

# UC Agriculture & Natural Resources

## Proceedings of the Vertebrate Pest Conference

### Title

Integrated pest management of black bear reforestation damage

### Permalink

<https://escholarship.org/uc/item/47p8v17k>

### Journal

Proceedings of the Vertebrate Pest Conference, 19(19)

### ISSN

0507-6773

### Authors

Witmer, Gary W.

Nolte, Dale L.

Stewart, William B.

### Publication Date

2000

### DOI

10.5070/V419110191

# INTEGRATED PEST MANAGEMENT OF BLACK BEAR REFORESTATION DAMAGE

GARY W. WITMER, USDA National Wildlife Research Center, 4101 LaPorte Avenue, Fort Collins, Colorado 80521-2154.

DALE L. NOLTE, USDA National Wildlife Research Center, 9730-B Lathrop Industrial Drive, Olympia, Washington 98512.

WILLIAM B. STEWART, USDI Fish and Wildlife Service, P.O. Box 21, Shirley, New York 11967.

**ABSTRACT:** Black bear damage to commercial, coniferous trees on intensively managed public and private forest lands of the Pacific Northwest continues to be a problem for forest managers. Historically, methods such as relocation or spring hunts have been used in an effort to reduce bear density and damage. More recently, supplemental feeding has been used in an attempt to provide for the nutritional needs of bears during the damage period. Alternative silvicultural practices and repellents are being investigated for their ability to reduce the likelihood of bear damage. These and other methods need to be examined for their effectiveness, especially in light of social attitudes, increasing costs, and legal constraints. As part of an integrated pest management (IPM) approach, there is a need to better define the nature, timing, and extent of tree damage by bears. We review the literature and discuss the results from several studies that help answer some of these questions. Managers and researchers will be continuously challenged to find innovative and publicly acceptable methods to maintain a harmonious and delicate balance between the needs and desires of humans and the needs and propensities of black bears.

**KEY WORDS:** Black bear, forest resources, wildlife damage, *Ursus americanus*, wildlife management

Proc. 19th Vertebr. Pest Conf. (T.P. Salmon & A.C. Crabb, Eds.) Published at Univ. of Calif., Davis. 2000.

(March 6-9, 2000, San Diego, California)

## INTRODUCTION

Black bears (*Ursus americanus*) range over much of eastern and western North America, especially in forested areas of rugged topography. Historically, they have been considered a pest and a threat to human life and property and, hence, were extirpated or reduced to very low numbers in many eastern and midwestern states. The basic biology, ecology, and management of bears has been reviewed by Kolenosky and Strathearn (1987), Pelton (1982), and Witmer et al. (1998). Black bears are considered common in many of the western states and provinces. Black bears receive much attention in the press and from the general public. While views are mixed, it seems that most people have an appreciation for bears, consider them quite intelligent, and often take an active role in how bears are treated and managed (Kellert 1994). Bears, along with other forest carnivores, are often used as an important indicator of forest ecosystem "health" and biodiversity (Witmer et al. 1998). Growing bear populations, the expansion of human habitations and activities into bear habitats, and restrictions on methods used to manage bear populations have all contributed to increased difficulties for resource managers, certain commodity producers, and landowners for dealing with human-bear conflicts. There appears to be a trend for increased complaints about bear activities and damage. Bears are implicated in many types of damage, including human safety, property, apiaries, crops, livestock, orchards, and regenerating forests (Hygnstrom 1994). In this paper, we will focus on black bear damage to reforestation, and will consider the nature of damage, traditional methods to reduce damage, some new methods being tried or investigated, and some of the challenges the resource managers face.

## REFORESTATION DAMAGE

Black bear damage to reforestation is common in the Pacific Northwest (PNW), from northern California northward well into British Columbia and even Alaska (Table 1). Damage also occurs in the interior PNW, especially in northern Idaho and western Montana. Occasionally, forest damage has been reported for other regions of North America (Table 1). Significant damage is usually related to cambium feeding, although some damage from territory marking occurs.

