

**Evelyn L. Bull**, Pacific Northwest Research Station, Forestry and Range Sciences Lab, 1401 Gekeler Lane, La Grande, Oregon 97850 email: ebull@fs.fed.us

**Keith B. Aubry**, Pacific Northwest Research Station, Forestry Sciences Laboratory, 3625 93<sup>rd</sup> Avenue, Olympia, Washington 98512-9193

and

**Barbara C. Wales**, Pacific Northwest Research Station, Forestry and Range Sciences Lab, 1401 Gekeler Lane, La Grande, Oregon 97850

## Effects of Disturbance on Forest Carnivores of Conservation Concern in Eastern Oregon and Washington

### Abstract

The effects on forest carnivores of forest insects, tree diseases, wildfire, and management strategies designed to improve forest health (e.g., thinning, salvage operations, prescribed burns, and road removal) are discussed. Forest carnivores of conservation concern in eastern Oregon and Washington include the Canada lynx (*Lynx canadensis*), wolverine (*Gulo gulo*), and fisher (*Martes pennanti*). All three species depend to some degree on forest structures, stands, and landscapes created by insects, disease, and fire. Wildfire and insect outbreaks maintain a mosaic of structural stages across the landscape that are used by lynx. Thinning of dense lodgepole pine (*Pinus contorta*) stands that result largely from wildfire and insect outbreaks is detrimental to snowshoe hares (*Lepus americanus*), which are the primary prey of lynx. Fishers use large stands of mature forest and snags, hollow live trees, logs, stumps, witches-brooms, and other structures for rest and den sites. Salvage harvesting, thinning, and conversion from predominantly fir stands to ponderosa pine (*Pinus ponderosa*) may adversely affect habitat conditions for fishers. Use of roads is perhaps most detrimental to wolverines because they are easily trapped and avoid humans.

### Introduction

This literature synthesis includes information on rare forest carnivores whose historical distributions include portions of eastern Oregon and Washington and that are classified by the Natural Heritage system as sensitive (State Status of S1-S3) in Oregon and Washington. The Canada lynx (*Lynx canadensis*), wolverine (*Gulo gulo*), and fisher (*Martes pennanti*) are listed or have been petitioned for federal listing under the Endangered Species Act (Carlton 2000, Greenwald et al. 2000, U.S. Fish and Wildlife Service 2000). This account is not intended as an exhaustive literature review; rather it is intended to provide readers with an introduction to potential effects of disturbance agents and related forest management strategies on rare forest carnivores. The management strategies being considered here include thinning, salvage operations, prescribed burns, and road removal, although there may be other treatments that apply as well.

### Canada Lynx

The primary habitat for Canada lynx in the western United States is cool, coniferous forests at

upper elevations (McKelvey et al. 2000a). In Washington, lynx occur in high-elevation forests in the north-central and northeastern portions of the state (Koehler and Aubry 1994, McKelvey et al. 2000a, Stinson 2001); available evidence suggests that the lynx has never been part of the resident fauna of Oregon (Verts and Carraway 1998).

In north-central Washington, lynx selected densely stocked, mid-successional lodgepole pine (*Pinus contorta*) forests at high elevations primarily for foraging (Koehler 1990, McKelvey et al. 2000b). Young stands with high stem densities may be preferred by lynx because they contain abundant populations of their primary prey, the snowshoe hare (*Lepus americanus*) (Koehler 1990, Aubry et al. 2000). Birds, other mammals, and carrion are also taken by lynx, especially during summer (Parker et al. 1983, Murray and Boutin 1991, Aubry et al. 2000, Mowat et al. 2000). Lynx typically do not hunt in large, open areas with little or no cover (Koehler 1990, Koehler and Brittell 1990). Koehler and Aubry (1994) suggested that frequent small patches of habitat alteration that mimic natural disturbance patterns may be beneficial to lynx foraging habitat.

