Identifying and Managing Fauna Sensitive to Forest Management: Examples From the Sicamous Creek and Opax Mountain Silvicultural Systems Sites

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ABSTRACT

An effective sensitive-species research and management program must include conservation of provincially rare species as well as: (1) knowledgeably managing relatively common species and habitat elements that are known to be sensitive to human activities, to prevent them from becoming rare; (2) maintaining throughout their range, species with critical functional roles ("keystones") in ecosystems; and (3) obtaining basic information on the many poorly known taxa. We illustrate how these 3 categories were used to identify priority taxa for study at the interdisciplinary silvicultural systems research sites at Sicamous Creek and Opax Mountain, and how the research may help keep species and ecosystems off our "at risk" lists. Examples discussed include species or habitat elements threatened or extirpated elsewhere (e.g., pine marten, spruce grouse, coarse woody debris), groups with known key roles (e.g., red-backed voles, snags), and little known taxa (e.g., beetles, grylloblattids, gastropods).

Key words: coarse woody debris, *Falcipennis canadensis, Martes americana,* Opax Mountain, research priorities, Sicamous Creek, silvicultural systems.

Biodiversity conservation in British Columbia is based primarily on managing for a range of diverse and representative habitats. Although this "coarse filter" approach may be sufficient to maintain 85–90% of species and the ecological processes that sustain them (Nature Conservancy 1982, Noss 1987), fine filter management is also required. A focus on preserving known species that are currently rare in British Columbia is a necessary, but not sufficient, "fine filter" strategy for preventing the long-term loss of biological diversity. Expanding the conservation of "species at risk" to include research into species that are not currently rare but that are sensitive to management will ultimately save money and species. Our emphasis is on forest-dwelling species, many of which are not officially "sensitive species," but are sensitive to forest management. Intensive forestry threatens some species through the loss of older seral stages and many other species through the loss of forest attributes, such as snags and coarse woody debris (CWD). A list of 1,487 threatened species in Sweden (Berg et al. 1994), a country with highly industrialized forestry, provides evidence of this risk. Additional species may be threatened by the shortening of early seral stages, or the elimination of special habitats created by natural disturbances (e.g., fire-killed wood used by many species of insects). For many species, the negative effects of intensive forestry may be mitigated by stand- and landscape-level management options, including alternative silvicultural systems (B.C. Ministry of Forests 1991), the retention of specific forest attributes in harvested areas (Thomas 1979), and long-term planning of harvest in time and space. However, current knowledge of most species in British Columbia is inadequate to support informed decisions on implementing these management options. Failure to obtain and apply this information will ultimately require expensive, contentious, and uncertain actions to retain or restore declining populations of many species.

The provincial Silvicultural Systems Research Program is aimed at experimentally testing operational alternatives to traditional silvicultural systems (i.e., large clearcuts, except in the Interior Douglas-fir zone where single-tree selection predominates) (B.C. Ministry of Forests 1991). The project sites

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provide opportunities for many researchers to study the effects of forest management alternatives on a wide range of ecosystem values; forest biodiversity is prominent among these. Based on our experience directing sporadically large faunal diversity research programs at 2 of these sites (Sicamous Creek and Opax Mountain), we suggest 3 criteria for determining priority species or higher taxa for applied research in developing a "preventative" sensitive species strategy. (See Vyse [1997] and Klenner and Vyse [1999] for an overview of the Sicamous Creek and Opax Mountain research.) Examples are all from our own research. However, we do not imply that our research is the perfect model (we would make many changes next time). More importantly, we believe that priorities for large research programs should be determined independently of specific interests of the researchers.

