Identified Wildlife Management Strategy

Accounts and Measures for Managing Identified Wildlife

Northern Interior Forest Region

Version 2004

British Columbia

Ministry of Water, Land and Air Protection

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Preface

The Identified Wildlife Management Strategy is an initiative of the Ministry of Water, Land and Air Protection, in partnership with the Ministry of Forests and carried out in consultation with other resource ministries, stakeholders and the public. Statutory authority is provided for the Ministry of Water, Land and Air Protection to carry out this strategy under provisions of the *Forest Practices Code of British Columbia Act* and regulations, and under the new *Forest and Range Practices Act* and regulations, to be implemented in 2004.

Two companion documents address the management of Identified Wildlife, and together, comprise the Identified Wildlife Management Strategy (IWMS). The first document, *Procedures for Managing Identified Wildlife*, describes the procedures for establishing, modifying and rescinding a wildlife habitat area (WHA), and for implementing strategic and landscape level planning recommendations. This document provides direction to government planners, foresters and wildlife managers.

The second document, *Accounts and Measures for Managing Identified Wildlife*, summarizes the status, life history, distribution and habitats of Identified Wildlife, and outlines specific guidelines for management of their habitats. For ease of use, the *Accounts and Measures* report is available as three separate documents, one for each of the Coast, Northern Interior, and Southern Interior regions. Only species occurring within that region are included along with all introductory and appendix materials. As a result, note that some species will occur in more than one report (e.g., Grizzly Bear occurs in all three reports).

These documents are a resource for government planners, foresters and wildlife managers, and for those persons interested in the life histories of Identified Wildlife. They provide the necessary information, procedures, practices and guidelines to help achieve effective management and conservation of Identified Wildlife under the *Forest and Range Practices Act*.

Acknowledgements

A project of this magnitude was made possible only through the long-standing executive support of Ralph Archibald, Gordon Macatee, Bruce Morgan, Larry Pedersen, Derek Thompson, Gary Townsend, Jim Walker, and Nancy Wilkin. Rod Davis and Brian Nyberg were also strong supporters, and provided prudent facilitation and direction.

The cooperation and advice of two important committees made this project go smoothly. The IWMS Technical Government Working Group and Technical Advisory Committee were integral in the development of the accounts, and contributed much time and effort to reviewing this document.

The IWMS Technical Government Working Group, an interagency committee, provided overall project direction as well as strategic and technical review of accounts. Representatives included Wayne Erickson (Ministry of Forests [MOF]); Doug Fraser (MOF); Stewart Guy (Ministry of Water, Land and Air Protection [MWLAP]); Gordon Haas (former Ministry of Fisheries); Andrew Harcombe (Ministry of Sustainable Resource Management [MSRM]); Eric Lofroth (MWLAP); Brian Nyberg (MOF); Kathy Paige (MWLAP); Susanne Rautio (MWLAP); Richard Thompson (MWLAP); and Liz Williams (MSRM). Of special note is Stewart Guy who demonstrated exceptional communication and project leadership that enabled this project to move forward. Likewise special thanks are due Wayne Erickson for diligently working to ensure the accuracy of all the accounts and for project direction; and Susanne Rautio for her leadership and project management in the early development of this document.

The IWMS Technical Advisory Committee, comprised of stakeholder representatives, reviewed all accounts many times over and in much detail (see Appendix 1 for agency representation). Representatives included David Borth (BC Cattlemen's Association); Colin Campbell (BC Environmental Network); Elaine Golds (BC Endangered Species Coalition/Federation of BC Naturalists); Carol Hartwig (BC Wildlife Federation); Bill Hadden (Federation of BC Woodlot Associations); Dr. Gilbert Proulx (Council of Forest Industries [COFI]); Paula Rodriguez de la Vega (BC Environmental Network); Geoff Scudder (University of British Columbia); Kari Stuart-Smith (COFI); Ken Sumanik (BC Mining Association); and Wayne Wall (Coast Forest & Lumber Association). Special mention is due Colin Campbell, Elaine Golds, Bill Hadden, Carol Hartwig, Dr. Gilbert Proulx, Paula Rodriguez de la Vega, and Wayne Wall for their dedication and thoughtful input throughout the production of this document.

Many other professionals were involved in the development and review of the accounts included in this document. Many experts wrote or reviewed accounts including staff from the MSRM Conservation Data Centre, MWLAP Biodiversity Branch, consultants, and many other organizations. All original authors have been acknowledged in the accounts. Some of the key technical and operational reviewers were Janice Anderson, Ted Antifeau, Harold Armleder, Mike Badry, Suzanne Beauchesne, Robb Bennett, Doug Bertram, Andy Bezgrove, Christine Bishop, Ian Blackburn, Louise Blight, Clait Braun, Andrew Breault, Mark Brigham, Kim Brunt, Doug Burles, Rob Butler, Carmen Cadrin, Richard Cannings, Robert A. Cannings, Syd Cannings, Adolf Ceska, Trudy Chatwin, Dave Christie, Myke Chutter, Alvin Cober, John Cooper, Brenda Costanzo, Ray Coupé, Vanessa Craig, Laura Darling, John Deal, Don Demarchi, George Douglas, Ted Down, Don Doyle, Frank Doyle, Dave Dunbar, Linda Dupuis, Orville Dyer, Wayne Erickson, Tom Ethier, Matt Fairbarns, Tracey Fleming, Dave Fraser, Doug Fraser, Laura Friis, Grant Furness, Judy Godfrey, William Golding, Steve Gordon, Crispin S. Guppy, Les Gyug, Cindy Haddow, Anne Harfenist, Ian Hatter, Don Heppner, Jim Herbers, Anne Hetherington, Jared Hobbs, Robin Hoffos, Tracey Hooper, Jeff Hoyt, Doug Janz, Bruce Johnson, Pierre Johnstone, Doug Jury, Thomas Kaye, Trevor Kinley, Jan Kirkby, Norbert Kondla, Pam Krannitz, John Krebs, Karl Larsen, Ted Lea, Carla Lenihan, Dave Low, Marlene Machmer, Nancy Mahony, Todd Manning, Malcolm Martin, Anre MacIntosh, Dean McGeough, Terry McIntosh, Will MacKenzie, Andy MacKinnon, Gordon Mackinnon, Scott McNay, Katherine Maxcy, Del Meidinger, Rhonda Millikin, Dave Nagorsen, Gary Norris, Penny Ohanjanian, Kristiina Ovaska, Allan Peatt, Mark Phinney, Jim Pojar, Juanita Ptolemy, James Quayle, Leah Ramsay, Sal Rasheed, John Richardson, Hans Roemer, Beth Rogers, Jordan Rosenfeld, Don Russell, Helen Schwantje, Geoff Scudder, Dale Seip, Jon Shepard, Michael G. Shepard, Chris Siddle, Andrea Sissons, Rick Smith, Al Soobotin, Julie Steciw, Andy Stewart, Jeff Stone, Thomas P. Sullivan, John Surgenor, Richard Thompson, Astrid Van Woodenberg, Ross Vennesland, Louise Waterhouse, Debbie Webb, Bryan Webster, Rich Weir, Troy Wellicome, Bill Westover, Liz Williams, Al Wilson, Doug Wilson, Guy Woods, Karen Yearsley, John Youds, Jim Young, and Fred Zwickel.

Maps were prepared by Dennis Demarchi, Diana Demarchi, Annika Livingston with input from authors and species experts including Carmen Cadrin, Wayne Campbell, Ray Coupé, Craig Delong, Wayne Erickson, Don Gayton, Crispin S. Guppy, Jan Kirkby, Ted Lea, Pontus Lindgren, Dave Nagorsen, Jenifer Penny, Jim Pojar, Mike Sarell, and Rick Tucker.

Thanks also to Chris Smith at TM NewMedia for all her hard work and patience. I'm sure it seemed like the changes were endless.

This document represents the efforts of many people and I would like to thank everyone for their contribution and support.

Every effort was made to maintain the integrity of the accounts while still working within the IWMS policy framework.

Kathy Paige
Editor and Compiler

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Appendices

Introduction

Identified Wildlife are species at risk and regionally important wildlife that the Minister of Water, Land and Air Protection designates as requiring special management attention under the Forest and Range Practices legislation. Under this legislation, the definition of species at risk includes endangered, threatened or vulnerable species of vertebrates, invertebrates, plants and plant communities. Regionally important wildlife include species that are considered important to a region of British Columbia, rely on habitats that are not otherwise protected under FRPA, and are vulnerable to forest and range impacts.