For denning and rearing kittens, lynx have been found to use late-successional forests (Koehler and Aubry 1994, Aubry et al. 2000). A common characteristic of lynx den sites is the presence of coarse woody debris on the ground that provides hiding and thermal cover for the kittens (Slough 1999). Denning habitat must be in close proximity and connected to good foraging habitat (Koehler and Brittell 1990). The Canada Lynx Conservation Assessment and Strategy (Ruediger et al. 2000) provides a management tool for land managers to provide appropriate habitat to maintain lynx. Additionally, a recently published book entitled *Ecology and Conservation of Lynx in the United States* (Ruggiero et al. 2000) provides a thorough review on this species.

### **Wolverine**

The present rare occurrence, low density, and limited distribution of this species have resulted in its imperiled status in Oregon and Washington where this species is typically associated with open forests at higher elevations and in alpine areas. Information on the distribution of wolverines in Oregon and Washington is extremely limited, and has been synthesized by Johnson (1977), Verts and Carraway (1998), and Edelman and Copeland (1999).

Hornocker and Hash (1981) reported a strong selection for fir forest types by wolverine in the summer, particularly at higher, cooler elevations in Montana. They reported that 70% of their telemetry locations occurred in medium-density or scattered mature forest at high elevation, and 30% were in ecotonal areas. In both this study and one conducted recently in Idaho, distinct seasonal shifts in elevation were observed, with higher elevation talus and rock cover types preferred in the summer, and montane coniferous forest types preferred in the winter where carrion was available from hunter kills (Copeland 1996). Lowland grass and shrub cover types and ponderosa pine forest types were avoided.

Wolverine hunt or scavenge on a wide variety of animal prey, and it is possible that reported elevational shifts in activity occur in response to changing food availability; carrion is more abundant at lower elevations during winter, whereas mammalian and avian prey are more abundant and accessible at higher elevations during summer. Although few reproductive den sites have

been found in forested areas, virtually all were in alpine or sub-alpine habitats in association with tree roots, boulders, rock ledges, and deep snow (Hash 1987, Banci 1994, Magoun and Copeland 1998). Copeland (1996) found that human disturbance at den sites resulted in den abandonment, but not kit abandonment.

### **Fisher**

Although fishers once occurred in dense coniferous forests throughout much of Oregon and Washington (Bailey 1936, Dalquest 1948), recent assessments indicate the species now occurs only in small isolated areas in southwestern Oregon (Aubry and Houston 1992, Aubry et al. 1996, Lewis and Stinson 1998). Source habitat for fishers is classified as late-seral stages of conifer forests in montane communities (Wisdom et al. 2000). Fisher occurrence in California was positively associated with large stands of mature forest and distance from clearcuts (Rosenburg and Raphael 1986). Fishers avoided stands with less than 40% canopy cover in Idaho (Jones 1991, Jones and Garton 1994). Their association with older stands is tied partially to their use of rest and den sites (de Vos 1951, Ingram 1973), which include snags, hollow live trees, logs, stumps, witches-brooms, and other structures (Hamilton and Cook 1955, Coulter 1960, Powell 1993, Arthur et al. 1989, Powell et al. 1997, Aubry and Raley 2001). Virtually all known natal dens of fishers were in cavities formed from extensive decay by heart-rot fungi in large-diameter trees (Paragi et al. 1996, Aubry and Raley 2001). Martin (1994) summarized studies reporting on the diet of fishers, which included snowshoe hares, red-backed voles (*Clethrionomys* sp.), red squirrels (*Tamiasciurus hudsonicus*), porcupines (*Erethizon dorsatum*), northern short-tailed shrew (*Blarina brevicauda*), passerine birds, and vegetation.

Fishers are among the most habitat-specialized mammals in western North America (Buskirk and Powell 1994), because of their association with closed-canopy forests and late-successional forest structures. Habitat availability, more than any other factor, will likely affect their distribution. Clearcutting, selective logging, and thinning may modify fisher habitats (Buck et al. 1994) by removing some of the insulating canopy; exposing the site to drying effects of sun and wind; removing large commercial conifers; removing

snags, which reduces the number of potential den and rest sites; and increasing the relative abundance of hardwoods in the understory. Many of the harvested sites are replanted with ponderosa pine in the Northwest, which changes the vegetation composition from a mesic closed-canopy forest of predominantly firs to a drier open forest dominated by ponderosa pine. The long-term effects of these changes may be detrimental to fishers (Buck et al. 1994).