CRITERION 1. SPECIES EXTIRPATED, ENDANGERED, OR THREATENED ELSEWHERE (OR HABITAT ELEMENTS LOST)

Europe, Scandinavia, eastern North America, and the U.S. Pacific Northwest all offer opportunities to learn from forests similar to those of British Columbia, but with longer histories of management. In Scandinavia, an excellent knowledge of natural history has resulted in extensive reviews of endangered species and causes of endangerment (e.g., Berg et al. [1994]), while legal requirements have produced the same information in the United States (Flather et al. 1994). Many of the same vertebrate, vascular plant, and lichen species, or closely related ecological equivalents, are found in the boreal or temperate forests of North America and Eurasia, providing a direct opportunity to foresee what will likely become threatened in British Columbia. The longer-term effects of forestry, over several rotations, on habitat elements can also be measured directly in these areas (Angelstam in press).

Examples of priority studies at Sicamous Creek and Opax Mountain based on this criterion include martens (*Martes americana*), spruce grouse (*Falcipennis canadensis*), and coarse woody debris (CWD). Martens have been extirpated by forest harvesting in several U.S. states and are endangered in Newfoundland from intensive clearcutting (Thompson 1991); they are considered sensitive species in several U.S. national forests (MacFarlane 1994) and are used to guide management in Oregon and Washington (Thompson and Harestad 1994). Winter studies at Sicamous Creek suggested that marten can be maintained by using arrays of small patch cuts, with an emphasis on retaining advanced regeneration, patches of dense canopy, and wetter sites (Huggard in press *a*).

Spruce grouse have been extirpated in highly fragmented areas of eastern North America (Fritz 1979) and around the periphery of their range in central and western North America (Braun et al. 1994). The ecologically similar capercaillie (*Tetrao urogallus*) has been extirpated from areas of Europe and is threatened by industrial fragmentation throughout much of its range (Rolstad 1989), as is the Siberian spruce grouse (*Falcipennis falcipennis*) (Andreev 1990). Spruce grouse at Sicamous Creek were closely associated with knolls and areas near wetlands, difficult tree-growing sites that would be good locations for reserves. Despite a short negative edge effect beside openings, spruce grouse occurred more frequently in patch cut arrays than in uniform partial cuts (Huggard 1997).

Coarse woody debris (CWD) in Swedish forests was reduced to one-third the volumes in similar British Columbia forests after 1 rotation, and to less than one-twentieth the volume after 2 or more rotations (Angelstam in press). Over 550 species are endangered in Sweden by this loss of dead wood (Berg et al. 1994). Large-scale replicated CWD manipulations have been conducted in uncut and clearcut forest at Sicamous Creek and Opax Mountain to measure the effect of these possible future conditions on small mammals and amphibians (Craig et al. 1997, Ferguson 1999).

We encourage a review of all species threatened elsewhere in intensively managed boreal and temperate forests, especially those for which we have a high provincial responsibility.

CRITERION 2. "KEYSTONE" SPECIES OR HABITAT ELEMENTS

"Keystone" species were originally defined as those whose presence in a community was required to maintain the diversity of the community (Paine 1969). The term has since been broadened and weakened to mean any species that a researcher feels is important, and its utility questioned (Mills et al. 1993, Hurlbert 1997). Our use of "keystone" is more similar to Hurlbert's (1997) less familiar "functional importance," the sum of changes in productivity of all species that would occur if the species or habitat feature of interest was not in the system. Although impractical to measure directly, some examples are obvious, and the idea gave priority to several studies at Sicamous Creek and Opax Mountain.

Red-backed voles (*Clethrionomys gapperi*) in the forests of British Columbia's interior play numerous roles, from being the primary food for many carnivores and raptors (especially those found in mature or old forest) to indirectly affecting numerous species through their contributions to forest productivity and heterogeneity. By dispersing ectomycorhizzal and wood-decaying fungi, red-backed voles enhance young conifer growth and decay of dead wood. This decay contributes habitat for many invertebrates and is a part of forest nutrient cycling. Red-backed voles can also affect regeneration by feeding on some seedlings or eating conifer seeds, while the roots of adult subalpine fir trees can be extensively damaged by vole feeding (Merler 1997). These feeding activities produce heterogeneity in the forest, and the latter contributes to numerous patches of snags, required by various species. Work at Sicamous Creek and Opax Mountain shows that red-backed voles can be maintained by uniform partial cutting, or arrays of small patch cuts, if shrub cover and at least moderate volumes of CWD are maintained (Klenner 1997, 1999).