When black bears leave their dens in spring, food resources are often scarce. Some bears begin feeding on the energy-rich cambium layer of trees, causing debarking damage. This feeding behavior usually ends rather abruptly by early summer when other forages become readily available. The amount of damage may hinder successful reforestation in some areas. Damaged trees may be killed or become more susceptible to disease and windfall. Intensive forest management and shortened rotations have made this problem more significant in recent decades. Many forestry practices may contribute to the severity of the problem: use of genetically-selected, fast growing trees, stand thinning, stand fertilization, short rotations, and, in some cases, a monoculture forest setting (Kimball et al. 1998a; Kimball et al. 1998b; Kimball et al. 1999; Nolte et al. 1998; Schmidt and Gourley 1992). This forest setting contains a variety of aged stands in close proximity, providing forage and cover for bears and supporting high densities of bears. In western Washington, for example, the bear population has been increasing at about 3% per year and densities of two bears per square mile are common (Washington Department of Fish and Wildlife 1996) with accompanying increases in tree damage.

Table 1. A reference list of reported bear damage to commercial forests by primary tree species and state or region.

Tree Species	Location	Reference
Alaska yellow cedar ( <i>Chamaecyparis nootkatensis</i> )	Alaska	Hennon et al. 1990
Western red cedar ( <i>Thuja plicata</i> )	British Columbia	Sullivan 1993
Douglas-fir ( <i>Pseudotsuga menziesii</i> )	Washington	Hartwell 1973; Pierson 1966; Stewart et al. 1999
Douglas-fir ( <i>Pseudotsuga menziesii</i> )	Oregon	Kanaskie et al. 1990; Maser 1967; Nelson 1989; Noble and Meslow 1998
Lodgepole pine ( <i>Pinus contorta</i> )	Oregon	Barnes and Engeman 1995
Redwood ( <i>Sequoia sempervirens</i> )	California	Guisti 1988, 1990a; Hosack and Fulghum 1996
Port Orford cedar ( <i>Chamaecyparis lawsoniana</i> )	California	Guisti 1990b
Western larch ( <i>Larix occidentalis</i> )	Idaho	Witmer and Pipas 1999
Western larch ( <i>Larix occidentalis</i> )	Montana	Mason and Adams 1989
Englemann spruce ( <i>Picea engelmannii</i> )	Arizona	Smith et al. 1992
Cork-bark fir ( <i>Abies lasiocarpa</i> )	Arizona	Smith et al. 1992
White fir ( <i>A. concolor</i> )	Arizona	Smith et al. 1992
Balsam fir ( <i>A. balsamea</i> )	Maine	Zeedyk 1957
Various woody species	Southeastern U.S.	Jackson 1990; Vaughan and Scanlon 1989

The species of tree preferred by foraging bears varies by region (Table 1). Key commercial conifer species damaged are redwoods (see Table 1 for scientific names) in northern California, Douglas-fir in western Oregon, Washington, and British Columbia, and western larch in the interior PNW. Low elevation, productive sites are especially vulnerable to damage, increasing the severity of economic loss in these intensively managed stands.

Stands, and even specific trees, can be repeatedly damaged over many years. Low density stands with preferred tree species in the 10 to 20 inch diameter-at-breast-height (dbh) class, and 15 to 50 years in age are particularly susceptible to damage (Noble and Meslow 1998; Schmidt and Gourley 1992; Stewart et al. 1999). There are, however, many exceptions to these generalizations.

## TRADITIONAL BEAR MANAGEMENT AND DAMAGE REDUCTION

Traditional bear management has relied heavily on hunter harvest (see review by Miller 1989). It is difficult to monitor bear populations and to determine densities. Resource managers have relied on monitoring and influencing hunter numbers and bear harvests as a way to indirectly monitor population status. The harvest information is supplemented, in some cases, by an evaluation of specific data on the age and sex of harvested animals. Harvest regulations involve the setting of seasons (e.g., spring, fall, and "hot spot" hunts) and the methods of take (e.g., firearm type, baiting, use of hounds), all within a game management unit system. Often, harvest regulations and objectives must vary by region. For example, bear populations in eastern Oregon and Washington must be managed differently than bear populations in western Oregon and Washington. Historically, spring hunts have accounted for greater hunter success than fall hunts, and harvests using baits or hounds are more successful than ordinary rifle or archery hunting that do not employ these methods. To a much lesser extent, trap and relocation has been a method of removing problem bears or reducing bear density in an area. While these traditional methods have not entirely held the bear population and damage situations in check, their vigorous application and an attempt to stay ahead of developing situations has been fairly successful. Bear management and damage reduction techniques were reviewed by Hygnstrom (1994).