The Identified Wildlife Management Strategy (IWMS) provides direction, policy, procedures and guidelines for managing Identified Wildlife. The goals of the Identified Wildlife Management Strategy are to minimize the effects of forest and range practices on Identified Wildlife, and to maintain their critical habitats throughout their current ranges and, where appropriate, their historic ranges. In some cases, this will entail restoration of previously occupied habitats, particularly for those species most at risk.

The Identified Wildlife Management Strategy applies to Crown forest and range land or private land that is subject to a tree farm or woodlot licence. It addresses forest and range practices regulated under British Columbia's forest legislation. It does not address activities such as recreation, hunting, or poaching. Under the *Wildlife Act*, native terrestrial vertebrates designated as "wildlife" are protected from killing, capture, and harassment except by permit or regulation. The strategy also does not address agriculture or urban development. The IWMS is not intended to be a comprehensive recovery strategy; instead it is intended to be one tool that can be used to manage or recover species habitats. A role of the Ministry of Water, Land and Air Protection is to direct or assist in the development of conservation strategies and recovery plans for species at risk. These plans and strategies can address all requirements for a species' conservation including research and inventory needs, habitat conservation, and regulatory measures.

Identified Wildlife are managed through the establishment of wildlife habitat areas (WHAs), objectives for wildlife habitat areas, and implementation of general wildlife measures (GWMs), or through other management practices specified in strategic or landscape level plans. Wildlife habitat areas are mapped areas that have been approved by the Minister of Water, Land and Air Protection as requiring special management. The purpose of WHAs is to conserve those habitats considered most limiting to a given species. For example, feeding lakes for American White Pelican are considered limiting because they must occur near the breeding site, contain the appropriate prey species, and be relatively free of human disturbance. Breeding sites for Ancient Murrelet are considered limiting because this species returns to the same area each year, breeds in undisturbed old forest habitat, and requires freedom from most mammalian predators.

General wildlife measures describe the management practices that must be implemented within an approved WHA or other spatially defined area. A GWM may limit activities partially (e.g., seasonally) or entirely. General wildlife measures prescribe a level of management appropriate to the conservation status of Identified Wildlife. Management objectives are consistent with the goals and commitments of the Canadian Biodiversity Strategy and provincial goals for the management of wildlife (i.e., as outlined in the Provincial Wildlife Strategy).

For the most part, Identified Wildlife provisions do not address the issues of habitat supply, habitat connectivity, and population viability and other issues such as access management. Such issues should be taken into account during strategic or landscape level planning. Species requiring consideration within strategic level plans are typically wide-ranging species that are sensitive to landscape level changes such as, but not limited to, Badger, Bull Trout, Caribou, Fisher, Grizzly Bear, Marbled Murrelet, Queen Charlotte Goshawk, Spotted Owl, and Wolverine.

The IWMS is a significant step toward responsible stewardship of Identified Wildlife. The management practices included in IWMS are designed to reduce the impacts of forest and range management on Identified Wildlife within targeted social and economic constraints, to balance both socio-economic considerations and conservation of species at risk in British Columbia's managed forest and rangelands. Identified Wildlife Management Strategy provisions in themselves may be insufficient to conserve viable populations of these species throughout their natural ranges in British Columbia. Other strategies and planning, such as Recovery Plans, may be required. The IWMS is intended to be the single-species complement to the broader, coarse-filter provisions of the province's forest and range practices legislation, and strategic land use plans.

Selection of Identified Wildlife

Forest practices legislation authorizes the Minister of Water, Land and Air Protection to establish categories of species at risk and regionally important wildlife, for purposes of establishing wildlife habitat areas, objectives and general wildlife measures that make up the IWMS.

Identified Wildlife are a sub-set of species and plant communities selected from provincially red- (Endangered or Threatened) or blue-listed (Special Concern, Vulnerable) vertebrates and invertebrates; red-listed plants or plant communities; and regionally important wildlife. The Conservation Data Centre (MSRM) is responsible for determining the status of elements in British Columbia. The Conservation Data Centre (January 2003) lists over 1500 animals, plants, and plant communities that are considered to be at risk in British Columbia.

Volume 1 of the Identified Wildlife Management Strategy included 40 Identified Wildlife. These 40 elements represented a portion of the elements at risk and affected by forest and range practices. The original list reflected the efforts of the IWMS interagency Technical Government Working Group to represent a diversity of species and habitats, and included elements from all forest regions. When Volume 1 was released in 1999, a commitment was made to evaluate and rank all species at risk for inclusion within IWMS. In the fall of 1999, a stakeholder Technical Advisory Committee (see Appendix 1) was established to participate and advise in the development of a systematic and defensible method to determine and rank candidates for designation as Identified Wildlife, thus ensuring that the elements most in need and most likely to benefit from inclusion in IWMS were identified. The method for setting priorities was completed in May 2000. For a detailed description of the method and results, see *Setting Priorities for the Identified Wildlife Management Strategy*.

By September 2001, over 800 species at risk that were eligible[1] to be designated as Identified Wildlife had been evaluated for inclusion within IWMS, including all elements in Volume 1 (see Appendix 2 for changes from Volume 1). Of a possible 889 eligible candidates, 246 were considered candidates for further consideration. These were divided into three priority categories: high priority ($n = 52$), intermediate priority ($n = 115$), and low priority ($n = 79$). Priority was determined by considering both the relative conservation risk (i.e., risk of extinction) and relative risk from forest and range management. Conservation risk was determined by considering both the global and provincial status for each element (see Table 1). Conservation risk was the primary factor involved in determining IWMS priority. Relative risk from forest and range management was determined using a coarse risk assessment. The risk assessment considered the main

1 See definition of "species at risk" and "wildlife."

threats causing an element to be at risk as well as the ability of existing habitat protection mechanisms (i.e., parks, FRPA provisions) to address the habitat requirements of each element. In addition the ability to apply Identified Wildlife provisions was also considered (i.e., whether known sites occur on private land where the Forest Practices Code did not apply, or where FRPA will not apply). In this way only those elements negatively affected by forest or range management that occur on Crown land and whose requirements are not adequately addressed by other provisions were selected for designation as Identified Wildlife.

Table 1. Relative conservation risk matrix (1 = highest risk, 15 = lowest risk)

Global rank	Provincial rank				
	S1	S2	S3	S4	S5
G1	1				
G2	2	3			
G3	4	5	6		
G4	7	9	11	13	
G5	8	10	12	14	15

The 2004 list of Identified Wildlife replaces the Volume 1 list. Some elements included in Volume 1 were considered of lower priority, and thus are not included in IWMS at this time (see Appendix 2). These elements may be reconsidered for inclusion later. In addition, while the Minister of Water, Land and Air Protection has legal authority to include regionally important wildlife, this category has not been evaluated at this time and thus is not included in this version. Regionally important wildlife are yellow-listed and were considered of lower priority. In some cases, it may be possible to address the management of specific, localized habitat features for regionally important wildlife using the revised "wildlife habitat feature" mechanism within FRPA. Others will be addressed within IWMS once the list of regionally important wildlife has been updated and approved by the Minister of Water, Land and Air Protection.

Identified Wildlife may be added or rescinded by the Minister of Water, Land and Air Protection. De-designation may occur when the status of a species or community changes. Likewise, the IWMS priority lists will be updated regularly (see *Procedures for Managing Identified Wildlife)*.

Account Development and Review

Accounts summarize the status, life history, distribution, habitat requirements and management standards for Identified Wildlife. Accounts were prepared according to IWMS priority (see Selection of Identified Wildlife). The priorities for account development were elements ranked as having a high priority for inclusion in IWMS. Candidates considered of intermediate priority were also considered, particularly those that are listed nationally by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and those that were originally included within IWMS Volume 1.

Additional accounts will be developed on an ongoing basis according to IWMS priority or national listing (COSEWIC). At this time it is anticipated that updates will be made available annually following updates to national and provincial status listings. Provisions may be made for emergency situations, see *Procedures for Managing Identified Wildlife*.