Snags are an obvious keystone habitat element, required by many vertebrates, invertebrates, and lichens (Thomas 1979, Berg et al. 1994, Goward and Arsenault 1997), and a source of future CWD, but also a potential hazard to forest workers. Abundances and types of snags needed by woodpeckers, small cavity-nesters, and lichens are being studied at Sicamous Creek and Opax Mountain (Goward and Arsenault 1997, Klenner and Huggard 1997, Klenner and Huggard 1999). A project at Sicamous Creek identified snag classes with a low risk of falling (Huggard in press *b*), but incorporating snag retention into partial cut systems remains a challenge.

We recommend identifying several diverse keystone species and elements in forested systems. Ideally, their functional importance would be tested through manipulative experiments (Mills et al. 1993, Hurlbert 1997). Because of their important roles, research should be directed at maintaining these keystones throughout stands in which they naturally occur, rather than in isolated reserves.

CRITERION 3. LITTLE-KNOWN TAXA

The much longer list of threatened species in Sweden than in British Columbia reflects not only the longer history of intensive forest use, but also the much greater knowledge of the biota of that country. Many of the endangered species in Sweden would not have been identified if they were in British Columbia. Our knowledge is particularly weak on invertebrates, lichens, bryophytes, and fungi, which form most endangered Swedish species (Berg et al. 1994). Ignorance of a species threatens its existence, and can also produce costly surprises to forest managers when a little-known species suddenly becomes a management issue (e.g., northern spotted owl, marbled murrelet).

Exploratory studies of ground-dwelling arthropods at Sicamous Creek and Opax Mountain demonstrated how much knowledge we lack, and the potential for surprises. One planned component of the study identified beetles to family and the carabid beetles to species; 52 families and over 50 species within the family Carabidae indicate the huge diversity within this single order. Even among the relatively well-known carabids, the response of many species to forest harvesting was unstudied, and several better known species did not respond to harvest treatments in the way expected from the few previous studies (Lavallee in prep.).

Pitfall trapping at Sicamous Creek also unexpectedly revealed many grylloblattids (*Grylloblatta campodeiformis*), members of a rare order of winter-specialist insects for which Canada has a high responsibility. No quantitative information on forest management effects was available for any species in the order before our work. The species showed seasonal declines in large clearcuts, but a preference for edge habitats and edge-rich patch-cut arrays (D. Huggard and W. Klenner unpublished data).

Jumping slugs (*Hemphillia* spp.), candidates for listing in the United States because of an association with old forest, are poorly known from British Columbia. However, they were also unexpectedly found to be widely distributed across all treatments at Sicamous Creek. At Opax Mountain, they were restricted to canopied wetter sites, mirroring the U.S. concern for these species in managed drier forests.

We expect that if funding were available in British Columbia for work on poorly known taxa, many more examples would be found of groups that are sensitive to some forest practices, but that could easily be retained in managed forests—if the knowledge of critical habitats were available. At Sicamous Creek and Opax Mountain, the replicated experimental designs and intensive sampling schemes allowed us to make useful conclusions about little-known taxa, even if these taxa were rare or unexpected in the studies.

CONCLUSION

Projects like those at the Sicamous Creek and Opax Mountain silvicultural systems sites help provide applied information that will keep species and habitat elements off our "at risk" lists. Investment in obtaining such information now should pay off by preventing the need for expensive, contentious, and risky preservation or recovery programs in the future. An integrated, prioritized, and proactive provincial research program on species sensitive to forest management is required to avoid the long lists of truly threatened species found in areas with longer histories of management. As priorities, we suggest species or habitat elements threatened or lost in those areas, ecological "keystones," and little-known taxa. We also suggest that priority be given to groups for which the province has a high global responsibility. Finally, we emphasize the importance of accepted study and sampling designs for scientifically valid, useful information, even on rare or unexpected species.