This approach to bear management has been changing dramatically in recent years because of many events or trends. In some areas, the number of hunters has been declining, resulting in less hunting pressure and reduced harvest numbers. Additionally, increased acreage of lands, both public and private, has been put off-limits to hunting. Finally, voter initiatives to restrict bear harvest seasons and methods have been passed and enacted into law in various states, including California, Oregon, Washington, and Colorado. Similar initiatives have been defeated in other states (e.g., Idaho, Michigan). As a result of these actions, many of the "tools" used by wildlife managers to accomplish harvest objectives are no longer available. Examples include spring hunts, use of hounds, use of bait, and the use of restraint devices (traps and snares). Part of the rationale by members of the public for these restrictions is that some methods and seasons are unfair or inhumane to bears. Resource managers fear that the resulting situation will allow bear populations to increase dramatically in some places and that there may be a sharp rise in the amount of damage and incidence of human-bear encounters (see discussion in Beck et al. 1995).

## OPTIONS AND CHALLENGES

Clearly, wildlife managers and others concerned with reducing bear populations or damage are operating under an increasing set of constraints. It is not unusual for practitioners of vertebrate pest management to have to work within an arena of sociopolitical acceptability, legality, regulatory authority, effectiveness, cost and duration, and environmental compatibility. Managers and researchers are challenged to find new or improved

methods of counteracting these restrictions on traditional bear and bear damage management. A wide array of approaches can be incorporated into an integrated pest management plan, including population management, habitat management, and people management (Giles 1980). Some damage reduction approaches or supporting data/method needs that are being used or investigated are presented in Table 2.

There have been a few efforts to estimate or predict timber losses to bear damage, but there are many difficulties, variables, and uncertainties that result in projections and analyses that are crude at best. Brodie et al. (1979) modeled tree growth with and without animal damage and predicted 13% higher yield and 18% greater return on the investment when trees were protected from animal damage. Mason and Adams (1987) projected a 17% reduction in stand yield from black bear damage, while Schmidt (1987) predicted a 27% tree mortality from black bears. Both Erickson and Hanson (1987) and Schreuder (1976) projected that lethal control of black bears where tree damage was occurring was economically justified. Erickson and Hanson (1987) felt that relocation was not economically justified and also mentioned the inherent dangers and difficulties in making this approach successful. They also commented that supplemental feeding was an approach worthy of further investigation. On the other hand, Helgenberg (1998) modeled tree response to various types and severity of animal damage and concluded that trees show substantial compensatory growth which may greatly reduce the net value of animal damage reduction efforts. Finally, low levels of losses spread over large timber land holdings may be more economically acceptable to the owner than localized losses to timber land owners with small holdings.

Remote cameras, DNA analyses, and radioisotopes are all being investigated as ways to better monitor bear populations (see references in Table 2). While all these approaches show considerable promise, they are expensive and not without various shortcomings and constraints. It would appear, however, that wildlife managers must do a more accurate and accountable job of monitoring bear populations if they are to continue to allow substantial harvest of those populations.

Managers also need a greater ability to predict the likely occurrence of damage and to identify the bears (sex, age class) that are involved in damage or adverse encounters with humans. Considerable progress has been made on identifying which forest stands are likely to be damaged in the future. Unfortunately, because bears are very adaptable and because modern forestry creates diversity of forest structure on a stand-to-stand basis, it is difficult to anticipate each possible situation or combination of factors and how bears will react to each specific set of conditions. It has been long surmised that female bears, especially those supporting cubs or yearlings, may be the primary culprits of tree damage. Recent investigations, using incisor mark widths on damaged trees (William Stewart, unpubl. data), suggest that female bears, or at least small bears, cause most of the damage to conifer trees in western Washington. Large bears may not get enough energy from feeding on cambium to support or encourage that type of activity. An important implication of this finding is that population

**Table 2. Approaches to black bear damage reduction to reforestation, additional data/method needs, and some references for further details.**

