Bear Response to Supplemental Feed Offered to Reduce Tree Peeling

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Abstract: Black bears (*Ursus americanus*) strip bark from coniferous trees to feed on newly forming vascular tissue during spring. Damage inflicted through this behavior can be extremely detrimental to the health and economic value of timber stands. A supplemental feeding program to provide bears an alternative food source during spring is practiced by some resource managers. We evaluated the efficacy of the program and conducted concurrent studies to assess select behavioral characteristics of feeding bears and impacts of providing supplemental feed on nutritional status of bears. The efficacy study revealed the percentage of damaged trees in stands with foraging bears varied from 2% to 52%. When supplemental feeding was introduced on these stands, damage was reduced to approximately 10% of that sustained on untreated stands. Concurrent experiments provided insightful data on bear use of feeding stations. Numerous bears fed at the stations, including females with and without cubs, yearlings, and boars. Bear feeding bouts at the stations were generally short, less than 30 minutes. Bears generally fed alone, although 2 to 3 adult bears were observed at a feeder simultaneously and the feeding partners were not consistent. There was little antagonistic behavior observed around the feeders, and no evidence that this behavior inhibited foraging opportunities for long. On the rare occasion a bear was driven from a feeder it returned later that same day to feed, generally within an hour. Supplemental feeding also did not affect the home range sizes of bears in feeding areas, but it may serve to concentrate bears in a particular location. Bears consuming supplemental feed did gain a significant nutritional advantage while feeding, but this did not equate to long term increases in age-specific body masses or fat content.

Key Words: behavior, black bear, *Ursus americanus*, damage, economics, forest, home range, nutritional status, supplemental feed

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INTRODUCTION

Black bears (*Ursus americanus*) commonly girdle Douglas-fir (*Pseudotsuga menziesii*) trees during the spring (Ziegltrum and Nolte 1996). Vascular tissues beneath the bark provide a readily available source of carbohydrates when alternative foods are limited (Kimball et al. 1998). Bears generally forage on the lower bole of trees ranging from 15 to 30 years of age. Any tree, however, is vulnerable to bear damage and occasionally an entire tree is stripped. Damage within a stand can be extensive as a single bear can peel bark from as many as 70 trees per day (Schmidt and Gourley 1992).

Damage inflicted by bears is extremely detrimental to the health and economic value of a timber stand (Ziegltrum and Nolte 2001). Complete girdling is lethal, while partial girdling reduces growth rates and provides avenues for subsequent insect and disease infestations (Kanaskie et al. 1990). Economic loss is compounded because bears select the most vigorous trees within the most productive stands, and frequently damage occurs after implementing stand improvements, such as thinning or applying fertilizer (Mason and Adams 1989, Nelson 1989, Kanaskie et al. 1990, Schmidt and Gourley 1992, Kimball et al. 1998). The problem is further exacerbated because of the extended time (20 plus years) necessary for a timber stand to return to its pre-damaged state.

Costs associated with bear damage occur as expenditures to prevent damage or timber value lost as a result of damage. The Oregon Forest Industry Council (OFIC) conducted a survey during 2000 to determine costs incurred by western Oregon timber managers because of foraging bears. A synopsis of the results was reported by Nolte and Dykzeul (2002). Briefly, the OFIC survey revealed that timber managers in western Oregon are spending $1,880,000 annually to reduce wildlife damage on 4,520,000 acres of timberland, or approximately \$0.42 per acre. The majority of these funds (68%) are spent to reduce mountain beaver damage, but management practices deterring bear damage account for 25%. Thus, timber mangers in western Oregon expend approximately half a million dollars per year to prevent bear damage. Although these measures reduce damage, bears continue to inflict sufficient damage causing substantial economic consequences. Aerial surveys indicate approximately 64,000 acres are affected by bear damage in western Oregon. Assuming a moderate stocking rate of 300 trees per acre combined with prior forest surveys, indicating peeling on 4% of the total area, then 768,000 trees (300 trees per acre × 64,000 ac × .04) are killed annually by bears. Assigning a value of \$15 per tree, average tree age of 25 years, the annual loss is estimated to be \$11.5 million. Another survey evaluated potential loss if no preventive measures were implemented on 40,000 ha of industrial timberland in western Washington (unpublished data). Using similar calculations as described for Oregon, the annual loss was approximately \$23 million.

