplemental black bear feeding,* Ursus americanus, *Washington Forest Protection Association, Washington State.*


Efforts to manage wildlife damage are no longer resistant to the forces of supply and demand that drive the actions of private industry (Shwiff 2004). The spring black bear (*Ursus americanus*) supplemental feeding program in western Washington, USA, minimizes the bears' tree damage (Ziegltrum 2004) but is a cost factor. Douglas-fir *(Pseudotsuga menziesii)* stands are vulnerable to black bear bark girdling during the spring from age 15 to about 25, after precommercial thinning takes place (Nolte et al. 1998). This damage is a significant economic problem, estimated in millions of dollars annually (Nolte and Dykzeul 2002). The Washington Forest Protection Association's (WFPA) Animal Damage Control Program (ADCP) developed the black bear supplemental feeding program in 1986 (Flowers 1986). It is a nonlethal damage control tool and is used in addition to lethal black bear damage control. The ADCP recognized in 1985 that providing wildlife with viable alternative foraging options can alleviate the extent of foraging pressure directed toward forest resources. The United States Department of Agriculture, Animal and Plant Health Inspection Service (USDA, APHIS) described the efficacy of the black bear supplemental feeding program as a nonlethal approach, which "overall reduces damage to Douglas-fir trees (Nolte 2003). Partridge et al. 2001 describes the supplemental bear feeding program as "successful at reducing conifer damage during the early spring when other food resources are limited" (Partridge et al. 2001).

One black bear may peel 70 trees a day and can completely destroy a precommercially thinned young Douglas-fir plantation in 6 years (Ziegltrum 1994). In less-damaged stands with partially debarked but surviving trees, the quality of the xylem of the most vigorous trees suffer because of decay from subsequent fungus and insect infestation (Kimball et al. 1998). Since nearly all tree damage occurs on the lower bole of trees (Nolte et al. 1998), the first 8 feet of the basal log may have no commercial value, especially in high-yield forests with short tree-stand rotations (Schmidt and Gourley 1992). Bear damage is not randomly distributed throughout a stand but is usually concentrated in a small area and, therefore, creates pockets (Schmidt and Gourley 1992). Average tree diameter of nondamaged Douglas-fir trees at the edge of these pockets may even increase after bear damage occurred (Tables 1 and 2) because these trees have more sunlight available to photosynthesize, after dead trees lose their needles (Kimball et al. 1998). They also continue to be most vulnerable to the bears' bark peeling, since the total carbohydrate concentration in the phloem is greater in low-density stands than in mid- or high-density stands (Kimball 1997).

The ADCP uses feeding stations, at an annual cost of about $150,000 (U.S.) to protect about 400,000 ha of vulnerable timber stands during mid-April to the end of June (Adams 1992, Mitchell 2001). Feeding costs in 2004 were approximately $2.70/ha for the industry in general. Individual costs ranged from $0.75–5.10/ha (Flowers 1988, K. Cross, Weyerhaeuser, Rainier, Wash., USA, personal communication).

My study examined only the costs of the black bear supplemental feeding program and the costs of bear tree-damage in western Washington. No national or international comparisons were made. Oregon and northern California feed bears but have no information on associated costs. Croatia used the ADCP pellets successfully around 1990 (D. Huber, University of Zagreb, Zagreb, Republic of Croatia, personal communication) and foresters of the town of Kiryu, Japan, received 1 ton of pellets over the last 3 years to protect trees from bears. International literature is mostly opposed to the supplemental feeding of wild animals to prevent damage. Schroeder (1992) described initial experiences with the European brown bear (*Ursus arctos)* and observed damage to trees, sheep, beehives, buildings, and logging equipment in the Alps. Moog (2005) compared costs of animal damage management with the costs of accepting animal damage after 1 stand rotation in a private forest in Bavaria, Germany.

I researched the efficacy of the black bear supplemental feeding program from 1999–2002 and concluded that it was a viable

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***Table 1.*** Douglas-fir control stand characteristics in Cowlitz County, Wash., USA, with 0% bear damage and no supplemental feed applied. Volume loss of 10% is assumed at 3 rotation ages because of malformed trees, weather related damages, logging losses or holes in the stand.

| Control stand 0% damage | | | |
|---|---|---|---|
| Rotation age | 35 | 40 | 45 |
| Board feet/ha | 72,381 | 95,544 | 106,637 |
| Trees/ha | 753 | 741 | 729 |
| Diameter at breast height (m) | 0.31 | 0.32 | 0.33 |
| Stumpage dollar value/ha | 30,959 | 40,587 | 46,105 |

***Table 2.*** Douglas-fir stand characteristics in Cowlitz County, Wash., USA, with assumed bear-damage levels of 15, 25, and 35% at rotation ages of 35, 40, and 45 years.