### **Potential Effects of Insects, Disease, Fire, and Management Strategies**

Forest insects, tree diseases and fire create many of the forest structures that these rare forest carnivores use across the landscape. Large-diameter trees and logs with extensive heartwood decay, brooms created by broom rust or dwarf mistletoe, and accumulations of coarse woody debris are used by fishers for rest and den sites (Powell and Zielinski 1994, Bull et al. 1997, Aubry and Raley 2001). Accumulations of coarse woody debris are also used as den sites by wolverines and lynx.

Large insect outbreaks and stand-replacement fires may convert mature forests to early successional forests. Early- and mid-successional stands provide high-quality foraging habitat for lynx because the dense young stands regenerating after a fire or insect outbreak provide optimal habitat for snowshoe hares. These young stands, however, do not provide suitable habitat for fishers, wolverines, or denning lynx.

Salvage or thinning operations that remove dead or decayed trees or coarse woody debris on the ground will reduce the availability of forest structures used by fishers and lynx for denning. The removal of these structures may also indirectly affect forest carnivores by adversely affecting the abundance of some of their prey species.

Conversion of closed-canopy fir stands to more open pine-dominated stands over large areas through thinning or prescribed fires may reduce habitat quality for fishers. Reductions in understory structural diversity would likely be detri-

mental to snowshoe hares, which depend on this structure for forage, thermal protection, and hiding cover. Any reduction in hare abundance would likely be detrimental to lynx.

Management activities designed to improve forest health (e.g., thinning, fuels reduction, prescribed fire) also result in increased human presence, noise, and other potential disturbance factors in the area over the short term. Any substantial increase in human activities in remote areas is likely to have adverse effects on rare forest carnivores. This is especially true for wolverines, which appear to exhibit a strong preference for areas that are far removed from human disturbance (Banci 1994, Copeland 1996). Human harassment has been shown to have adverse effects on wolverine (Copeland 1996), and they are particularly vulnerable to illegal trapping (Hornocker and Hash 1981). Roads built to support logging operations often remain open after harvest and increase human activity in the area; thus, road closures and removal would likely be beneficial to rare forest carnivores as it would result in a reduction of human activity (including winter recreation), incidental trapping and poaching, and any risk of mortality from vehicles.

In conclusion, the overview presented here just touches on the ecology of each rare forest carnivore, but emphasizes the need for additional information on the effects of disturbance agents and their related management strategies. The following documents are available to assist managers in making management decisions regarding rare forest carnivores: *The Scientific Basis for Conserving Forest Carnivores: American Marten, Fisher, Lynx, and Wolverine in the Western United States* (Ruggiero et al. 1994), *Forest Carnivore Conservation and Management in the Interior Columbia Basin: Issues and Environmental Correlates* (Witmer et al. 1998), *Canada Lynx Conservation Assessment and Strategy* (Ruediger et al. 2000), and *Source Habitats for Terrestrial Vertebrates of Focus in the Interior Columbia River Basin* (Wisdom et al. 2000).