Historically, management to protect timber resources from bear damage consisted of lethal removal. Control agents or professional hunters were hired to trap and hunt bears where damage was occurring (Poelker and Hartwell 1973). Private timber managers began investigating alternative damage control techniques during the mid-1980s. The first directed effort to provide bears with an alternative food to reduce tree girdling was attempted in 1985 (Ziegltrum 1994). During the first year approximately 2,250 kg of pellets were fed to bears through 10 feeders. Since its inception the program has continued to grow. During 2001 roughly 300 metric tons of pellets were offered through approximately 900 feeders spread across western Washington, with a few in Oregon and California.

Questions raised by timber and wildlife managers regarding efficacy and long-term consequences required further investigation. The supplemental feeding program appears to be an effective means to reduce bear damage in select timber stands. Bears generally reduce tree girdling once they start consuming pellets. Limited empirical evidence, however, has been available to document these observations. The impact of supplemental feeding on bear behavior also is largely unknown. Interest in possible long-term consequences has increased as the program has grown and become more widespread across western Washington. This paper summarizes a series of studies implemented to assess efficacy of providing supplemental feed to protect select timber stands, impact of the feed on bear nutritional status, behavior of bears in the vicinity of feeders, and effect of an unlimited resource on bears home ranges and movements.

EFFICACY TO REDUCE BEAR GIRDLING

The approach used to feed bears in western Washington is consistent among most forest managers (Ziegltrum 1994). Feeding stations are constructed from 55-gallon metal or plastic drums. An opening in the front provides access to pellets. A simple self-feeding delivery system restricts bears from playing with pellets, making it difficult for them to spill excessive amounts. A plywood roof, generally insulated with foam, keeps pellets dry. A single feeder holds approximately 90 kg of pellets. Commercial pellets are approximately 0.6 cm in diameter and 1.3 cm long, with a greenish color, resembling dry commercial dog food. Pellet sugar concentration is high (approximately 20%), at least 4 times the carbohydrate concentrations found in Douglas-fir during the spring (Kimball et al. 1998). Fats, proteins, vitamins, and minerals also are included to ensure the bears a nutritionally balanced diet. Feeders are normally placed near a road to provide easy access for restocking feeders, but away from public areas to avoid possible conflicts with humans. All feeders are removed from the forest at the end of the feeding season, which occurs mid-July. Bears normally wean themselves from feeders as alternative foods (e.g., berries) become available. Thus, feeding stations are no longer necessary; their removal reduces vandalism and eliminates any perception that feeders may serve as bait stations to hunt bears.

This study was conducted to better assess the efficacy of providing supplemental feed to protect timber stands. Ziegltrum and Nolte (2000) presented preliminary results at the Seventh Western Black Bear Workshop, Coos Bay, Oregon.

Methods

The study was conducted on timber stands located on the Olympic Peninsula. No management efforts to reduce bear damage had been practiced on any of the 14 selected study sites prior to treatment. Initially stands were paired to minimize differences in elevation and timber growth potential. All stands had been thinned to pre-commercial stocking rates. One stand within each pair was randomly selected for supplemental feeding stations. Subsequently, bear damage surveys revealed that pre-study damage intensity was not always similar between paired sites, thereafter the pair connotation was dropped. Two feeding stations were placed on each of the 7 treated timbers stands early in spring before bears began foraging on trees. Beaver carcasses were initially hung near each station to assist bears in locating pellets. Feeders were restocked weekly throughout the damage period (early April through mid-July). Other than feeding, no bear management efforts were implemented on feeding sites and there were no efforts practiced to reduce bear damage on control sites.

Pre-treatment damage surveys were conducted during the last 2 weeks of March 1999. Stand edges were divided into 4 equal sections and a single 10-m wide transect was established perpendicular to the edge at randomly assigned points within each quarter. Transect placement was stratified to ensure transects were spread across stands. Trained observers evaluated and marked the first 250 trees encountered along each transect; this equated to 1,000 trees per site. Bear-damaged and undamaged trees were counted and marked with spray paint: red for damaged trees and blue for undamaged trees.

Post treatment surveys were conducted the following March (first year damage) and then again during late July 2000 (second year damage). These surveys recorded new damage and checked trees marked during pre-treatment for signs of additional damage. Bears may return and forage on trees minimally damaged in previous years. Thus, it was possible for trees recorded as damaged during pre-treatment surveys to be counted again as having fresh damage on subsequent surveys.