Each account was peer reviewed by a technical reviewer, operational reviewer, and IWMS reviewer. In addition, the IWMS Technical Government Working Group, IWMS stakeholder Technical Advisory Committee, and regional WHA committees reviewed accounts. In many cases other professionals and specialists, especially those involved in setting species management or recovery direction (i.e., Recovery Teams), also reviewed accounts.

Account Template

English Name[2]

Scientific name

Original author[3]

Species or Plant Community Information

Taxonomy

Describes current taxonomic classification. Not included in plant community accounts.

Description

Describes distinguishing features used for identification.

Distribution

Global

Describes global range.

British Columbia

Describes distribution in British Columbia.

Forest regions and districts

Describes distribution according to the Ministry of Forests administrative units (Appendix 3).

Ecoprovince and ecosections

Describes distribution using the ecoregion classification system (Appendix 4), which divides the province into hierarchically and ecologically defined units. Units are defined by climate, physiography, vegetation, and wildlife potential.

Biogeoclimatic units

Describes distribution using the biogeoclimatic ecosystem classification system (Appendix 5). Biogeoclimatic units are defined based on geographically related ecosystems that are distributed within a vegetationally inferred climatic space.

Broad ecosystem units

Describes distribution using the broad ecosystem inventory classification system (Appendix 6). A broad ecosystem unit is a permanent area of the landscape, meaningful to animal use, that supports a distinct kind of dominant vegetative cover, or distinct non-vegetated cover (such as lakes or rock outcrops). Each vegetated unit is defined as including potential (climax) vegetation and any associated successional stages (for forests and grasslands). Broad ecosystem classes have been created based on the integration of vegetation, terrain, topography, and soil characteristics. They are amalgamations of different groups of site series units, as well as site associations. Each BEU may include many distinct climax plant associations. Broad ecosystem units may not be intuitively obvious as many associated habitats may occur in a single unit (i.e., trembling aspen in the Interior Douglas-fir Forest unit).

Elevation

Elevation in metres.

2 English and scientific names largely follow 2003 Resource Information Standards Committee (RISC) standards except for those subspecies without standardized English names. Non-standard English names are noted in quotation marks (e.g., "Queen Charlotte" Goshawk) in the account titles.

3 Accounts were modified from the original drafts as part of the peer review process; IWMS legal, policy, and technical reviews; or recommendations from the IWMS Technical Advisory Committee and regional reviews.

Life History or Plant Community Characteristics

For vertebrates and invertebrates, information on the diet and foraging behaviour, reproduction, site fidelity, home range, and movements is provided. For plants, information on reproduction and dispersal is provided. For plant communities, the structural stage, natural disturbance regime, and fragility of the community are described.

Habitat

Structural stage

Lists structural stages used (Appendix 7) for forested habitats and usually only coniferous species. Structural stage depends on the age class of the ecosystem and vegetation species. For plant community accounts, the structural stage at climax condition is listed.

Important habitats and habitat features

Describes important habitats (e.g., nesting habitat) or habitat features such as wildlife trees (see Appendix 8), coarse woody debris (see Appendix 9), or canopy structure. Not included in plant community accounts. If not specifically described, age follows the definitions of the *Biodiversity Guidebook* (1995 – see http://www.for.gov.bc.ca/tasb/legsregs/fpc/fpcguide/biodiv/biotoc.htm). See Appendix 10 for scientific names of commonly referred to tree species.

Conservation and Management

Status

Describes status in British Columbia (*Red, Blue,* or *Yellow*), as determined by the Conservation Data Centre (MSRM). Provincial status is determined and reviewed biannually using the internationally accepted methods of the NatureServe. For more information, see http://wlapwww.gov.bc.ca/wld/documents/ranking.pdf. In summary, elements are ranked from 1 to 5 where 1 is critically imperilled and 5 is secure. Generally, red-listed elements are ranked 1 or 2, blue-listed elements are ranked 3, and yellow-listed elements are ranked 4 or 5.

Status in Canada, as determined by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) is also provided. COSEWIC lists species as *Extinct*, *Extirpated*, *Endangered*, *Threatened*, *Special Concern*, *Not at Risk,* or *Data Deficient*. For the most up-to-date lists, see http://www.cosewic.gc.ca.

NatureServe ranks are also provided for British Columbia (BC) and neighbouring jurisdictions including Alaska (AK), Yukon (YK), Northwest Territories (NWT), Alberta (AB), Washington (WA), Idaho (ID), and Montana (MT). National (N) and Global (G) ranks, which reflect an elements' status in Canada or throughout its global range, are also provided when known. This information can indicate the relative importance of conservation within British Columbia and may be used to set regional or provincial management priorities. See Appendix 11 for a description of ranking methodology and codes.

Trends

Population trends

Indicates any noted trends as well as information on abundance, number of known occurrences, and any noted increases, declines, or losses of previously occupied sites.

Habitat trends

Provides general indication of trend (i.e., unknown, likely increasing, likely decreasing, or stable).

Threats

Population threats

Describes threats to populations, such as low reproductive rate, limited dispersal ability, and disease.

Habitat threats

Describes the type of threats to a species' habitat or to a plant community, with particular emphasis on threats from forest or range management practices.

Legal Protection and Habitat Conservation

Summarizes existing legislation, policy, or guidelines that directly protect or manage elements or their habitats with emphasis on FRPA provisions and protected areas.

Identified Wildlife Provisions

Identified wildlife provisions include (1) sustainable resource management and planning recommendations, (2) wildlife habitat areas, and/or (3) general wildlife measures. There is a new provision under FRPA that enables government to set objectives for wildlife habitat areas. This provision is consistent with the shift towards more results based forest practices and enables forest tenure holders to prepare results and strategies for Forest Stewardship Plans that are consistent with objectives for wildlife habitat areas. Objectives for wildlife habitat areas have not been included in the accounts. Procedures for using this new provision are currently under development.

Sustainable resource management and planning recommendations

Recommendations for strategic or landscape level planning. Where appropriate and consistent with current land use plans and future planning processes, these recommendations may be adapted as resource management zone objectives, landscape unit objectives, or land use objectives under a sustainable resource management plan. Where recommendations are not established as legal objectives, they may provide guidance to operational plans such as forest stewardship plans.

Under the 1995 Forest Practices Code (FPC), most Identified Wildlife were managed through the establishment of wildlife habitat areas and did not require specific land use objectives to be established. Three species (Bull Trout, Fisher, and Grizzly Bear) were designated "Higher Level Plan" (HLP) species, and could be managed through the establishment of resource management zone objectives (a type of HLP under the FPC). Under the new forest legislation (FRPA), it is anticipated that, where necessary, strategic or landscape level land use objectives will be established under the *Land Act*. Nonetheless, there may be benefits from planning for the requirements of elements at the strategic and landscape level in that it may be possible to effectively plan for a greater number of species and accommodate connectivity requirements while reducing the incremental impacts to resource industries.

Strategic and landscape level objectives should be considered for species that have large home ranges, occur at low densities, have widely and sparsely distributed limiting habitats, or are sensitive to landscape level disturbances. The requirements of such species must be addressed over large areas, such as regions or watersheds, to effectively manage their populations. There are at least nine species within IWMS for which strategic level objectives should be considered: Badger, Bull Trout, Caribou, Fisher, Grizzly Bear, Marbled Murrelet, Queen Charlotte Goshawk, Spotted Owl, and Wolverine.

The requirements of Identified Wildlife may also be considered within landscape level plans. Generally, the biodiversity goal of landscape level planning is to maintain representative elements (i.e., ecosystems and stand level structural features) across the landscape to increase the probability of maintaining plant communities, species, populations, and community processes over time. However, some elements, particularly those at risk, or those associated with rarer or unique habitats, may not be adequately addressed; thus, it is important to consider more specific requirements or locations of these elements. The FRPA priorities for landscape level planning are old forest and wildlife tree retention. For many Identified Wildlife, recommendations have been made within accounts for old forest or wildlife tree retention to best meet their needs and to assist planning to meet multiple goals (i.e., IWMS, landscape or stand level biodiversity), where possible, and where these goals are compatible. These recommendations are provided for use during landscape level planning and may be developed as legal objectives.

However, in some cases, using landscape level provisions (i.e., old forest) to manage for a single species may compromise the ability to represent the full array of biodiversity elements within the landscape; thus, the implications to other biodiversity elements should always be considered.