<b>Approaches</b>	<b>References</b>
<b><u>Population Reduction Approaches</u></b>	
Bear harvest (seasons, weapon type, baiting, use of hounds)	Koch 1994; Litvaitis and Kane 1994; Miller 1989; Oregon Dept. of Fish and Wildlife 1993; Poelker and Parsons, 1980; Washington Dept. of Fish and Wildlife 1996; Beck et al. 1995; Kontio et al. 1998
Trap and remove (relocate or euthanize)	Armistead et al. 1994; Garshelis 1989; Rogers 1986; Rutherglen and Herbison 1977
<b><u>Habitat/Cultural and Other Approaches</u></b>	
Silvicultural methods (species selection, thinning, pruning, genetic stock)	Kimball et al. 1998a, 1998b, 1999; Nelson 1989; Nolte et al. 1998
Supplemental feeding	Flowers 1987; Ziegler 1994; Ziegler and Nolte 1997
Repellents and barriers	Colvin 1975; McCarthy and Seavoy 1994; Pratt 1990; Rogers 1984; Witmer and Pipas 1999
Dogs and frightening devices	Derr 1999; Gillin et al. 1994; Green 1990; Green and Woodruff 1989; McCarthy and Seavoy 1994
Damage compensation	Calvert et al. 1992; Hygnstrom and Hauge 1989
Public education	Garshelis 1989; Gourley and Vomocil 1987; Kellert 1994; Koch 1994; Thompson and McCurdy 1995
<b><u>Additional Data/Methods Needs</u></b>	
Population estimation (DNA analysis, cameras, radioisotopes)	Beck In Press; Garshelis 1993; Helene et al. 1992; McLellan and Woods In Press
Damage prediction, economic projections, benefit:cost analysis	Brodie et al. 1979; Erickson and Hanson 1987; Helgenberg 1998; Mason and Adams 1989; Schmidt 1987; Schreuder 1976

harvest or control methods that primarily focus on adult male bears might not help reduce reforestation damage levels.

Various silvicultural methods have the potential to reduce bear damage to conifer trees (see references in Table 2). Some of these were discussed: delaying thinning of stands, maintaining a higher stand density, avoiding stand fertilization, and planting less susceptible tree species (Kimball et al. 1998a; Schmidt and Gourley 1992). It has also been determined that pruning the lower branches of trees in thinned stands may reduce the likelihood of future damage (Kimball et al. 1998b). Additionally, some genetic strains of a conifer species are more or less susceptible to damage by bears or other damaging organisms. It may be possible to determine and utilize strains that will greatly reduce future damage in stands that would otherwise be very susceptible to damage (Kimball et al. 1999).

Supplemental feeding is a wildlife management technique used in a variety of situations to support populations or to reduce damage with big game on winter range being a classic example. In response to public aversion to lethal control of black bears, foresters in the PNW have been conducting a large and growing bear supplemental feeding program (Flowers 1987; Ziegler 1994; Ziegler and Nolte 1997). A pelleted feed, rich in sugars, is placed out in large feeding barrels and replenished regularly from spring through early summer in areas of historic or anticipated high levels of bear tree damage. Although success has not been well documented yet, it appears that this program has greatly reduced bear damage in some areas. The program is costly, and costs increase each year as additional feeders are put out. A cost:benefit analysis should be conducted to assess this aspect of the program. There is some concern that supplemental feeding programs increase the carrying capacity for animals in the area and, hence, may lead to more problems in the future. It has also been speculated that the feeders may be dominated by large, adult bears and, hence, may be less available to the targeted segment of the bear population—adult female bears and smaller bears. Ongoing research with remote cameras suggests, however, that a variety of bears are actually able to access the feeders at various times. Because bears readily habituate to the feeders, it might be possible, in the future, to place fertility control materials in the feeders and thus reduce the bear population over time.