Results

A simple analysis of variance revealed damage intensity on treated and untreated sites were similar ($P > 0.35$) prior to implementing the study (Table 1). Fewer ($P = 0.0003$) trees were damaged on sites with supplemental feeders than were damaged on control sites the first season after feeders were installed (Table 1). Mean damage occurring the second year was similar between treated (10) and untreated sites (22; $P = 0.2045$) (Table 2). However, damage intensity on two sites, one treated and one untreated, was substantially different (greater than 50% of mean) than other sites with similar treatments. Removing these outliers has a considerable effect on comparative analysis; treated stands (3) received substantially less ($P = 0.0001$) damage than untreated stands (25).

Discussion

Bear damage to timber stands prior to the study varied among sites. Damage intensity ranged from 2% to 52%, with a mean value of 26%. Although bear damage varied among sites, there was no mean difference between those randomly selected as treated or control sites, indicating bear activity on average was similar across treatments. The pre-treatment study also indicated the potential severity of bear impacts to timber production if no management practices were implemented. A quarter of the surveyed trees had suffered at least some damage. Since these stands were already pre-commercially thinned, such losses significantly reduce future harvest. Further, damage usually occurs in pockets often resulting in barren areas, at times several hectares. Study criteria stipulated sites containing bear damage. Thus, the 25% estimate cannot be extrapolated across all stands, but is indicative of potential damage on stands within the vulnerable 15- to 30-year age class.

Overall, providing bears a feeding alternative to stripping Douglas-fir trees reduced damage. Damage on treated stands was one-fifth the damage on untreated stands the first year pellets were offered to bears. Difference between treatments is more striking when results are extrapolated across a 20-ha stand. The surveys indicate that on untreated stands 769 of the 20,000 stems

Table 1. Total number of Douglas-fir trees damaged by black bears prior to treatment on 7 treated and 7 untreated 20-ha timber stands, and number of trees damaged on the same stands the first year supplemental feeding was practiced.

Damage Prior to Treatment			
	Damaged	Undamaged	Total
Feeders	1798	5181	6979
No Feeders	1647	5104	6751
Damage Post-Treatment			
	Damaged	Undamaged	Total
Feeders	35	5002	5037
No Feeders	187	4861	5048

Table 2. Number of Douglas-fir trees damaged by black bears on individual treated (7) and untreated (7) 20-ha timber stands the second year after supplemental feeding was implemented.

Feed	No Feed
55	33
2	33
2	22
5	21
4	3
2	24
2	15
Total 72	*Total 151*

(1000/ha) were likely to suffer bear damage annually. These figures extended across a 15-year vulnerable period yield 11,535 damaged trees. This estimate is only slightly higher (57% trees) than the damage intensity (52%) found on some stands during our pre-treatment surveys. Damage estimates for the stands with feeding stations across the same 15-year period, using the same calculations, would be considerably less– 2,100 trees or approximately 10%. Although less than untreated stands, 2,100 trees still equate to a considerable economic loss.

Damage on most feeding sites was less severe the second year. Bears probably require time to locate feeders and establish a feeding pattern. Competition among bears for this resource also probably declines with time resulting in feeder access to non-dominant animals, who otherwise may peel trees. Extensive damage did occur on one treated site. Damage also is occasionally reported on stands with feeders under operational conditions. Generally, when damage is reported then efforts to reduce bear populations are implemented and efficacy improves. This response suggests a correlation among population densities, resource availability, and damage. No efforts, other than providing feed, were made to reduce damage during this study. Thus, once damage was detected, it was not surprising that it continued throughout the vulnerable season. Likewise, minor damage was detected on one control site. Whether this response reflected a decline in bear populations or changing resources is unknown.

EFFECT ON BEAR NUTRITIONAL STATUS

Supplemental feeding reduced damage within most test stands. However, providing a highly palatable and nutritious diet to a species inflicting damage may lead to greater long-term problems, particularly if providing food, during a period when food is normally scarce, creates more productive bear populations. Therefore, a study was conducted to assess nutritional importance and use of supplemental feed by bears. An overview of the study, along with pertinent results, is provided; a more complete study description and interpretation of results were previously published in the *Journal of Wildlife Management* (Partridge et al. 2001).

Methods

The study area was approximately 80 km southwest of Olympia, Washington (USA) between 123°37'30" and 123°00'00" longitude and between 46°42'30" and 47°02'00" latitude. Elevation ranged from 30 m along the Chehalis River to 798 m on Larch Mountain. Bears with access to supplemental feed were located on Weyerhaeuser Company-owned timber stands. Supplemental feeding to reduce bear damage had been practiced for several years. Nonfeeding areas were located on the Capitol State Forest and the Lower Chehalis State Forest; physical characteristics of these stands were similar to the Weyerhaeuser stands.