| | | | |
|---|---|---|---|
| **15% damage** | | | |
| Rotation age | 35 | 40 | 45 |
| Board feet/ha | 62,763 | 83,923 | 94,060 |
| Trees/ha | 709 | 697 | 684 |
| Diameter at breast height (m) | 0.31 | 0.33 | 0.34 |
| Stumpage dollar value/ha | 26,787 | 36,163 | 40,335 |
| **25% damage** | | | |
| Rotation age | 35 | 40 | 45 |
| Board feet/ha | 55,237 | 72,959 | 88,090 |
| Trees/ha | 682 | 667 | 657 |
| Diameter at breast height (m) | 0.32 | 0.33 | 0.34 |
| Stumpage dollar value/ha | 23,475 | 31,371 | 37,719 |
| **35% damage** | | | |
| Rotation age | 35 | 40 | 45 |
| Board feet/ha | 50,398 | 67,881 | 85,751 |
| Trees/ha | 652 | 640 | 627 |
| Diameter at breast height (m) | 0.32 | 0.34 | 0.35 |
| Stumpage dollar value/ha | 21,380 | 29,008 | 36,828 |

damage control tool (Ziegltrum 2004). The cost-effectiveness of the feeding program was an important additional question for the forest products industry in western Washington. Therefore, I performed present value (PV) calculations to determine if this program offers the best expenditure for the ADCP's financial resources. The study helped foresters make the best investment decisions within their budget by showing under what conditions the supplemental feeding program was economically beneficial. My procedure also documented how the bear-feeding program could be analyzed under any number of assumptions and may serve as a guide for forest managers.

I hypothesized that providing black bears with the supplemental feeding program as an alternative food source during the vulnerable age period of a tree stand is economically beneficial to the forest products industry in western Washington.

## Methods

### *Control Stand*

I chose 1 typical Douglas-fir stand in western Washington, established in 1963, for the case study. The stand was stocked with 790 Douglas-firs/ha and precommercially thinned. It was located in Cowlitz County along the Cowlitz River between longitude 122°75′00″ and latitude 46°22′00″. Site index was 125 (42 m height at age 50), and average rain fall was 0.25 m annually.

An actual stand table was developed from the Barnes Drive Relative Density Plots, which is still used at the Washington State Department of Natural Resources (DNR; Table 1). The plots were established in 1983 at stand age 20 (C. Chambers, DNR [retired], Olympia, Wash., USA, personal communication) and generated to ages 35, 40, and 45, which are typical harvest rotations for Douglas-fir on industrial forest lands in these areas. I used the DNR Intensive Management Program Simulator (DNRIMPS) for the stand volume calculations, which were updated to better reflect different levels of bear damage (Chambers 2004).

### *Damage Definition*

Pretreatment damage surveys during the efficacy study in 1999 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, with no significant statistical difference ($P = 0.60$) between them (Ziegltrum 2004).

Damage in this cost-effectiveness analysis was defined as the percentage of trees hit by bears at age 15. Surveys showed about 30% of the damaged trees in a stand to be 100% girdled; these died within the following year, providing no revenue (Schmidt and Gourley 1992; Ziegltrum 1994; 1996, Miller et al. 2005). Based on 790 trees/ha and 15% damage with 30% mortality, 119 trees would suffer some form of bear damage. Of these 119 trees, 38 would be 100% girdled and die the following year. At the 25% damage level, 198 trees/ha would be hit by bears, and 59 would die. Assuming 35% tree damage, 277 trees/ha would be damaged, and 83 of them would die within 1 year. About 10% of all damaged trees would be debarked by 76–99% and would have additional mortality of 5% from windbreak, fungus, and insect infestation at harvest age (Schmidt and Gourley 1992, Ziegltrum 1994). The surviving trees would provide revenue but the basal logs would be lost. About 60% of the damaged trees would have bark loss between 1–75% (Schmidt and Gourley 1992) but would survive and the top and middle logs would provide revenue.

With these assumptions, I modeled tree loss for minimum tree damage of 15%, average tree damage of 25%, and maximum tree damage of 35% (Table 2). For the PV calculations, I used a sensitivity analysis with 5, 6, and 7% interest rates, since these rates are common for the forest products industry in Washington.

The control stand was reduced from the gross volume by 10% to reflect the actual timber volume at harvest because of malformed trees, weather-related damages, logging losses, and holes in the stand. I also used 10% of loss for the bear-damaged trees in the upper logs for the same reasons.

### *Value Calculations*

Approximately 70% of the tree's height is merchantable. Usually, 3 logs can be cut. The top log represents about 9% of value and the middle log 28% of the value. Most valuable is the basal log with about 63% (Mosman 2004). The stumpage calculation was based on the simulated stand table from DNRIMPS. I projected the stand tables with a modified version of a standard DNR log-scale tree-volume tariff computer program to fit the bear-damage losses better and to generate the trees diameter at breast height (DBH) class/ha (Table 2; Chambers et al. 1976). Each tree by DBH class was cut into 9.7-m logs (32 feet). The board foot volume of each log was assigned based on the inside bark diameter

Bear at supplemental feeding station.