Wildlife habitat area

Wildlife habitat areas (WHAs) are areas of limiting habitat that have been mapped and approved by the Minister of Water, Land and Air Protection. Wildlife habitat areas are designed to minimize disturbance or habitat alteration to a species' limiting habitat or to a rare plant community. In most cases, a WHA contains both a core area that is protected from habitat alteration and a management zone to minimize disturbance during critical times or to core area habitats.

Goal

Refers to the overall purpose and management of the WHA.

Feature[4]

Describes an appropriate feature that is required for establishment of a WHA (e.g., active nest area, specific number of breeding pairs or density, maternity colony, or hibernacula). Typically these will be based on limiting habitats, significant concentrations, or those habitats not addressed by coarse filter provisions (i.e., riparian management and landscape unit planning) that are currently occupied. In some cases, WHAs may be recommended for potentially or historically suitable sites for recovery or recruitment. Generally, these will be recommended or endorsed by established recovery teams to meet the requirements of the federal *Species at Risk Act*.

Size

The size of the WHA is estimated; however, these are rough estimates and are subject to site-specific considerations. Further study may determine whether these estimates are adequate to conserve the species or plant community.

Design

Describes the configuration of a WHA including recommendations for inclusion of a core area and a management zone as well as other important considerations for designing a WHA. The general design of WHAs is based on important life history characteristics such as home range size. Typically the WHA will be designed to address key management concerns, whether those are related to habitat or disturbance. Thus, in some cases the design of the WHA will be based on habitat factors and in other cases it may simply be based on distance from an important habitat feature (i.e., a nest) to minimize disturbance at that feature.

General wildlife measures

General wildlife measures (GWMs) direct forest and range practices within a WHA, specified ecosystem unit, or other spatially defined area, and have been approved by the Minister of Water, Land and Air Protection.

Goals

List of the overall objectives and desired results for management within a WHA or otherwise defined area.

Measures

General wildlife measures can address forest and range practices carried out under the Forest Practices Code (during transition) or under FRPA. The practices include road construction, road maintenance, livestock grazing, hay cutting, pesticide use, and timber harvesting. Practices have been grouped under the following headings: access, harvesting and silviculture, pesticides, range, and recreation. A GWM may limit activities partially or entirely. A GWM may apply to the core area or management zone of a WHA. When neither are specified, the GWM applies to the entire WHA. All general wildlife measures may be modified case by case by the Minister of Water, Land and Air Protection or designate. For more information, see *Procedures for Managing Identified Wildlife.*

4 Not to be confused with "wildlife habitat feature."

Additional Management Considerations

Recommendations for managing an area adjacent to a WHA or for managing activities that are not regulated under the FRPA.

Information Needs

Suggested list of three main research or inventory priorities.

Cross References

List of other Identified Wildlife whose requirements and distribution may overlap with the species or plant community under consideration.

References Cited

Personal Communications

Identified Wildlife by Forest Region

See Appendix 13 for lists of Identified Wildlife by Northern Interior forest districts.

English name	Scientific name	Coast	Southern Interior	Northern Interior
	Plant Communities			
Alkali Saltgrass herbaceous vegetation	*Distichlis spicata var. stricta* herbaceous vegetation		x	
Antelope Brush/Bluebunch Wheatgrass	*Purshia tridentata/ Pseudoroegneria spicata*		x	
Antelope Brush/ Needle-and-Thread Grass	*Purshia tridentata/ Hesperostipa comata*		x	
Douglas-fir/Alaska Oniongrass	*Pseudotsuga menziesii/ Melica subulata*	x		
Douglas-fir/Common Juniper/Cladonia	*Pseudotsuga menziesii/ Juniperus communis/Cladonia*		x	
Douglas-fir/Dull Oregon-grape	*Pseudotsuga menziesii/ Mahonia nervosa*	x		
Douglas-fir/Snowberry/Balsamroot	*Pseudotsuga menziesi/ Symphoricarpos albus/ Balsamorhiza sagittata*		x	
Hybrid White Spruce/Ostrich Fern	*Picea engelmannii* x *glauca/ Matteuccia struthiopteris*		x	x
Ponderosa Pine/Bluebunch Wheatgrass – Silky Lupine	*Pinus ponderosa/ Pseudoroegneria spicata – Lupinus sericeus*		x	
Vasey's Big Sage/Pinegrass	*Artemisia tridentata* ssp. *vaseyana/ Calamagrostis rubescens*		x	
Water Birch – Red-Osier Dogwood	*Betula occidentalis – Cornus stolonifera*		x	
Western Hemlock – Douglas-fir /Electrified Cat's-Tail Moss	*Tsuga heterophylla – Pseudotsuga menziesii/ Rhytidiadelphus triquetrus*	x	x	
Western Redcedar/Devil's-club/ Ostrich Fern	*Thuja plicata/Oplopanax horridus/ Matteuccia struthiopteris*			x
Western Redcedar – Douglas-fir/ Devil's-club	*Thuja plicata – Pseudotsuga menziesii/ Oplopanax horridus*	x	x	
Western Redcedar – Douglas-fir/ Vine Maple	*Thuja plicata – Pseudotsuga menziesii/Acer circinatum*	x	x	
	Plants			
Scouler's Corydalis	*Corydalis scouleri*	x		
Tall Bugbane	*Cimicifuga elata*	x		
	Invertebrates			
Gillett's Checkerspot	*Euphydryas gillettii*		x	
Johnson's Hairstreak	*Loranthomitoura johnsoni*	x		
Quatsino Cave Amphipod	*Stygobromus quatsinensis*	x		
Sonora Skipper	*Polites sonora*	x	x	
Sooty Hairstreak	*Satyrium fuliginosum*		x	

English name	Scientific name	Coast	Southern Interior	Northern Interior
	Vertebrates			
Fish				
Bull Trout	*Salvelinus confluentus*	x	x	x
Vananda Creek Limnetic and Benthic Sticklebacks	*Gasterosteus* spp. 16 and 17	x		
"Westslope" Cutthroat Trout	*Oncorhynchus clarki lewisi*		x	introduced
Amphibians				
Coastal Giant Salamander	*Dicamptodon tenebrosus*	x		
Coastal Tailed Frog	*Ascaphus truei*	x	x	x
Coeur d'Alene Salamander	*Plethodon idahoensis*		x	
Great Basin Spadefoot	*Spea intermontana*		x	
Northern Leopard Frog	*Rana pipiens*	introduced	x	
Red-legged Frog	*Rana aurora*	x		
Rocky Mountain Tailed Frog	*Ascaphus montanus*		x	
Tiger Salamander	*Ambystoma tigrinum*		x	
Reptiles				
"Great Basin" Gopher Snake	*Pituophis catenifer deserticola*		x	
Racer	*Coluber constrictor mormon*	x	x	
Western Rattlesnake	*Crotalus oreganus*		x	
Birds				
American White Pelican	*Pelecanus erythrorhynchos*	x	x	x
Ancient Murrelet	*Synthliboramphus antiquus*	x		
Bay-breasted Warbler	*Dendroica castanea*			x
Black-throated Green Warbler	*Dendroica virens*			x
Burrowing Owl	*Athene cunicularia*		x	
Cape May Warbler	*Dendroica tigrina*			x
Cassin's Auklet	*Ptychoramphus aleuticus aleuticus*	x		
"Columbian" Sharp-tailed Grouse	*Tympanuchus phasianellus columbianus*		x	x
Connecticut Warbler	*Oporornis agilis*			x
Flammulated Owl	*Otus flammeolus idahoensis*		x	
Grasshopper Sparrow	*Ammodramus savannarum perpallidus*		x	
Great Blue Heron	*Ardea herodias fannini*, *Ardea herodias herodias*	x	x	x
"Interior" Western Screech-Owl	*Otus kennicottii macfarlanei*		x	
Lewis's Woodpecker	*Melanerpes lewis*	historical	x	
Long-billed Curlew	*Numenius americanus*		x	x
Marbled Murrelet	*Brachyramphus marmoratus*	x		x
Nelson's Sharp-tailed Sparrow	*Ammodramus nelsoni*			x
Prairie Falcon	*Falco mexicanus*		x	
"Queen Charlotte" Goshawk	*Accipiter gentilis laingi*	x		
"Queen Charlotte" Hairy Woodpecker	*Picoides villosus picoideus*	x		
"Queen Charlotte" Northern Saw-whet Owl	*Aegolius acadicus brooksi*	x		