A capture and recapture approach, with a minimum interval of 4 weeks, was used to monitor changes in body mass and composition. On capture, bears were weighed, blood-sampled for isotopic analysis of diet, aged, and when possible body composition was determined by bioelectrical impedance analysis (Model BIA-101A, R.J.L. systems, Detroit, Michigan) and isotopic water dilution (Farley and Robbins 1994, Hilderbrand et al. 1998). Diet was determined using stable isotopic (Hilderbrand et al. 1996) and scat analyses (Hewitt and Robbins 1996). Dietary contribution determined by stable isotopes is defined as the proportion of assimilated carbon and nitrogen derived from a particular source, and does not directly reflect biomass consumed because assimilation incorporates both digestibility and metabolizability, which vary depending on the food source (Pritchard and Robbins 1990, Hilderbrand et al. 1998). Scat samples were collected to determine species and relative proportions of plants and animals being ingested.

Results

Seventy-six individual bears were captured during the study (Table 3): 68 captures, 53 different bears, on feeding sites; and 28 captures, 23 different bears, on non-feeder areas. Mass gains for recaptured bears were higher ($P = 0.03$) in feed areas (153 ± 199 g/d) than in nonfeeder areas (12 ± 104 g). Fourteen of the 15 bears captured in the feeder areas gained mass, whereas 4 of the 5 bears recaptured in nonfeeder areas lost weight. The body composition of mass change for bears that gained mass was on average 72 ± 13% lean body mass, and 28 ± 13% body fat. For bears that lost mass, 30 ± 10% was lost as lean body mass and 70 ± 10% as body fat. However, there was no detectable difference in age-specific body masses between feeder and nonfeeder area for males or females.

Table 3. Body mass and fat content of black bears captured in areas with and without supplemental feeders in western Washington. Adopted from Partridge et al. (2001).

	Areas with pellets				Areas without pellets			
Sex/Age	Mass (kg)	n	Body Fat (%)	n	Mass (kg)	n	Body Fat (%)	n
Spring Captures								
Sub-adult Female	41 ± 13	5	13 ± 2	5	45	2	12	2
Adult Female	75 ± 12	11	15 ± 7	11	60 ± 10	6	10 ± 1	4
Sub-adult Male	60 ± 32	9	11 ± 5	9	44 ± 13	4	10	2
Adult Male	145 ± 35	11	19 ± 5	10	120 ± 35	8	12 ± 6	8
Summer Captures								
Sub-adult Female	53 ± 14	6	12 ± 4	5	29 ± 10	3	8	2
Adult Female	89 ± 16	10	19 ± 6	9	60 ± 14	4	10 ± 3	3
Sub-adult Male	48 ± 22	12	9 ± 4	9	50	1		
Adult Male	90 ± 15	4	12 ± 4	4				

Isotopic signatures indicated all bears captured in feeder areas after 30 April had ingested pellets, while none of the bears captured on nonfeeder areas had eaten pellets (Table 4). Average diet of bears consuming pellets was 55 ± 22% pellets, 7 ± 7% meat, and 38 ± 18% plant matter. Bears intake of pellets was higher (P = 0.02) for males (61 ± 21%) than females (41 ± 22%) during early spring, but was similar (P = 0.91) between males (58 ± 24%) and females (60 ± 16%) during early summer. Average diet of bears in nonfeeder areas was 13 ± 17% meat and 87 ± 17% plant matter (Table 4). Animal matter ingested by bears was primarily insects, and use increased as the season progressed. Grasses and sedges composed the major vegetative component of the diet. Bear use of forbs increased from late April to July as plants became more abundant.

Scat analysis revealed similar results as the isotopic signatures (Table 5). Pellets composed a primary portion of the diet for bears on feeder areas but were not detected in scat found on nonfeeder areas. Graminoids were common in scats collected in either area. Scat analysis indicated bears fed on Douglas-fir on feeder and nonfeeder areas. However, the frequency and percent volume per scat of cambium detected in scat was considerably greater for nonfeeder areas (22 and 20) than feeder areas (5 and 10).

Table 4. Percentage of diet containing pellets, meat and native plants based on isotopic signatures for black bears captured during the spring or summer in sites with or without supplemental feeders in western Washington.