(DIB), according to the yield table. The logs were sorted in 3 DIB classes: logs ≤0.18 m, logs >0.18–0.41 m, and logs >0.41 m.

I assigned the log value based on the average log values for western Washington in December 2004. Once all DBH classes were completed, I calculated total log price. Logs for chip and saw wood ≤0.18 m have a value of $487/thousands of board-feet per acre (MBDFT), saw logs >0.18 m – 0.41 m have a value of $630/MBDFT, and saw logs >0.41 m are valued with $580/MBDFT. I then calculated the stumpage/ha by subtracting the logging costs of $150/MBDFT.

### *Future Value (FV) Supplemental Feeding Costs*

Within a vulnerable stand at age 15, PV costs of the feeding program are $2.70/ha annually. These costs need to be paid for 10 years to stand age 25, when bear damage ceases. At the end of this period, these feeding costs are prolonged to the end of the stand rotation. I performed PV calculations for 35-, 40-, and 45-year stand rotations, $FV = PV \times (1 + i)^n$ ,where i = interest rate and n = compounded years. Assuming a maximum interest rate of 7% and a maximum stand rotation of 45 years (n = 30), the FV cost for the black bear supplemental feeding program is $21/ha.

## Results

The black bear supplemental feeding program was economically beneficial under all damage, interest rate, and rotation age scenarios. Compared with the control stand, the discounted value of the stand at age 15 (Table 3) without the feeding program was reduced by 13% at a stand rotation of 35 years and bear damage of 15%, independent of the real interest rate of 5, 6, or 7%. At rotation age 40, this stand lost 11% of its value, and at rotation age 45 it lost 13%. More significant was the loss of value at a 25% damage level. At rotation age 35, the stand lost 24% of its value at the assumed interest rates. At rotation age 40, it lost 23%, and at age 45, it lost 18% of its value. The difference in value was most significant at a damage level of 35%. At rotation age 35, the stand lost 31% of value, 29% of value at age 40, and 20% of its value at age 45, assuming interest rates of 5, 6, and 7%.

## Discussion

There could be endless examples with regard to stand quality, bear damage severity, with many assumptions of income loss through other animals, interest rate at harvest age, stand rotation, stocking, yield, and weather damage. My model was based on 1 typical Douglas-fir stand in the Pacific Northwest and showed that the supplemental feeding program was cost-effective under a wide spectrum of scenarios. I chose a site index of 125 for the case study because bear damage usually is low on poor growing sites, since the concentration of carbohydrates in the phloem provides no incentives for bears to peel such a tree (Kimball et al. 1998).

Currently, there is only the supplemental feeding program and lethal removal of bears with the assistance of hound hunters and the Aldridge foot snare available in western Washington to control black bear damage. In comparison, foresters in Oregon concentrate their damage control efforts with the Aldridge food snares and are willing to spend $65/ha to protect their timber resources (K. Cross, Weyerhaeuser, Rainier, Wash., USA, personal communication). The USDA investigates the use of contraceptives for bears, fencing of vulnerable tree stands, quartz sand to discourage bears from peeling trees, and multiple tree age–classes within a stand. None of these alternatives promise any practical and cost-effective solution for the near future for the forest products industry.

Wildlife does not have a clearly defined market value since it is

***Table 3.*** The western Washington black bear supplemental feeding program (1992–2002) was economically beneficial under all damage, interest rate, and rotation age scenarios. The future stumpage value is discounted back to the year 15, when damage occurred. The cost of $2.70 (U.S.)/ha for the feeding program is included in the control stand values. The percentage difference is the amount of discounted income a stand lost at age 15 because the black bear supplemental feeding program was not implemented.

| | Real interest % | Rotation age 35 | Rotation age 40 | Rotation age 45 |
|---|---|---|---|---|
| 0% damage | 5 | 11,668 | 11,985 | 10,668 |
| | 6 | 9,653 | 9,458 | 8,028 |
| | 7 | 8,000 | 7,440 | 6,057 |
| 15% damage | 5 | 10,095 (13%) | 10,678 (11%) | 9,332 (13%) |
| | 6 | 8,354 (13%) | 8,425 (11%) | 7,022 (13%) |
| | 7 | 6,924 (13%) | 6,664 (11%) | 5,298 (13%) |
| 25% damage | 5 | 8,848 (24%) | 9,265 (23%) | 8,729 (18%) |
| | 6 | 7,319 (24%) | 7,309 (23%) | 6,546 (18%) |
| | 7 | 6,066 (24%) | 5,780 (23%) | 4,955 (18%) |
| 35% damage | 5 | 8,057 (31%) | 8,566 (29%) | 8,522 (20%) |
| | 6 | 6,667 (31%) | 6,758 (29%) | 6,410 (20%) |
| | 7 | 5,525 (31%) | 5,345 (29%) | 4,839 (20%) |

not determined by supply and demand (Shwiff 2004). However, there are many different ways to develop a range of values for wild animals, based on license fee costs, illegal take penalties, or the amount of revenues garnered by hunting animals (Loomis and Walsh 1997). It is becoming more important for private forest managers to recognize the value of a bear, which is not killed to protect timber resources by using a nonlethal approach, since this bear is then available for hunters in Washington who are an important economic consideration.