English name	Scientific name	Coast	Southern Interior	Northern Interior
Sage Thrasher	*Oreoscoptes montanus*		x	
"Sagebrush" Brewer's Sparrow	*Spizella breweri breweri*		x	
Sandhill Crane	*Grus canadensis*	x	x	x
Short-eared Owl	*Asio flammeus*	x	x	x
Spotted Owl	*Strix occidentalis*	x	x	
"Vancouver Island" Northern Pygmy-Owl	*Glaucidium gnoma swarthi*	x		
"Vancouver Island" White-tailed Ptarmigan	*Lagopus leucurus saxatilis*	x		
White-headed Woodpecker	*Picoides albolarvatus*		x	
Williamson's Sapsucker	*Sphyrapicus thyroideus nataliae, Sphyrapicus thyroideus thyroideus*		x	
Yellow-breasted Chat	*Icteria virens*	x	x	
Mammals				
Badger	*Taxidea taxus jeffersonii*	extreme east only	x	
Bighorn Sheep	*Ovis canadensis*		x	x
Caribou (mountain, boreal and northern ecotypes)	*Rangifer tarandus caribou*	x	x	x
Fisher	*Martes pennanti*	x	x	x
Fringed Myotis	*Myotis thysanodes*		x	
Grizzly Bear	*Ursus arctos*	x	x	x
Keen's Long-eared Myotis	*Myotis keenii*	x		
Pacific Water Shrew	*Sorex bendirii*	x		
Spotted Bat	*Euderma maculatum*		x	
"Vancouver Island" Common Water Shrew	*Sorex palustris brooksi*	x		
Vancouver Island Marmot	*Marmota vancouverensis*	x		
Wolverine	*Gulo gulo luscus, Gulo gulo vancouverensis*	x	x	x

Fish

Bull Trout

Salvelinus confluentus

Original[1] prepared by Jay Hammond

Species Information

Taxonomy

As a member of the genus *Salvelinus,* Bull Trout (family Salmonidae) are not a true trout, but rather a char. Bull Trout have a complicated taxonomic history, in part due to Bull Trout and Dolly Varden (*Salvelinus malma*) being considered for a time as the same species, until Cavender (1978) identified a number of morphological characteristics of the skull and distribution patterns that suggested the two species were actually distinct. Haas and McPhail (1991) also concluded that Bull Trout and Dolly Varden are separate species, based on principal component analyses of meristic and morphometric data. In addition, genetic studies of the genus *Salvelinus*, using ribosomal DNA (Phillips et al. 1992; Phillips et al. 1994) and mitochondrial DNA (Grewe et al. 1990), supported the findings of the morphological studies. In fact, in each of these genetic studies, Bull Trout and Dolly Varden were not as closely related to each other as they were to other char species. This separation between the two species has been recognized by the American Fisheries Society since 1980 (Robins et al. 1980).

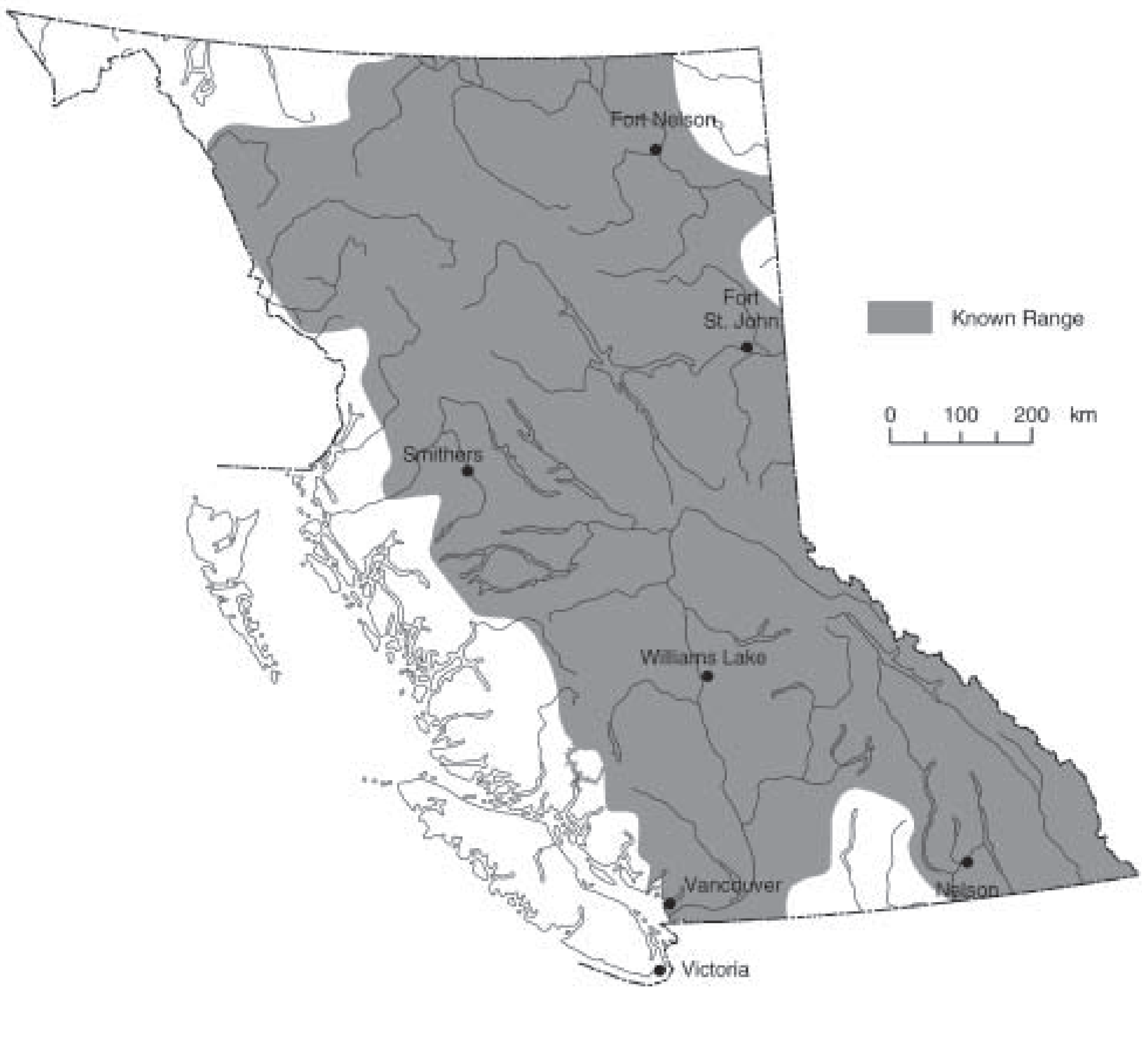
The taxonomic history is also complicated by records of hybridization between Bull Trout and Dolly Varden, where these species occur in sympatry (McPhail and Taylor 1995; Baxter et al. 1997). However, Hagen (2000) undertook a detailed study in the Thutade watershed, where Bull Trout and Dolly Varden ranges overlap, and concluded that ecological factors and niche selection were supporting reproductive isolation between the two species and that the hybrids were generally not as fit as either parent species in this environment. Taylor et al. (2001) noted that, despite the gene flow brought about by hybridization, Bull Trout and Dolly Varden are clearly distinct gene pools. The maintenance of this distinction, in sympatry and in the face of gene flow, was considered conclusive in meeting the test of biological species.

There are no recognized subspecies of Bull Trout. However, Taylor et al. (1999) identified two evolutionarily distinct units—coastal and interior—based on range-wide mitochondrial DNA studies. In British Columbia, the coastal unit is concentrated in the lower Fraser (downstream of Hell's Gate) and other south coast rivers such as the Squamish. This group likely invaded British Columbia from the Chehalis refuge and may extend farther north up the coast; however, sample coverage was poor in that area. The interior unit, occupying the remainder of the species' range in British Columbia, likely invaded British Columbia from the Columbia refuge.

Taylor et al. (1999) also noted that genetic diversity in Bull Trout was principally found between (rather than within) populations and stressed the importance of maintaining as many populations as possible to conserve the species. Costello et al. (2003) used microsatellite DNA to examine genetic structure at the basin level. Their results supported the earlier work and demonstrated high levels of population subdivision within basins. Importantly, above-barrier populations were found to contain locally rare alleles, suggesting the possibility of distinct founding events. These results suggest that recolonization of extirpated populations from neighbouring watersheds may not be sufficient to maintain the species diversity.