	Areas with pellets				Areas without pellets		
Sex/Age	n	%Pellets	%Meat	%Plants	n	%Meat	%Plants
Spring Captures							
Sub-adult Female	4	30 ± 10	8 ± 7	62 ± 4	2	3	97
Adult Female	11	45 ± 24	6 ± 7	49 ± 20	6	1 ± 2	99 ± 2
Sub-adult Male	8	67 ± 14	5 ± 5	28 ± 11	4	6 ± 7	94 ± 7
Adult Male	9	56 ± 23	5 ± 7	39 ± 19	8	14 ± 13	86 ± 13
Summer Captures							
Sub-adult Female	6	54 ± 16	5 ± 5	41 ± 17	3	24 ± 38	76 ± 38
Adult Female	10	64 ± 15	3 ± 4	33 ± 14	4	17 ± 18	83 ± 18
Sub-adult Male	11	54 ± 25	9 ± 8	37 ± 21	1	21	79
Adult Male	5	66 ± 21	6 ± 11	29 ± 16			

Table 5. Diet of black bears based on analysis of scat collected from sites with and without supplemental feeders in western Washington.

	Areas with Feeders (n = 78)			Areas without Feeders (n = 46)		
Forage Item	% Freq	% Vol	% Vol/Scat	% Freq	% Vol	% Vol/Scat
Graminoids	88	39	44	98	57	59
Forbs	65	19	30	87	32	37
Cambium	5	1	10	22	4	20
Pellets	65	33	51			
Animal Matter	36	6	16	35	4	11
Berries	9	2	22	7	3	45

Discussion

All bears captured in areas with feeder stations ingested pellets, but they also continued to consume natural forage. Bears living in feeder areas gained more mass than bears outside the feeding area during the same period. However, the lack of detectable differences in age-specific body masses between feeder and nonfeeder bears suggests that nonfeeder bears overcome difference in mass gain during the spring during later foraging bouts. Beers feeding on berries can gain mass 3 to 4 times faster than noted for bears feeding on pellets (Welch et al. 1997). Weight gain composition (28% fat and 72% lean body mass) was similar between feeder and nonfeeder animals. This composition also is characteristic for bears in other areas (Hilderbrand et al. 1999). Thus, pellet consumption did not influence body composition. These results suggest providing pellets to bears during the spring does not produce larger bears or animals in better physiological condition than bears found outside the program. Therefore, the program probably does not improve the reproductive fitness of bears. The study did not assess whether the program benefited lactating females. However, this high-energy diet may enhance milk production, thus improving chances for cub survival.

BEAR BEHAVIOR IN VICINITY OF FEEDERS

Bear behavior around feeders was largely unknown but considered important to the overall success of the program. Dominant bears could impede access to feeders, or females with cubs may avoid feeders rather than risk exposing their offspring to potential risks. Managers expressed concerns that any bear excluded or independently avoiding feeders would likely continue to girdle trees. This study was conducted to better understand the demographics and activities of bears using feeders.

Bear activity in the vicinity of feeders was videotaped from early May to mid-July. The first year taping was concentrated on 4 feeders throughout the feeding period. The next year activity around the previous 4 feeders, and another 17 feeders spread across western Oregon and Washington, was videotaped for three 10-day periods dispersed through the feeding period. The initial year provided a more thorough survey of activity, while the second year was more indicative of bear behavior across more varied conditions. Specifics for videotaping equipment and methods, along with the first year's results were published in the proceedings for the 7^{th} Western Black Bear Workshop (Nolte et al. 2000).

Methods

Video cameras were mounted on platforms within 10 meters of feeding stations. Platforms (2.5 × 2.5 m) were built around a Douglas-fir tree at least 4 m above ground. Tree stands were constructed at least 3 weeks prior to videotaping to ensure bears were familiar with their presence. Individual bear identification was enhanced because several bears in the area had been captured and ear-tagged for the nutritional status study described above. Indicators used to assess wariness of bears were when an animal exhibited one of 3 behaviors: 1) "looking away"; 2) "walking around"; and 3) "standing up." "Looking away" was defined as remaining at the feeder but staring at something off-camera for several seconds. "Walking around" was defined as leaving the feeder and walking to the edge of the feeding site and staring at something off-camera for several seconds. "Standing up" was defined as a bear raising on its hind legs and appearing to look around the feeding area. Camera limitations prohibited nighttime monitoring.