Repellents and barriers might reduce bear damage to individual trees, but neither method has been investigated in great detail. Barriers, either electric or heavy woven-wire, are sometimes used to protect apiaries, cabins, landfills, and high-value properties. Excluding bears from large forested areas would be difficult, expensive, and, in many cases, counterproductive to managing bears as an important and valued part of forested ecosystems. Nonetheless, barriers—physical or chemical—could potentially protect high-valued commercial trees. An application of three candidate repellents (a bittering agent, a chemically hot material, and grizzly bear feces) to western larch trees in northern Idaho in the fall resulted in reduced bear damage levels of about 50% (from 20% of trees damaged in control plots to about 10% in treated plots; Witmer and Pipas 1999). Various plant extracts are

also being investigated for their potential as vertebrate repellents (Kimball and Nolte, unpubl. data).

Relocation is still used to help reduce human-wildlife conflicts in some situations. It is becoming a less acceptable solution for many reasons (Washington Department of Fish and Wildlife 1996). Trapping and relocating bears is expensive and not without an element of danger to bear and human alike. Released bears usually try to return to familiar territory and long distance movements are common. Mortality rates of relocated animals are typically high, resulting from starvation, highway and other accidents, aggressive encounters with resident animals, and other factors. It is becoming increasingly difficult to find appropriate and publicly acceptable sites for relocations. Bears typically get involved in the same type(s) of trouble after relocation. The result of all these considerations is that many states have adopted a two-strikes-you're-out policy with relocated bears (e.g., Oregon Department of Fish and Wildlife 1993; Washington Department of Fish and Wildlife 1996). If the bear gets into trouble with humans after being relocated, it is captured and euthanized.

Damage compensation payments are used for bear damage to apiaries, crops, livestock, and property in some states. It is unlikely, however, that there would be adequate interest or funds to support a similar program for reforestation damage.

It appears that public education and tolerance of wildlife damage are becoming a more important part of vertebrate pest management (see references in Table 2). It is our experience that many commercial forestry companies are more tolerant of wildlife damage and also more sensitive to public relationships regarding how they deal with wildlife damaging their property. Winning public support for lethal control of bear populations in forest damage areas can be difficult (Gourley and Vomocil 1987).

## CONCLUSIONS

Wildlife managers face many challenges in providing for the many public and commercial needs of citizens that relate to wildlife populations and the reduction of adverse interactions. Much of the decision-making authority of wildlife management agencies is now being legislated or strongly directed by political bodies. On the other hand, wildlife managers may need to rise above the paradigm that 1) bears that come into repeated contact with humans or occasionally damage resources become habitual problem bears, 2) problem bears should be removed from the population, and 3) it is not always necessary to carefully consider alternatives or the bear's contribution to the gene pool (Taylor et al. 1989). Managers and researchers will be continuously challenged to find innovative and publicly acceptable methods to maintain a harmonious and delicate balance between the needs and desires of humans and the needs and propensities of black bears.

## LITERATURE CITED

- ARMISTEAD, A., K. MITCHELL, and D. G. CONNOLLY. 1994. Bear relocations to avoid bear/sheep conflicts. *Proc. Vertebr. Pest Conf.* 16:31-35.