1 Volume 1 account prepared by J. Ptolemy.

Bull Trout
(Salvelinus confluentus)



Note: This map represents a broad view of the distribution of habitat used by this species. The map is based on current knowledge of the species' distribution. This species may or may not occur in all areas indicated.

Description

Bull Trout have a large head and jaws in relation to their long, slender body (Post and Johnston 2002). Cavender (1978) reported that Bull Trout have a larger, broader, and flatter head, and a more ventrally flattened body, than Dolly Varden. Bull Trout colouration ranges from green to greyish-blue, with lake-resident fish often displaying silvery sides (Nelson and Paetz 1992; Berry 1994). The dorsum and flanks are spotted with pale yellowish-orange spots. The absence of black spots on the dorsal fin distinguishes Bull Trout from other species of char and trout that are native to western Canada (Berry 1994). The pelvic and anal fins of mature male Bull Trout develop a tri-colour sequence beginning with white leading edges progressing to a black band fading to grey and ending with a bright orange trailing edge. Mature female Bull Trout exhibit a similar pelvic and anal fin colouration, though the colour contrast is not as pronounced as that of male fish (McPhail and Murray 1979).

Bull Trout are large fish relative to other char and trout species (Ford et al. 1995). Stream-resident populations often reach maturity and maximum length at 20–33 cm (Robinson and McCart 1974; Craig and Bruce 1982; Pollard and Down 2001). The maximum size of mature Bull Trout has been reported to vary from 20 to 40 cm in some habitats (Bjornn 1961; McPhail and Murray 1979). However, Pollard and Down (2001) also reported that the mean size of mature Bull Trout in a selection of large lakes, reservoirs, and rivers in British Columbia ranged from 60 to 66 cm for females and from 65 to 73 cm for males. The minimum size for spawners typically exceeded 50 cm. The largest recorded Bull Trout captured, from Pend Oreille Lake, Idaho, was 100 cm long and weighed 15 kg (Goetz 1989).

Sexual dimorphism exists in Bull Trout and male fish are often larger than females (McPhail and Murray 1979; Carl et al. 1989). Spawning males often develop a pronounced hook, or kype, on the lower jaw (McPhail and Baxter 1996).

Distribution

Global

Bull trout are endemic to western Canada and the U.S. Pacific Northwest (Federal Register 1998). Historically they were found in most of the large river systems from about 41° N (i.e., McCloud River drainage in northern California and the Jarbridge River in Nevada) to about 60° N (i.e., headwaters of the Yukon River) (Federal Register 1998). Although mostly located west of the Continental Divide, Bull Trout are also found in certain headwater systems of the Saskatchewan and McKenzie river systems of Alberta and British Columbia (Federal Register 1998). In British Columbia and Washington, Bull Trout have been primarily considered to be an interior species, found mostly east of the Coast (Cascade) Mountains (McPhail and Baxter 1996). However, as the ability of fisheries biologists to discriminate between Bull Trout and Dolly Varden has improved, coastal populations have been recognized (e.g., Olympic Peninsula; lower Fraser and Squamish rivers), with some individuals even making forays into salt water (T. Down, pers. comm.). Through the years, the distribution of Bull Trout has diminished throughout its range; most of this reduction has occurred at its southern fringe.

British Columbia

In British Columbia, Bull Trout are found in practically every major mainland drainage, including those major coastal drainages which penetrate the Coast Mountains into the interior of the province (e.g., Fraser, Homathko, Klenaklini, Bella Coola, Dean, Skeena and Nass rivers). In addition, some coastal populations of Bull Trout have been recognized (e.g., Squamish River).

Drainages/locations where they do *not* occur include Vancouver Island and the Queen Charlotte Islands; the lowermost reaches of some of the major drainages penetrating the Coast Mountains; the Petitot and Hay river systems in the north-east; most of the headwaters of the Yukon River system, except for Swan Lake in the Teslin drainage; and the Alsek system on the north coast (McPhail and Carveth 1993; McPhail and Baxter 1996).

Note that, at the current time, Dolly Varden rather than Bull Trout are identified as the species present in the majority of the coastal drainages that do not penetrate into the interior of the province.

Forest regions and districts

Coast: Chilliwack, North Island (mainland portion), Squamish

Northern Interior: Fort Nelson (absent in Petitot and Hay River drainages), Fort St. James, Kalum, Mackenzie, Nadina, Peace, Prince George, Skeena Stikine (absent in Alsek drainage and all upper Yukon drainage except for Swan Lake in Teslin system), Vanderhoof

Southern Interior: Arrow Boundary (absent in Kettle River), Cascades, Central Cariboo, Chilcotin, Columbia, Headwaters, Kamloops, Kootenay Lake, Okanagan Shuswap (absent in Similkameen and Okanagan rivers), Quesnel, Rocky Mountain

Ecoprovinces and ecosections

BOP: CLH*, HAP, KIP, PEL

CEI: BUB, BUR, CAB, CAP, CCR, CHP, FRB, NAU, NEU, QUL, WCR, WCU

COM: CBR*, CPR*, CRU, EPR, KIM, MEM*, NAB, NAM*, NBR*, NWC, SBR*, SPR*

GED: FRL

NBM: CAR, EMR, HYH, KEM, LIP, MUF, NOM, SBP, SIU, STP, TEP*, THH*, TUR*, WMR

SBI: BAU, ESM, HAF, MAP, MCP, MIR, NEL, NHR, NSM, PAT, PEF, SHR, SOM, SSM

SIM: BBT, BOV, CAM, CCM, COC, CPK, EKT, ELV, EPM, FLV, FRR, MCR, NKM, NPK, QUH, SCM, SFH*, SHH, SPK, SPM, UCV, UFT

SOI: GUU, HOR*, LPR, NIB, NOH*, NTU, PAR, SCR, SHB, STU*, THB, TRU

TAP: ETP*, FNL*, MAU*, MUP

* = presence in portion of ecosection only

Broad ecosystem units

FS, IN, LL, LS, OW, RE, SP

Elevation

The occurrence of Bull Trout is strongly associated with elevational (Rieman and McIntyre 1995) and thermal (Pratt 1984) gradients in streams, and with thermal gradients in individual habitats (Bonneau and Scarnnechia 1996). There are anecdotal observations that Bull Trout do not occur, or are much less frequently observed, above certain threshold temperatures (e.g., Fraley and Shepard 1989; Rieman and McIntyre 1993; Parkinson and Haas 1996). In Washington State, on the west side of the Cascades, 94% of known spawning occurred above 210 m elevation. On the east side of the Cascades, 94% of known spawning occurred above 610 m elevation (Washington State Internet site). Note that these elevation data are mostly from the United States where higher temperatures have often limited Bull Trout distribution to headwater areas. In a study on B.C. populations, Parkinson and Haas (1996) considered temperature to be more important in determining Bull Trout distribution than other physical factors.

Life History

Diet and foraging behaviour

In general, Bull trout fry tend to stay near the substrate to avoid being swept downstream (Ford et al. 1995). Juvenile Bull Trout predominantly feed on aquatic insects and amphipods from benthic, pelagic, and littoral zones (Connor et al. 1997). Boag (1987) reported that juveniles in western Alberta preferentially feed on plecopterans, trichopterans, ephemeropterans, and coleopterans. Juveniles in the Flathead Basin in Montana feed on dipterans and ephemeropterans (Shepard et al. 1984).

The three life history strategies of Bull Trout largely influence diet and foraging behaviour. Steam-resident Bull Trout are often smaller than migratory fish. Of the migratory strategies, adfluvial (spawn in tributary streams and reside in lakes or reservoirs) populations tend to experience greater growth than fluvial (spawn in tributaries, but live in mainstem rivers) fish (Berry 1994; Ratcliff et al. 1996). The growth rate of Bull Trout rapidly increases in populations that enter rivers and lakes with plentiful fish prey (McPhail and Murray 1979). Adfluvial fish are predominantly piscivorous (Berry 1994; Connor et al. 1997; Mushens and Post 2000), which plays a large role in the more rapid growth rate of adfluvial fish over fluvial or resident populations.