Video equipment used in the study included Panasonic WV-BP310 (black and white series) cameras with a fixed iris lens (Broadcast and Televisions Systems Company, Secaucus, New Jersey), Pelco (MD2001) single channel analog video motion detectors (Pelco, Clovis, California), and Panasonic (model AG1070) direct current time lapse recorders (Broadcast and Televisions Systems Company, Secaucus, New Jersey). All equipment was powered by marine 205-minute reserve capacity batteries.

Results

Bear activity demonstrated the first year was similar to behavior exhibited the second year. Numerous bears fed at stations, including females with and without cubs, yearlings, and males (Table 6). Overall, 77 bears were recorded at feeding stations. Feeders were used by bears throughout the study period. Bear activity, particularly early in the spring, was greatest early in the morning and then again during late afternoon or early evening. Bears, however, were recorded visiting stations at all hours of the day. There was no indication that one class of bears (e.g., females) avoided feeders during times of high use by another class of bears (e.g., large males). Most bears visited multiple feeders, and generally fed at stations every 2 or 3 days. Visits were usually short (< 20 min). While at a feeder site, bears generally spent most of their time in front of a feeder (10 to 15 min), but the time their heads were inside a feeder, an indicator of feeding, was fairly short (1.5 to 2.5 min) (Table 7). Bears tended to spend more time at feeders and more time eating the second year relative to the first. Cubs were seen playing

Table 6. Status and number of black bears videotaped at feeders in western Washington during 1999 and in western Oregon and Washington during 2000.

	Year	
Bear Status	1999	2000
Females	4	12
Females/Cubs	2	2
Cubs (sets)	2	2
Adult Males	5	32
Sub-adult Males	6	2
Yearlings	1	7
Total	*20*	*57*

Table 7. Mean minutes black bears were videotaped visiting feeders in western Washington during 1999 and western Oregon and Washington during 2000; time spent sitting in front of feeders, time with their head inside a feeder, and time spent in the vicinity but not directly in front of a feeder.

Bear Status	Total Time		Away from Feeder		Front of Feeder		Head in Feeder	
Year	**1999**	**2000**	**1999**	**2000**	**1999**	**2000**	**1999**	**2000**
Females	14:44	17:19	04:27	03:03	09:53	14:08	01:19	02:48
Females/Cubs	13:24	05:36	03:07	00:12	10:36	03:02	02:50	01:00
Cubs (sets)	14:05	00:52	03:25	00:04	10:40	00:47	05:00	00:36
Adult Males	14:02	17:37	03:20	02:38	11:08	15:25	01:02	02:40
Sub-adult Males	14:03	18:20	02:36	00:35	11:14	17:45	01:55	03:48
Yearlings	20:13	16:51	06:05	02:12	14:02	14:27	00:38	02:26
Combined	*14:50*	*17:10*	*03:49*	*02:28*	*10:52*	*14:27*	*01:38*	*02:26*

Table 8. Mean number of times black bears were videotaped exhibited alert behaviors while visiting feeders in western Washington during 1999 and western Oregon and Washington during 2000.

Bear Status	Looking Away		Standing Up		Walking Around	
Year	**1999**	**2000**	**1999**	**2000**	**1999**	**2000**
Females	5.3	12.2	0.1	0.3	1.1	0.7
Females with Cubs	8.4	14.0	3.4	0.0	2.7	0.5
Cubs	0.4	1.3	0.3	0.0	0.6	0.0
Adult Males	2.7	9.0	0.1	0.1	0.6	0.7
Sub-adult Males	5.4	16.1	0.0	0.3	0.9	0.5
Yearling	4.9	14.4	0.4	0.1	0.8	1.1

in feeders the first year, but this activity was not observed the following year. Adult males were seen occasionally walking through feeding sites without stopping to eat. Use of feeders declined toward the end of the feeding period, and feeders were removed from the field by mid-July.

Alert activities were exhibited by lactating females more frequently than by other bears, while there was a tendency for adult male bears to demonstrate these behaviors the least (Table 8).

Although single bears at feeding stations was the most common observation, 60 instances were recorded with multiple bears present (Table 9). Most often these multiple visits consisted of a male and female (46). Less frequent were 2 males (10); only twice were 3 bears recorded at a station (2 males with 1 female, and 2 females with 1 male). Partners at stations were not consistent; one female appeared at a feeding station on separate occasions with 3 different males. During 50 multiple encounters, bears simply ignored one another, or a bear waited its turn to eat. Antagonistic behavior was infrequent; aggressive behavior was thought to cause another bear to leave a feeding area 10 times during the study. This aggression did not appear to inhibit feeding opportunities for long. On the rare occasion a bear was driven from a feeding site, it was observed returning later the same day to feed.