- BARNES, V., and R. ENGEMAN. 1995. Black bear damage to lodgepole pine in central Oregon. *Northwestern Naturalist* 76:127-129.
- BECK, T. In Press. A mark-resight system for estimating black bear density. *Proc. Western Black Bear Workshop* 6.
- BECK, T., D. MOODY, D. KOCH, J. BEECHAM, G. OLSON, and T. BURTON. 1995. Sociological and ethical considerations of black bear hunting. *Proc. Western Black Bear Workshop* 5:119-131.
- BRODIE, D., H. BLACK, E. DIMMICK, J. EVANS, C. KAO, and J. ROCHELLE. 1979. Animal damage to coniferous plantations in Oregon and Washington: Part II. An economic evaluation. *Research Bulletin* 26. Oregon State University, Corvallis. 24 pp.
- CALVERT, R., D. SLATE, and P. DEBOW. 1992. An integrated approach to bear damage management in New Hampshire. *Proc. Eastern Black Bear Workshop* 11:96-103.
- COLVIN, T. 1975. Aversive conditioning black bear to honey utilizing lithium chloride. *Proc. Annual Conf. of the Southeastern Association of Game and Fish Commissioners* 29:450-453.
- DERR, M. 1999. If you're a bear, these dogs will give you paws. *Smithsonian* 30:92-98.
- ERICKSON, A., and M. HANSON. 1987. An assessment of the effectiveness of abating bear damage to forest plantations by the translocation and deterrent feeding of bears. Unpublished Report. Wildlife Science Group, University of Washington, Seattle. 98 pp.
- FLOWERS, R. 1987. Supplemental feeding of black bears in tree-damaged areas of western Washington. Pages 147-148 in *Animal damage management in the Pacific Northwest forestry*, D. Baumgartner, ed. Cooperative Forestry Extension, Washington State University, Pullman. 164 pp.
- GARSHELIS, D. 1989. Nuisance bear activity and management in Minnesota. Pages 169-180 in *Bear-people conflicts—proc. of a sympos. on management strategies*, M. Bromley, ed. Northwest Territories Dept. of Natural Resources, Yellowknife. 246 pp.
- GARSHELIS, D. 1993. Monitoring black bear populations: pitfalls and recommendations. *Proc. Western Black Bear Workshop* 4:123-144.
- GILES, R. 1980. Wildlife and integrated pest management. *Environmental Manage.* 4:373-374.
- GILLIN, C., F. HAMMOND, and C. PETERSON. 1994. Evaluation of an aversive conditioning technique used on female grizzly bears in the Yellowstone ecosystem. *Intl. Conf. Bear Research and Manage.* 9:503-512.
- GUISTI, G. 1988. Recognizing black bear damage to second growth redwoods. *Proc. Vertebr. Pest Conf.* 13:188-189.
- GUISTI, G. 1990a. Black bear feeding on second growth redwoods: a critical assessment. *Proc. Vertebr. Pest Conf.* 14:214-217.
- GUISTI, G. 1990b. Observations of black bear feeding damage to Port Orford cedar in Del Norte County, California. *Calif. Fish and Game* 76:127-128.
- GOURLEY, M., and M. VOMOCIL. 1987. Public involvement in a black bear damage control program on private land. Pages 149-153 in *Animal damage management in the Pacific Northwest forestry*, D. Baumgartner, ed. Cooperative Forestry Extension, Washington State University, Pullman. 164 pp.
- GREEN, J. 1990. Reducing predation with guard animals. Pages 62-68 in *Predator management in North Coastal California*, G. Guisti, ed. University of California, Hopland Field Station Publ. No. 101. Hopland, California. 95 pp.
- GREEN, J., and R. WOODRUFF. 1989. Livestock-guarding dogs reduce depredation by bears. Pages 49-53 in *Bear-people conflicts—proc. of a sympos. on management strategies*, M. Bromley, ed. Northwest Territories Dept. of Natural Resources, Yellowknife. 246 pp.
- HARTWELL, H. 1973. A survey of tree debarking by black bear in Capitol Forest. *DNR Note No. 7*. Washington Department of Natural Resources, Olympia. 7 pp.
- HELENE, J., K. GREGORY, and L. ROLLAND. 1992. Radioisotope tagging for the determination of black bear population densities in Quebec. *Proc. Eastern Black Bear Workshop* 11:208-220.
- HELGENBERG, A. 1998. Effects of simulated animal damage on the growth and form of western white pine, ponderosa pine, and Douglas-fir seedlings. M.S. Thesis. University of Idaho, Moscow. 39 pp.
- HENNON, P., E. HANSEN, and C. SHAW. 1990. Causes of basal scars on *Chamaecyparis nootkantensis* in Southeast Alaska. *Northwest Sci.* 64:45-54.
- HOSACK, D., and K. FULGHUM. 1996. Black bear damage to regenerating conifers in northwestern California. *J. Wildl. Research* 1:32-37.
- HYGNSTROM, S. 1994. Black bears. Pages C-5-C-15 in *Prevention and control of wildlife damage*, S. Hygnstrom, R. Timm, G. Larson, eds. Cooperative Extension, University of Nebraska, Lincoln.
- HYGNSTROM, S., and T. HAUGE. 1989. A review of problem black bear management in Wisconsin. Pages 163-168 in *Bear-people conflicts—proc. of a sympos. on management strategies*, M. Bromley, ed. Northwest Territories Dept. of Natural Resources, Yellowknife. 246 pp.
- JACKSON, J. 1990. Controlling vertebrate animal damage in southern pines. *Proc. Vertebr. Pest Conf.* 14:199-202.
- KANASKIE, A., G. IRWIN, J. CHETOCK, and D. OVERHULSER. 1990. Black bear damage to forest trees in northwest Oregon. *Pest Management Report* No. 90-1. Oregon Dept. of Forestry, Salem. 37 pp.
- KELLERT, S. 1994. Public attitudes towards bears and their conservation. *Intl. Bear Research and Manage.* 9:43-50.
- KIMBALL, B., E. TURNBLOM, D. NOLTE, D. GRIFFIN, and R. ENGEMAN. 1998a. Effects of thinning and nitrogen fertilization on sugars and terpenes in Douglas-fir vascular tissues: implications for black bear foraging. *Forest Science* 44:599-602.