Reproduction

Bull trout often reach sexual maturity at 5–7 years of age, but the range is 3–8 years (McPhail and Murray 1979; Fraley and Shepard 1989; Rieman and McIntyre 1996). The body size of mature Bull Trout varies according to their life history strategy (Post and Johnston 2002). Fecundity of females is proportional to body size; small, resident females may produce 500 eggs, while the much larger migratory fish will produce 2000–5000 eggs (McPhail and Murray 1979; Berry 1994).

Bull trout spawn between mid-August and late October (McPhail and Murray 1979; Rieman and McIntyre 1996). Pollard and Down (2001) noted that spawning windows for northern Bull Trout populations were generally earlier than for southern populations and may be affected by annual climatic conditions. Distance covered during spawning migrations and timing of migration varies and depends upon life history strategy (Post and Johnston 2002). Resident populations tend to migrate short distances to spawning grounds, while migratory populations may travel up to or over 250 km (McLeod and Clayton 1997; Burrows et al. 2001). McPhail and Murray (1979) and Weaver and White (1985) reported that 9°C appears to be the temperature threshold below which Bull Trout begin their spawning activities.

Females select redd sites and excavate the nest. Courtship and spawning are carried out at the redd and a complete round of spawning requires several days to complete (McPhail and Baxter 1996).

Site fidelity

Approximately 50% of radio-tagged Bull Trout in a study by Carson (2001) exhibited signs of spawning migration and post-spawning homing behaviour. The results of Carson's study suggest that Bull Trout in the McLeod system in west-central Alberta occupy a small home range and exhibit strong fidelity to their range. Swanberg (1997) also reported strong post-spawning homing behaviour suggesting some degree of site fidelity. Burrows et al. (2001) reported mixed fidelity to summer and fall habitat for feeding and spawning in the Halfway River system in northeastern British Columbia; some radio-tagged Bull Trout had returned to locations where they had been previously located, but other fish remained in streams where they had not been previously observed.

The homing ability of Bull Trout appears to be variable and is perhaps an adaptive trait that is subject to natural selection (McPhail and Baxter 1996). McPhail and Baxter (1996) speculate that the degree of homing may be related to stream size and stability. Baxter (1995) reported that different females will select previously used redd locations in different years suggesting some degree of spawning site fidelity.

Home range

Bull Trout home range is highly variable depending upon life history strategy. The home range for resident populations is much smaller than that of migratory fluvial or adfluvial populations, which can have very large home ranges, usually because resident populations are restricted to stream reaches located above barriers to migration. Burrows et al. (2001) reported annual movement of up to 275 km in the Halfway River system. Carson (2001) reported small, discrete home ranges for Bull Trout tracked in the McLeod River system in Alberta.

Movements and dispersal

Bull Trout populations may move long or short distances to and from feeding, spawning, and overwintering sites depending upon their life history strategy. Timing of the spawning migration depends on a number of variables that include water temperature, habitat, genetic stock, and possibly daylight (photoperiod regulates endocrine control of these types of behaviour in other salmonids) (Ford et al. 1995). Mature fish from fluvial populations make spawning migrations from large to smaller rivers in mid- to late summer when the water temperatures are relatively high and water levels are typically declining (Oliver 1979; Fraley and Shepard 1989; Hagen and Baxter 1992). Many of the juvenile fish from fluvial populations migrate from their natal areas during their third summer, but some do not emigrate until their fourth summer (Oliver 1979; Pratt 1992; Sexauer 1994). Juvenile migrations begin in spring and continue through summer months (Oliver 1979).

Fluvial forms in the Peace River system make long distance migrations to and from spawning locations (Pattenden 1992; McPhail and Baxter 1996; Burrows et al. 2001), as do populations in the Columbia River system (O'Brien 1996). Adfluvial populations exhibit similar migratory patterns as the fluvial form where mature Bull Trout migrate from lakes to spawning streams (McPhail and Murray 1979; Fraley and Shepard 1989). Juvenile fish (fry, 1+, 2+, and 3+) emigrate from natal streams to lakes or reservoirs through summer months (McPhail and Murray 1979).

Habitat

Structural stage

Forest health and the maintenance of riparian forests are very important in maintaining the integrity of fish habitat. In addition, the forest structural stage surrounding streams may also play an important role. Generally, mature structural stages (5–7) produce more large woody debris than younger seral stages (Robison and Beschta 1990); more sediment trapping and storage (Bragg et al. 2000); more nutrient cycling (Bilby and Likens 1980); and more fish habitat structure (Bragg et al. 2000).

Important habitats and habitat features

Bull Trout are cold water specialists which Rieman and McIntyre (1993) identified as having more specific habitat requirements than other salmonids. These authors reviewed five habitat features that consistently influence Bull Trout distribution and abundance: channel and hydraulic stability; substrate; cover; temperature; and the presence of migration corridors. The influence and temporal importance of each of these features can be modified depending on the life history strategy (fluvial, adfluvial, or resident) and life history stage.

Spawning

Bull Trout spawn in flowing water (references cited in McPhail and Baxter 1996) and show a preference for gravel and cobble sections in smaller, lower order rivers and streams. Bull Trout tend to be very selective when choosing spawning locations. Spawning sites are characterized by low gradients (~1.0–1.5%); clean gravel <20 mm; water velocities of 0.03–0.80 m/s; and cover in the form of undercut banks, debris jams, pools, and overhanging vegetation (references cited in McPhail and Baxter 1996).

Water temperature plays an important role in Bull Trout spawning success. A threshold temperature of 9°C has been suggested as the temperature below which spawning is initiated (McPhail and Murray 1979; Weaver and White 1985), at least for more southern stream systems. More recent data on temperature/spawning timing in northern B.C. systems suggest that temperature thresholds are lower or that temperature is not as important a cue because mean stream temperatures at spawning locations rarely exceed 9° at any time of the year (T. Zimmerman, pers. comm.).

The stability of the temperature environment in natal streams is likely a much more critical feature of high quality spawning locations. There may also be a lower temperature threshold below which spawning is suspended. Allan (1987) reported that Bull Trout in Line Creek in the east Kootenay region of British Columbia stopped spawning when water temperatures dropped below 5°C. Egg incubation requires temperatures <8°C and an optimal range of 2–4°C (Berry 1994; Fairless et al. 1994).

Groundwater interaction with surface water likely creates thermal stability at spawning sites that can act to minimize winter hazards for incubating eggs (Baxter and McPhail 1999). During the winter, stream temperatures in parts of British Columbia are at or very near 0°C; therefore, anchor ice formation is a constant threat to incubating eggs. A stable winter environment would be a spawning site that (1) could be predicted to be anchor ice free for most winters, or (2) demonstrates a stable thermal signature above 0°C year over year (T. Zimmerman, pers. comm.).

Rearing and foraging

In general, all Bull Trout (regardless of the life stage or life history strategy) are cold water specialists. Bull Trout are seldom found in systems where water temperature is above 15°C for prolonged periods (references cited in McPhail and Baxter 1996). Adults are primarily piscivorous and depend on an adequate forage base to support growth and reproduction. Bull Trout appear to be primarily ambush predators and are highly dependent on cover, usually in the form of deep pools, woody debris jams and undercut banks (T. Down, pers. comm.).

Bull Trout fry are often associated with shallow water, low-velocity side channels, and abundant instream cover in the form of cobble and boulders (Environmental Management Associates 1993; Baxter 1994, 1995). Bull Trout fry focus their feeding on aquatic insects near or on the bottom of the stream (Nakano et al. 1992).

Most juveniles rear in streams and appear to prefer pools over riffles, runs, or pocket water (Fraley and Shepard 1989; Nakano et al. 1992). Adequate instream cover is an important component of juvenile habitat. Juveniles in Line Creek in the east Kootenay region of southeastern British Columbia were associated with large woody debris (LWD), undercut banks, and coarse substrate (Allan 1987). Juveniles are benthic and drift foragers (Nakano et al. 1992) that feed on aquatic insects until the fish reach about 11 cm, at which time they usually switch to preying on other fish (Pratt 1992).

Overwintering

Juvenile overwintering in streams is more closely associated with cover than during summer months (Sexauer 1994). Overhead cover, deep, low-velocity water, and the absence of anchor ice are important overwintering habitat features for juveniles (Thurow 1997).