## Literature Cited

- Arthur, S.M., W.B. Krohn, and J.R. Gilbert. 1989. Habitat use and diet of fishers. *Journal of Wildlife Management* 53:680-688.
- Aubry, K.B., and D.B. Houston. 1992. Distribution and status of the fisher (*Martes pennanti*) in Washington. *Northwestern Naturalist* 73:69-79.
- Aubry, K.B., J.C. Lewis, and C.M. Raley. 1996. Reintroduction, current distribution, and ecology of fishers in southwestern Oregon: a progress report. *Martes Working Group, Newsletter* 4(1):8-10.
- Aubry, K.B., G.M. Koehler, and J.R. Squires. 2000. Ecology of Canada lynx in southern boreal forests. Pages 373-396 *In* L.F. Ruggiero, K.B. Aubry, S.W. Buskirk, G.M. Koehler, C.J. Krebs, K.S. McKelvey, and J.R. Squires. *Ecology and Conservation of Lynx in the United States*. University Press of Colorado, Boulder, Colorado. 480 p.
- Aubry, K.B., and C.M. Raley. 2001. Ecological characteristics of fishers in southwestern Oregon: progress report 1 January 2000-31 December 2000. Unpublished report on file at USDA Forest Service, Pacific Northwest Research Station, Forestry Sciences Laboratory, Olympia, Washington. 10 p.
- Bailey, V. 1936. The mammals and life zones of Oregon. *North American Fauna* 55:1-416.
- Banci, V. 1994. Wolverine. Pages 99-127 *In* L.F. Ruggiero, K.B. Aubry, S.W. Buskirk, L.J. Lyon, and W.J. Zielinski (technical editors), *The Scientific Basis for Conserving Forest Carnivores: American Marten, Fisher, Lynx and Wolverine in the Western United States*. USDA Forest Service General Technical Report RM-254. Rocky Mountain Research Station, Fort Collins, Colorado. Chapter 5.
- Buck, S.G., C. Mullis, A.S. Mossman, I. Show, and C. Coolahan. 1994. Habitat use by fishers in adjoining heavily and lightly harvested forests. Pages 368-376 *In* S.W. Buskirk, A.S. Harestad, M.G. Raphael, and R.A. Powell (editors), *Martens, Sables, and Fishers: Biology and Conservation*. Cornell University Press, Ithaca, New York.
- Bull, E.L., C.G. Parks, and T.R. Torgersen. 1997. Trees and logs important to wildlife in the interior Columbia River basin. USDA Forest Service General Technical Report PNW-GTR-391. Pacific Northwest Research Station, Portland, Oregon. 51 p.
- Buskirk, S.W., and R.A. Powell. 1994. Habitat ecology of fishers and American martens. Pages 283-296 *In* S.W. Buskirk, A.S. Harestad, M.G. Raphael, and R.A. Powell (editors), *Martens, Sables, and Fishers: Biology and Conservation*. Cornell University Press, Ithaca, New York.
- Carlton, J. 2000. Petition for a rule to list the wolverine (*Gulo gulo luscus*) as threatened or endangered under the Endangered Species Act. 16 U.S.C. 1531 *et seq.* (1973 as amended) within the contiguous United States. Biodiversity Legal Foundation, Louisville, Colorado. 130 p.
- Copeland, J.P. 1996. Biology of the wolverine in central Idaho. M.S. Thesis, University of Idaho, Moscow.
- Coulter, M.W. 1960. The status and distribution of fisher in Maine. *Journal of Mammology* 41:1-9.
- Dalquest, W.W. 1948. *Mammals of Washington*. University of Kansas, Publications in Natural History 2:1-444.
- deVos, A. 1951. Recent findings in fisher and marten ecology and management. *Transactions of the North American Wildlife Conference* 16:498-507.
- Edelmann, F., and J. Copeland. 1999. Wolverine distribution in the northwestern United States and a survey in the Seven Devils Mountains of Idaho. *Northwest Science* 73:295-300.
- Greenwald, D.N., J. Carlton, and B. Schneider. 2000. Petition to list the fisher (*Martes pennanti*) as an endangered species in its West Coast range. Center for Biological Diversity, Tucson, Arizona. 92 p.
- Hamilton, W.J., Jr., and A.H. Cook. 1955. The biology and management of the fisher in New York. *New York Fish and Game Journal* 2:13-35.
- Hash, H. 1987. Wolverine. Pages 574-585 *In* M. Novak, J.A. Baker, M.E. Obbard, and B. Malloch (editors), *Wild Furbearer Management and Conservation in North America*. Ministry of Natural Resources, Ontario, Canada.
- Hornocker, M.G., and H.S. Hash. 1981. Ecology of the wolverine in northwestern Montana. *Canadian Journal of Zoology* 59:1286-1301.
- Ingram, R. 1973. Wolverine, fisher and marten in central Oregon. Oregon State Game Commission, Central Region Administration Report 73-2.
- Johnson, R.E. 1977. An historical analysis of wolverine abundance and distribution in Washington. *The Murrelet* 58:13-16.
- Jones, J.L. 1991. Habitat use of fisher in north central Idaho. M.S. Thesis, University of Idaho, Moscow.
- Jones, J.L., and E.O. Garton. 1994. Selection of successional stages by fishers in north-central Idaho. Pages 377-387 *In* S.W. Buskirk, A.S. Harestad, M.G. Raphael, and R.A. Powell (editors), *Martens, Sables, and Fishers: Biology and Conservation*. Cornell University Press, Ithaca, New York.
- Koehler, G.M. 1990. Population and habitat characteristics of lynx and snowshoe hares in north central Washington. *Canadian Journal of Zoology* 68:845-851.
- Koehler, G.M., and K.B. Aubry. 1994. Lynx. Pages 74-98 *In* L. Ruggiero, K. Aubry, S. Buskirk, L.J. Lyon, and W.J. Zielinski (technical editors), *The Scientific Basis for Conserving Forest Carnivores: American Marten, Fisher, Lynx and Wolverine in the Western United States*. USDA Forest Service General Technical Report RM-254. Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado. Chapter 4.
- Koehler, G.M., and J.D. Britnell. 1990. Managing spruce fir habitat for lynx and snowshoe hares. *Journal of Forestry* 88:10-14.
- Lewis, J.C., and D.W. Stinson. 1998. Washington State status report for the fisher. Washington Department of Fish and Wildlife, Wildlife Management Program, Olympia. 64 p.