LITERATURE CITED

Andreev, A. V. 1990. The winter biology of Siberian spruce grouse *Falcipennis falcipennis* in the Priamurie. Zoologicheskii Zhurnal 69:69–80.

Angelstam, P. In Press. Forest characteristics across a large-scale transect. For. Ecol. Manage.

Berg, Å., B. Ehnström, L. Gustafsson, T. Hallingbäck, M. Jonsell, and J. Weslien. 1994. Threatened plant, animal, and fungus species in Swedish forests: distribution and habitat associations. Conserv. Biol. 8:718–731.

Braun, C. E., K. Martin, T. E. Remington, and J. R. Young. 1994. North American grouse: Issues and strategies for the 21st century. Trans. N. Am. Wildl. Nat. Resour. Conf. 59:428–438.

B.C. Ministry of Forests. 1991. Silvicultural systems: their role in British Columbia's forest management. Silviculture Branch, Victoria, BC.

Craig, V. J., W. Klenner, and T. Sullivan. 1997. Relationship between small mammals and downed wood at Sicamous Creek. Pp. 243–253 *in* C. Hollstedt, and A. Vyse, eds. Sicamous Creek Silvicultural Systems Project: Workshop proc. B.C. Minist. For., Victoria, BC. Work. Pap. 24/1997.

Ferguson, C. 1999. Impacts of forest harvesting on the long-toed salamander (*Ambystoma macrodactylum*) at Opax Mountain. Pp. 221–229 *in* C. Hollstedt, A. Vyse, and D. Huggard, eds. New information for the management of dry Douglas-fir forests: Proc. dry Douglas-fir workshop. B.C. Minist. For., Victoria, BC.

Flather, C. H., L. A. Joyce ,and C. A. Bloomgarden. 1994. Species endangerment patterns in the United States. U.S. Dep. Agric., For. Serv. Gen. Tech. Rep. RM-241.

Fritz, R. S. 1979. Consequences of insular population structure: distribution and extinction of Spruce Grouse populations. Oecologia 42:57–65.

Goward, T., and A. Arsenault. 1997. Notes on the assessment of lichen diversity in old-growth Engelmann Spruce–Subalpine Fir forests. Pp. 67–78 *in* C. Hollstedt, and A. Vyse, eds. Sicamous Creek Silvicultural Systems Project: Workshop proc. B.C Minist. For., Victoria, BC. Work. Pap. 24/1997.

Huggard, D. J. 1997. Spruce grouse distribution and habitat use at Sicamous Creek. Pp. 214–223 *in* C. Hollstedt, and A. Vyse, eds. Sicamous Creek Silvicultural Systems Project: Workshop proc. B.C. Minist. For., Victoria, BC. Work. Pap. 24/1997.

_____. In Press *a*. Marten use of different harvesting treatments in high-elevation forest at Sicamous Creek. B.C Minist. For. Res. Rep.

_____. In Press *b*. Static life-table analysis of fall rates of subalpine fir snags. Ecol. Appl.

Hurlbert, S. H. 1997. Functional importance vs keystoneness: reformulating some questions in theoretical biocenology. Aust. J. Ecol. 22:369–382.

Klenner, W. 1997. Effects of harvest treatments on the abundance of small mammals at Sicamous Creek. Pp. 234–242 *in* C. Hollstedt, and A. Vyse, eds. Sicamous Creek Silvicultural Systems Project: Workshop proc. B.C. Minist. For., Victoria, BC. Work. Pap. 24/1997.