- KIMBALL, B., D. NOLTE, D. GRIFFIN, S. DUTTON, and S. FERGUSON. 1998b. Impacts of live canopy pruning on the chemical constituents of Douglas-fir vascular tissues: implications for black bear tree selection. *Forest Ecology and Manage.* 109:51-56.
- KIMBALL, B., G. JOHNSON, D. NOLTE, and D. GRIFFIN. 1999. An examination of the genetic control of Douglas-fir vascular tissue phytochemicals: implications for black bear foraging. *Forest Ecology and Manage.* 123:245-251.
- KOCH, D. 1994. Biopolitical management of mountain lions, Tule elk, and black bears in California. *Intl. Bear Research and Manage.* 9:561-566.
- KOLENOSKY, G., and S. STRATHEARN. 1987. Black bear. Pages 443-454 in *Wild furbearer management and conservation in North America*, M. Novak, ed. Ontario Ministry of Natural Resources, Toronto. 1150 pp.
- LITVAITIS, J., and D. KANE. 1994. Relationship of hunting technique and hunter selectivity to composition of black bear harvest. *Wildl. Soc. Bull.* 22:604-606
- KONTIO, B., D. GARSHELIS, E. BIRNEY, and D. ANDERSEN. 1998. Resilience of a Minnesota black bear population to heavy hunting: self-sustaining population or population sink? *Ursus* (formerly: *Intl. Bear Research and Manage.*) 10:139-146.
- MASER, C. 1967. Black bear damage to Douglas-fir in Oregon. *Murrelet* 48:34-38.
- MASON, A., and D. ADAMS. 1989. Black bear damage to thinned timber stands in northwest Montana. *Western J. Appl. Forestry* 4:10-13.
- MCCARTHY, T., and R. SEAVOY. 1994. Reducing non-sport losses attributable to food conditioning: human and bear behavior modification in an urban environment. *Intl. Bear Research and Manage. Conf.* 9:75-84.
- MCLELLAN, B., and J. WOODS. In Press. DNA workshop update/summary. *Proc. Western Black Bear Workshop* 6.
- MILLER, S. 1989. Population management of bears in North America. *Intl. Bear Research and Manage. Conf.* 8:357-373.
- NELSON, E. 1989. Black bears prefer urea-fertilized trees. *Western J. Appl. Forestry* 4:13-15.
- NOBLE, W., and E. MESLOW. 1998. Spring foraging and forest damage by black bears in the Central Coast Ranges of Oregon. *Ursus* (formerly: *Intl. Bear Research and Manage.*) 10:293-298.
- NOLTE, D., B. KIMBALL, and G. ZIEGLTRUM. 1998. The impact of timber management on the phytochemicals associated with black bear management. *Proc. Vertebr. Pest Conf.* 18:111-117.
- OREGON DEPARTMENT OF FISH AND WILDLIFE. 1993. Oregon's black bear management plan 1993-1998. Oregon Dept. of Fish and Wildlife, Salem. 33 pp.
- PELTON, M. 1982. Black bear. Pages 504-514 in *Wild mammals of North America: biology, management, economics*, J. Chapman and G. Feldhamer, eds. The Johns Hopkins University Press, Baltimore. 1147 pp.
- PIERSON, D. 1966. Washington's black bear problem. *Proc. Western Assoc. of Game and Fish Commissioners* 46:96-100.
- POELKER, R., and L. PARSONS. 1980. Black bear hunting to reduce forest damage. *Proc. Intl. Bear Research and Manage. Conf.* 4:191-193.
- PRATT, D. 1990. Electric fences for predator control. Pages 75-80 in *Predator management in North Coastal California*, G. Guisti, ed. University of California, Hopland Field Station Publ. No. 101. Hopland, California. 95 pp.
- ROGERS, L. 1984. Reactions of free-ranging black bears to capsaicin spray repellent. *Wildl. Soc. Bull.* 12:59-61.
- ROGERS, L. 1986. Effects of translocation distance on frequency of return by adult black bears. *Wildl. Soc. Bull.* 14:76-80.
- RUTHERGLEN, R., and B. HERBISON. 1977. Movements of nuisance black bears in Southeastern British Columbia. *Canadian Field-Naturalist* 91:419-422.
- SCHMIDT, W. 1987. Bear damage—a function of stand density in young larch forests? Page 145 in *Animal damage management in Pacific Northwest forestry*, D. Baumgartner, ed. Cooperative Forestry Extension, Washington State University, Pullman. 164 pp.
- SCHMIDT, W., and M. GOURLEY. 1992. Black bear. Pages 309-331 in *Silvicultural approaches to animal damage management in Pacific Northwest forests*, H. Black, ed. USDA Forest Service General Technical Report PNW-GTR-287. Portland, OR. 422 pp.
- SCHREUDER, G. 1976. Economic decision making in black bear damage control. Unpublished Report. College of Forest Resources, University of Washington, Seattle. 43 pp.
- SMITH, A., R. MANNAN, and R. DAVIS. 1992. Pages 179-183 in *Old-growth forests in the Southwest and Rocky Mountain Region*, M. Kaufmann, W. Moir, and R. Bassett, eds. USDA Forest Service General Technical Report RM-213. Fort Collins, CO.
- STEWART, W., G. WITMER, and G. KOEHLER. 1999. Black bear damage to forest stands in western Washington. *Western J. Appl. Forestry* 14:128-131.
- SULLIVAN, T. 1993. Feeding damage by bears in managed forests of western hemlock-western red cedar in midcoastal British Columbia. *Can. J. Forest Research* 23:49-54.
- TAYLOR, M., S. KEARNEY, P. WATTE, J. DALLEMOLLE, W. HOWARD, I. STIRLING, and F. BUNNELL. 1989. The future direction of problem bear research and management. Pages 225-228 in *Bear-people conflicts—proc. of a sympos. on management strategies*, M. Bromley, ed. Northwest Territories Dept. of Natural Resources, Yellowknife. 246 pp.
- THOMPSON, S., and K. MCCURDY. 1995. Black bear management in Yosemite National Park: more a people management problem. *Proc. Western Black Bear Workshop* 5:105-115.