Discussion

Bear visits to feeder areas were only every 2 or 3 days and their visits were relatively short, less than 20 minutes. Contrary to opinions expressed by several persons familiar with the feeding program, there was no indication that large boars dominated feeding sites. Reproductive males are normally exploring for partners during this period (Pelton 1982). Males walking past feeders without eating most likely were searching for females. The only bear that made daily visits to a feeding station was a yearling male. Early in the spring this particular bear appeared at feeding stations with his mother and later came to the station alone. Meanwhile, the mother began coming to the stations accompanied by different males. While at the station the yearling also remained longer (20 min) than most bears, but spent little time eating from the feeder (38 seconds per visit). Thus, it is probable the yearling was visiting feeder sites because the sites were familiar to him and to locate his mother, rather than solely as a place to feed.

Table 9. **Total number of times multiple black bears visited feeders at the same time, total number of times aggressive behavior exhibited by one bear caused another bear to leave the feeding area, and total number of times bears remained at the feeding area together. Feeders were located in western Washington during 1999 and in western Washington and Oregon during 2000.**

Bear Status	Encounters		Aggressive		Nonaggressive	
Year	1999	2000	1999	2000	1999	2000
Female/Female	0	0	0	0	0	0
Male/Male	6	4	0	3	6	1
Male/Female	17	29	2	3	15	26
Male/Female/Male	1	0	0	0	1	0
Female/Male/Female	1	0	1	0	0	0
Male/Cub	0	1	0	0	0	1
Female/Yearling	0	1	0	1	0	0
Total	*25*	*35*	*3*	*7*	*22*	*28*

Efficacy of a supplemental feeding program would be compromised if there were continuous conflicts among animals at feeders. This study suggests that aggressive interactions among bears at feeding stations are minimal and access to feeders is available to most if not all bears. The results, however, also demonstrate numerous bears were encouraged to frequent timber stands that were most vulnerable to damage. This would be problematic if the feeding program was interrupted while trees within these areas remain vulnerable to bear damage, or if bear populations continue to increase until it exceeds a threshold where damage levels are likely to increase regardless of the availability of supplemental feed.

EFFECT ON BEAR HOME RANGE AND MOVEMENTS

The approach used to monitor bear movements was described in Fersterer et al. (2001). Briefly, bears were captured and collared during the spring months of 1998 and 1999. Bears in stands with feeders were captured near feeding stations. Nonfeed bears were captured in stands being damaged by bears that had similar timber characteristics. Subsequently, samples collected for the nutrition study confirmed bears captured near feeding stations were eating pellets and those caught outside feeder areas had not consumed pellets. During the summer and fall of 1998, movements of 4 bears within feeding areas and 5 bears outside known feeding areas were monitored after feeding had been concluded for the year. Sixteen additional bears were incorporated in the study during the spring of 1999, providing a total of 17 bears within feeding areas and 8 outside supplemental feeding sites. Movements were monitored throughout the period when bears were actively feeding at stations, as well as outside this period.

Bear locations were identified by triangulating telemetry points. Attempts to locate bears were repeated until all points were within a 35 × 35-square-meter area. The home ranges were estimated using the minimum polygon method with a 5% reduction of area (Kenward 1987). A 3-factor analysis of variance was used to compare home range size differences among bears with treatment (supplemental feed, no supplemental feed), gender (male, female) and period (feeding period, outside feeding period) as factors. Feeding period was defined as the time between May 1 and June 30 when there was high activity around feeders inside the study area.

Results

Home range sizes varied among bears. However, the home range size of bears in feeding areas did not differ ($P > 0.35$) from that of bears in nonfeeding areas. Male bears had larger ($P = 0.0002$) home ranges than female bears, but this difference was consistent across both treatments ($P > 0.35$). Bear home ranges were reduced ($P = 0.029$) during the feeding period relative to the non-feeding period, but again this difference did not interact with treatment ($P = 0.262$), nor was there an interaction between period and gender ($P = 0.112$). The 3-way interaction among treatments, periods, and gender was not significant ($P = 0.098$).