The black bear supplemental feeding program was frequently introduced to the public in Washington over the last 15 years in newspaper articles, on radio, and on television news. The public feedback on nonlethal damage control tools was always positive. Working relationships with animal rights groups improved greatly during this time. The forest products industry in Washington recognized the benefits of using the black bear supplemental feeding program in 2 ways. In addition to saving timber resources and increasing revenue, it proved to positively influence public opinion about private forest management.

## Management Implications

I found that the black bear supplemental feeding program is a cost-effective, nonlethal black bear damage control tool to protect conifers during the spring in western Washington. The costs of this program over 10 years were always lower than the costs of accepting bear damage over the same time period. Landowner investments are expected to pay off at stand harvest age, which typically is between 35 and 45 years in this region. Thirty-two ADCP members represent 1.3 million ha of forests in western Washington of which 400,000 ha are vulnerable to black bear girdling. Over the last 7 years, the forest products industry used about 450,000 metric tons of pellets annually in 900 bear-feeding stations (Ziegltrum 2003).

Since 1996 the ADCP has reached a threshold with about 450,000 metric pounds of pellets annually. The total amount of pellet use will not appreciably change over the next 20 years since the vulnerable timber base will not change (Adams 1992). The supplemental feeding program may, therefore, continue to be used in the future, unless more effective tools are found.

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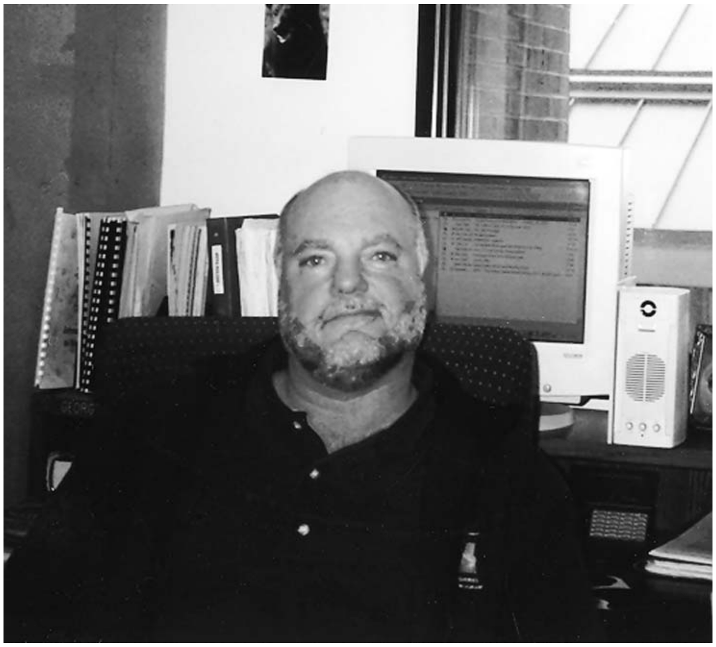

***Georg J. Ziegltrum*** was born in Munich, Germany. He studied optometry in Bavaria and worked in this profession for 6 years. In 1980 Georg developed an interest for forest and wildlife management and begun the study of forest and wildlife ecology at the Georg–August University in Goettingen, Germany, where he received an M.S. In 1988 Georg moved with his American wife to Washington where he worked as a cook and guide for a hunting outfitter and later as a lifeguard at the Chelan City Park during the summer. In February of 1989, Georg accepted a position with the Washington Forest Protection Association (WFPA) as Animal Damage Control Program supervisor. In 1991 he worked temporarily with the Washington State Department of Fish and Wildlife as area biologist in Aberdeen but was offered a full-time position with WFPA as staff biologist the same year. Over the last 10 years, Georg concentrated his work on black bears and studied in cooperation with the United Stated Department of Agriculture, Animal and Plant Health Inspection Service many aspects of damage management. Georg has well-established research connections to Germany, Austria, and Croatia. His current responsibilities for WFPA include animal damage control management and associated research, publications, public relations, policy work with legislators and the Washington State Fish and Wildlife Commission. In addition, Georg coordinates the Washington Tree Farm Program for WFPA.

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