- VAUGHAN, M., and P. SCANLON. 1989. The extent and management of damage by black bears. *Trans. Intl. Union of Game Biologists* 19:581-591.
- WASHINGTON DEPARTMENT OF FISH AND WILDLIFE. 1996. Environmental impact statement for black bear management. Washington Dept. of Fish and Wildlife, Olympia. 274 pp.
- WITMER, G., S. MARTIN, and R. SAYLER. 1998. Forest carnivore conservation and management in the interior Columbia Basin: issues and environmental correlates. USDA Forest Service General Technical Report PNW-GRT-420. Portland, Oregon. 51 pp.
- WITMER, G., and M. PIPAS. 1999. A field evaluation of candidate repellents to reduce black bear damage to western larch trees. Unpubl. Report. USDA National Wildlife Research Center, Fort Collins, Colorado. 12 pp.
- ZEEDYK, W. 1957. Why do bears girdle balsam fir in Maine? *J. Forestry* 55:731-732.
- ZIEGLTRUM, G. 1994. Supplemental bear feeding program in western Washington. *Proc. Vertebr. Pest Conf.* 16:36-40.
- ZIEGLTRUM, G., and D. NOLTE. 1997. Black bear damage management in Washington State. *Proc. Eastern Wildl. Damage Manage. Conf.* 7:104-107.