____. 1999. Effects of experimental harvesting treatments on the demography of mice and voles at Opax Mountain. Pp. 230–238 *in* C. Hollstedt, A. Vyse, and D. Huggard, eds. New information for the management of dry Douglas-fir forests: Proc. dry Douglas-fir workshop. B.C. Minist. For., Victoria, BC.

_____, and D. J. Huggard. 1997. Three-toed woodpecker nesting and foraging at Sicamous Creek. Pp. 224–233 *in* C. Hollstedt, and A. Vyse, eds. Sicamous Creek Silvicultural Systems Project: Workshop proc. B.C. Minist. For., Victoria, BC. Work. Pap. 24/1997.

_____, and _____. 1999. Nesting and foraging habitat requirements of woodpeckers in relation to experimental harvesting treatments at Opax Mountain. Pp. 252–266 *in* C. Hollstedt, A. Vyse, and D. Huggard, eds. New information for the management of dry Douglas-fir forests: Proc. dry Douglas-fir workshop. B.C. Minist. For., Victoria, BC.

_____, and A. Vyse. 1999. The Opax Mountain Silvicultural Systems Project: Evaluating alternative approaches to managing dry Douglas-fir forests. Pp. 128–135 *in* C. Hollstedt, A. Vyse, and D. Huggard, eds. New information for the management of dry Douglas-fir forests: Proc. dry Douglas-fir workshop. B.C. Minist. For., Victoria, BC.

Lavallee, S. In Prep. Changes in the carabid beetle community of the Sicamous Creek Research Site in response to prescribed logging practices. Thesis, Univ. B.C., Vancouver, BC.

Macfarlane, D. 1994. National Forest System status information. Pp. 176–184 *in* L. F. Ruggiero, K. B. Aubry, S. W. Buskirk, L. J. Lyon, and W. J. Zielinski, eds. American marten, fisher, lynx, and wolverine in the western United States. U.S. Dep. Agric., For. Serv. Gen. Tech. Rep. RM-254.

Merler, H. 1997. Forest pathology at Sicamous Creek. Pp. 41–44 *in* C. Hollstedt, and A. Vyse, editors. Sicamous Creek Silvicultural Systems Project: Workshop proc. B.C. Minist. For. Victoria, BC. Work. Pap. 24/1997.

Mills, L. S., M. E. Soulé, and D. F. Doak. 1993. The keystone-species concept in ecology and conservation. BioScience 43:219–224.

Nature Conservancy. 1982. Natural heritage program operations manual. Arlington, VA.

Noss, R. F. 1987. From plant communities to landscapes in conservative inventories: a look at the Nature Conservancy (USA). Biol. Conserv. 41:11–37.

Paine, R. T. 1969. A note on trophic complexity and community stability. Am. Nat. 103:91–93.

Rolstad, J. 1989. Effects of logging on Capercaillie (*Tetrao urogallus*) leks. I. Cutting experiments in southcentral Norway. Scandinavian J. For. Res. 4:99–109.

Thomas, J. W., ed. 1979. Wildlife habitats in managed forest in the Blue Mountains of Oregon and Washington. U. S. Dep. Agric., For. Serv. Agric. Handb. 553.

Thompson, I. D. 1991. Could marten become the spotted owl of eastern Canada? For. Chron. 67:136–140.

_____, and A. S. Harestad. 1994. Effects of logging on American martens, and models for habitat management. Pp. 355–367 *in* S. W. Buskirk, A. S. Harestad, M. G. Raphael, and R. A. Powell, eds. Martens, sables, and fishers. Biology and conservation. Comstock Publishing Assoc., Ithaca, NY.

Vyse, A. 1997. The Sicamous Creek silvicultural systems project: How the project came to be and what it aims to accomplish. Pp. 4–14 *in* C. Hollstedt, and A. Vyse, eds. Sicamous Creek Silvicultural Systems Project: Workshop proc. B.C. Minist. For., Victoria, BC. Work. Pap. 24/1997.