Discussion

These data suggest that the supplemental feeding program did not significantly affect the home range size of black bears in western Washington. Bear home ranges were similar regardless of their proximity to supplemental feed. Males had a larger home range than females, which is consistent with other studies (Amstrup and Beecham 1976, Lindzey 1977, Young and Ruff 1982). Although the supplemental feeding program did not affect home range sizes, there were indications that individual bears altered their travel patterns to use feeding stations. In one case, a female swam a river and traveled several kilometers to frequent a feeding station every 3 or 4 days. After a brief feeding bout, she returned to her original location and confined herself to a relatively small area.

Bear movements were less extensive during the feeding period. However, this response was similar on areas with and without feeders, suggesting that bears were not merely remaining close to feeders. Expanding home ranges coincided with the ripening of the berry crop. For example, one male covered more than twice the area during the first few weeks of June, when salmonberry (*Rubus spectabilis*) was ripe, than he had previously. This particular bear moved to an adjoining area to feed on ripening berries and returned only once to a feeder during the last 2 weeks that supplemental feed was available.

The study did not include a sufficient number of females with young cubs to confidently state the effect of feeding stations on their behavior. Only 2 females with newborn cubs were included in the telemetry study. These females, however, did not avoid areas with feeders. A female with triplets remained close (< 0.5 km) to a feeder throughout the spring. Video monitoring of this feeder for the behavioral study showed this female visiting the feeder with her cubs toward the end of the feeding period. The other female and her cubs were recorded at supplemental feeding stations throughout the feeding period.

SUMMARY

Bear foraging on Douglas-fir can cause considerable economic loss. A single animal can peel as many as 70 trees per day. At present there are 400,000 ha of industrial forest in western Washington alone within the age class regarded as vulnerable to bear damage and this number is anticipated to increase to more than 600,000 ha within the next 15 yeas (Munson 1999). Extensive vulnerable resources combined with a bear population estimated between 25 and 50 thousand bears (Tirhi 1996) renders a high potential for substantial losses of timber in the future unless effective management practices can be implemented.

The efficacy study demonstrated that providing bears a foraging option can reduce damage to timber resources. However, damage was not eliminated on any site and extensive damage occurred on one feeding site. Although this study supports a supplemental feeding program as a viable tool, it should not be regarded as a solution to all bear damage problems. A mixture of tools will best enable managers to meet their objectives of producing timber while maintaining viable wildlife populations on their land. Reported failures of the supplemental feeding program have invariably occurred on sites with high bear densities (Ziegltrum 1994). Historically, sport hunting was encouraged in areas with high bear populations. Recently, bear densities have been reduced with removal efforts targeted in specific areas where damage levels have become unacceptable. Our study incorporated no efforts to restrict damage other than through supplemental feeding. Whether the damage occurring on feeding sites warrants efforts to reduce bear densities would depend on management objectives. However, it is likely that reduced bear numbers would equate to fewer damaged trees. A similar statement could be made for untreated stands, although the proportion of bears needed to be removed to achieve similar damage levels probably would be far greater than required on treated stands.

Bear behaviors exhibited in the vicinity of feeding stations suggest that bears were not competing with each other for this nutritional resource. No bears were observed protecting feeders from intruders. Dual visits were generally nonaggressive. We speculate that the reason a dominant bear does not restrict access to the resource is because feeders provide an unlimited amount of food. Food is always available, regardless of the number of bears that feed at a station or how much each consumes. Therefore, this food source is different from an animal carcass or even a berry patch containing a finite resource. The mechanism by which bears learn to modify their behavior to be less competitive is unknown, although this response is similar to multiple bears feeding adjacently to each other along a stream abundant with trout (Reinhart and Mattson 1990). Perhaps the time required to acquire this behavior is why the efficacy of providing supplemental feed improves over time if used repeatedly in the same area, provided bear populations do not expand.

The telemetry study data, supported by data collected through video monitoring of feeding sites, indicated that feeding stations attracted and concentrated bears at specific locations. Numerous bears used the same feeders, 18 bears frequented one specific feeder, and home ranges often overlapped at the feeding stations. Bears also were recorded using numerous feeding sites, often moving from one feeder to another within a single day. These results suggest that potentially damaging bears are being encouraged to frequent specific locations most vulnerable to damage. This may be problematic if the feeding program is interrupted while trees within these areas remain most vulnerable to bear damage or if bear populations continue to increase. The supplemental feeding program generally becomes less effective as bear populations increase (Ziegltrum 1994), and high populations are likely to correspond to increase damage regardless of whether supplemental feed is available.

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