- Magoun, A.J., and J.P. Copeland. 1998. Characteristics of wolverine reproductive den sites. *Journal of Wildlife Management* 62:1313-1320.
- Martin, S.K. 1994. Feeding ecology of American martens and fishers. Pages 297-315 *In* S.W. Buskirk, A.S. Harestad, M.G. Raphael, and R.A. Powell, (editors). *Martens, Sables, and Fishers: Biology and Conservation*. Cornell University Press, Ithaca, New York.
- McKelvey, K.S., K.B. Aubry, and Y.K. Ortega. 2000a. History and distribution of lynx in the United States. Pages 207-264 *In* L.F. Ruggiero, K.B. Aubry, S.W. Buskirk, G.M. Koehler, C.J. Krebs, K.S. McKelvey, and J.R. Squires (editors). *Ecology and Conservation of Lynx in the United States*. University Press of Colorado, Boulder.
- McKelvey, K.S., Y.K. Ortega, K.B. Aubry, and J.D. Britnell. 2000b. Canada lynx habitat and topographic use patterns in north central Washington: a reanalysis. Pages 307-336 *In* L.F. Ruggiero, K.B. Aubry, S.W. Buskirk, G.M. Koehler, C.J. Krebs, K.S. McKelvey, and J.R. Squires (editors). *Ecology and Conservation of Lynx in the United States*. University Press of Colorado, Boulder.
- Mowat, G., K.G. Poole, and M. O'Donoghue. 2000. Ecology of lynx in northern Canada and Alaska. Pages 265-306 *In* L.F. Ruggiero, K.B. Aubry, S.W. Buskirk, G.M. Koehler, C.J. Krebs, K.S. McKelvey, and J.R. Squires (editors). *Ecology and Conservation of Lynx in the United States*. University Press of Colorado, Boulder.
- Murray, D.L., and S. Boutin. 1991. The influence of snow on lynx and coyote movements: Does morphology affect behavior? *Oecologia* 88:463-469.
- Paragi, T.F., S.M. Arthur, and W.B. Krohn. 1996. Importance of tree cavities as natal dens for fishers. *Northern Journal of Applied Forestry* 13:79-83.
- Parker, G.R., J.W. Maxwell, and L.D. Morton. 1983. The ecology of lynx (*Lynx canadensis*) on Cape Breton Island. *Canadian Journal of Zoology* 61:770-786.
- Powell, R.A. 1993. *The Fisher: Life History, Ecology, and Behavior*, 2<sup>nd</sup> ed. University of Minnesota Press, Minneapolis.
- Powell, R.A., and W.J. Zielinski. 1994. Fisher. Pages 38-73 *In* L.F. Ruggiero, K.B. Aubry, S.W. Buskirk, L.J. Lyon, and W.J. Zielinski (editors). *The Scientific Basis for Conserving Forest Carnivores: American Marten, Fisher, Lynx, and Wolverine in the Western United States*. USDA Forest Service General Technical Report RM-254. Rocky Mountain Research Station, Fort Collins, Colorado. Chapter 3.
- Powell, S.M., E.C. York, J.J. Scanlon, and T.K. Fuller. 1997. Fisher maternal den sites in central New England. Pages 265-278 *In* G. Proulx, H.N. Bryant, and P.M. Woodard (editors). *Martes: Taxonomy, Ecology, and Management*. Provincial Museum of Alberta, Edmonton, Alberta, Canada.
- Rosenberg, K.V., and M.G. Raphael. 1986. Effects of forest fragmentation on vertebrates in Douglas-fir forests. Pages 263-272 *In* J. Verner, M.L. Morrison, and C.J. Ralph (editors). *Wildlife 2000: Modeling Habitat Relationships of Terrestrial Vertebrates*. University of Wisconsin Press, Madison.
- Ruediger, B., J. Claar, S. Gniadek, B. Holt, L. Lewis, S. Mighton, B. Naney, G. Patton, T. Rinaldi, J. Trick, A. Vandehey, F. Wahl, N. Warren, D. Wenger, and A. Williamson. 2000. Canada lynx conservation assessment and strategy. 2<sup>nd</sup> edition. USDA Forest Service, USDI Fish and Wildlife Service, USDI Bureau of Land Management, USDI National Park Service. Publication #R1-00-53. Missoula, Montana. 142 p.
- Ruggiero, L.F., K.B. Aubry, S.W. Buskirk, G.M. Koehler, C.J. Krebs, K.S. McKelvey, and J.R. Squires. 2000. *Ecology and Conservation of Lynx in the United States*. University Press of Colorado, Boulder. 480 p.
- Ruggiero, L.F., K.B. Aubry, S.W. Buskirk, L.J. Lyon, and W.J. Zielinski (editors). 1994. *The Scientific Basis for Conserving Forest Carnivores: American Marten, Fisher, Lynx, and Wolverine in the Western United States*. USDA Forest Service General Technical Report RM-254. Rocky Mountain Research Station, Fort Collins, Colorado. 184 p.
- Slough, B.G. 1999. Characteristics of Canada lynx, *Lynx canadensis*, maternal dens and denning habitat. *Canadian Field-Naturalist* 113:605-608.
- Stinson, D.W. 2001. Washington State recovery plan for the lynx. Washington Department of Fish and Wildlife, Olympia, Washington. 78 p.
- U.S. Fish and Wildlife Service. 2000. Endangered and threatened wildlife and plants; determination of threatened status for the contiguous U.S. distinct population segment of the Canada lynx and related rule. *Federal Register* 65:16051-16086.
- Verts, B.J., and L.N. Carraway. 1998. *Land Mammals of Oregon*. University of California Press, Berkeley. 668 p.
- Wisdom, M.J., R.S. Holthausen, B.C. Wales, C.D. Hargis, V.A. Saab, D.C. Lee, W.J. Hann, T.D. Rich, M.M. Rowland, W.J. Murphy, and M.R. Eames. 2000. Source habitats for terrestrial vertebrates of focus in the Interior Columbia Basin: broad-scale trends and management implications. USDA Forest Service General Technical Report PNW-GTR-485. Pacific Northwest Research Station, Portland, Oregon. 3 volumes, 1119 p.
- Witmer, G.W., S.K. Martin, and R.D. Sayler. 1998. Forest Carnivore Conservation and Management in the Interior Columbia Basin: Issues and Environmental Correlates. USDA Forest Service General Technical Report PNW-GTR-420. Pacific Northwest Research Station, Portland, Oregon. 51 p.

## Note

This special issue of *Northwest Science* is a set of papers reviewing the state of knowledge about disturbance processes in eastern Oregon and Washington, related management practices, and effects on key management issues.