Stream-resident populations of Bull Trout, particularly those in northern latitudes, require suitable ice-free overwintering sites and this is a critical component in maintaining viable populations (McPhail and Baxter 1996). In the fall, fish will move from small tributaries into larger streams or rivers (Craig and Bruce 1982; Stewart et al. 1982). In the Sukunka River in northeastern British Columbia, Bull Trout overwinter in deep pools (Stuart and Chislett 1979). As for juveniles, adult overwintering habitat requirements are low velocity water with sufficient depth to provide ice-free refuges and overhead and instream cover (Rhude and Rhem 1995). Adults often undergo extensive downstream migrations to overwintering habitat (e.g., Burrows et al. 2001).

Conservation and Management

Status

The Bull Trout is on the provincial *Blue List* in British Columbia. Its status in Canada has not been determined (COSEWIC 2002).

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

BC	AB	ID	AK	MT	OR	WA	YK	Canada	Global
S3	S3	S3	S?	S3	S3	S3	S?	N3	G3

Trends

Population trends

Generally, Bull Trout populations are considered to be declining in abundance throughout their native range in Canada and the United States (references cited in Post and Johnston 2002). For the most part, this range reduction is comprised of localized extinctions, although in at least one system (the McCloud in California) they no longer exist (McPhail and Baxter 1996). In Alberta, Bull Trout populations have been in decline since the beginning of the 1900s.

In British Columbia, the general trend for Bull Trout populations is stable to diminishing (Pollard and Down 2001) – stable if adequate protection measures are implemented and enforced, but diminishing if forest practices and road development activities (including petroleum development roads in northeastern British Columbia) continue to degrade and exclude suitable Bull Trout habitat. Population trends for Bull Trout in British Columbia are shown in Figure 1 (note that there are minor inconsistencies between the Bull Trout distributions shown in Figure 1 and the Bull Trout distributions noted earlier in this account).

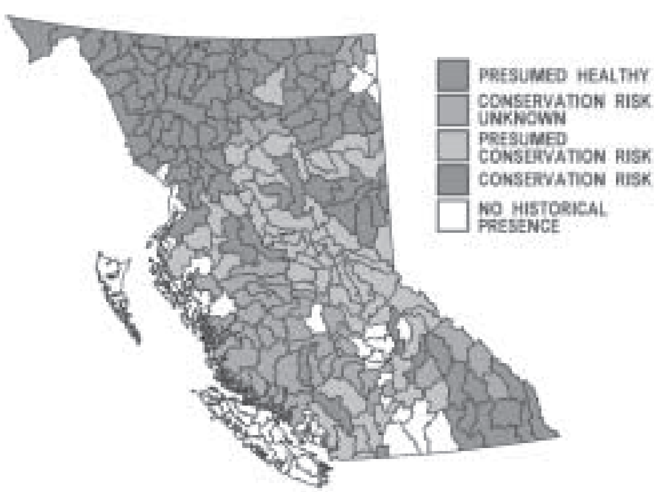


Figure 1. Status of Bull Trout in British Columbia by watershed group. Conservation risk means that the population is known to be in decline (B.C. MWLAP 2002).

Habitat trends

Given the broad distribution of Bull Trout in British Columbia, no studies have attempted to quantify trends in Bull Trout habitat across the provincial landscape. In this situation, it is appropriate to use indicators of general habitat condition; one such indicator is road density in watershed groups (B.C. MWLAP 2002), with road density being a surrogate measure of the amount of development in a given watershed. Cross and Everest (1997) examined the link between changes in habitat attributes for Bull Trout in "managed" watersheds (roaded and subject to logging and/or mining activity) and unroaded/unlogged watersheds. They noted, among other findings, a reduction in pool depth and volume in managed watersheds, which were considered to be key impacts to Bull Trout habitat. In British Columbia, road length increased by 45% between 1988 and 1999 (B.C. MWLAP 2002). This finding suggests a general decline in the quality of Bull Trout habitat in British Columbia.

Threats

Population threats

In British Columbia, a primary threat to Bull Trout is the fragmentation of populations through the disruption of migration patterns. Except for populations upstream of migration barriers, subpopulations that occur in the same watershed most likely exchange genetic material and are able to recolonize streams following catastrophic events. Studies on these clusters of subpopulations or "metapopulations" indicate that the likelihood of persistence decreases as local populations become isolated from each other through the creation of barriers to migration. Obstructions to Bull Trout movement can be fairly obvious (e.g., perched culvert outlets or water velocity through a culvert) or more subtle, such as sections of degraded habitat (e.g., stream channel instability, increasing water temperatures, sedimentation of substrate, or lack of cover). Once fragmented, the components of a metapopulation are much more prone to extirpation from both stochastic and deterministic risks.

A second primary threat to Bull Trout is their sensitivity to angling pressure. The significant increase in the number of roads, and other linear developments such as seismic trails, pipelines, and power line corridors, in previously unroaded watersheds, especially in northeastern British Columbia, is a major concern for Bull Trout populations because it allows anglers and poachers unprecedented access to streams that were previously protected by their remoteness. Poaching and non-compliance with conservative regulations for Bull Trout is a serious problem in previously more remote regions of the province.

Other threats to Bull Trout populations include disease and competition with other species.

Habitat threats

Of all the salmonid species, Bull Trout have the most specific habitat requirements (Rieman and McIntyre 1993) and are very sensitive to habitat degradation. Their specialization as a cold water species makes them highly susceptible to activities such as riparian timber harvesting. Loss of stream shading can lead to elevated water temperatures (both daily mean and peak temperatures), which can be problematic for a species that is seldom found in streams or lakes where temperatures rise above 15°C. Increasing water temperatures can lead to population fragmentation and increase the risk of invasion by other species that may displace Bull Trout and lead to further decreases in their abundance (Parkinson and Haas 1996).

Bull Trout require clean, well-oxygenated water; as a result, the distribution and abundance of all Bull Trout are strongly influenced by channel and hydrologic stability. The eggs and young of this fall-spawning species are vulnerable to winter and early spring conditions such as low flows, which can strand eggs and embryos or lead to freezing within the substrate. These life stages are also susceptible to flooding and scouring. Success of embryo survival, fry emergence, and overwinter survival of juveniles is related to low sedimentation levels, because increased sediment leads to losses in pool depth and frequency; reductions in interstitial spaces; channel braiding; and potential instabilities in the supply and temperature of groundwater inputs (Rieman and McIntyre 1993).

Forest harvesting, petroleum and mining development, and associated access; livestock grazing; and urban development are all anthropogenic threats to the integrity of Bull Trout habitat. The effects of these threats can be separated into three general categories: (1) elimination of habitat or restriction of fish access; (2) sedimentation and erosion; and (3) alteration or loss of required habitat characteristics.

Elimination or restriction

Pre-Forest Practices Code forest harvesting and forestry road development, and petroleum exploration and development access construction, have contributed to the decline in Bull Trout populations around the province by disrupting migration corridors. Perched culverts, debris, channelization, increased water temperatures, and increased water velocities are all capable of influencing access to important habitats utilized by adfluvial, fluvial, and resident Bull Trout populations. Construction of dams and reservoirs in the Peace River and Columbia River watersheds eliminated significant amounts of stream habitat through inundation and also created barriers that, in some cases, have altered historical migration patterns. The resultant isolation and restriction of populations related to these access barriers may reduce the gene flow within and between populations and negatively affect the long-term success of distinct Bull Trout populations throughout the province.

Sedimentation and erosion

Significant changes in unit area peak flows, unit area storm volumes, and response time to storm events are known to be associated with increased development within a watershed (e.g., forest harvest; grazing; petroleum resource, mining, and urban development). As the area of a clearcut increases, a corresponding increase in storm volume occurs. Road development leads to earlier, higher peak flows and can also alter groundwater flows. In addition to influencing peak flows, roads may act as sediment sources.

An increase in sediments and erosion (above natural background levels) are undesirable as they can degrade spawning and rearing habitat, and cause direct injury to fish, by:

- infilling gravel spawning substrate;
- infilling pool and riffle habitat;
- impairing feeding ability, through increased turbidity;
- reducing food availability for juvenile fish and lowering stream productivity, through smothering of aquatic insects; and
- clogging and abrading of fish gills.

Alteration of habitat characteristics

The presence of riparian vegetation is a critical factor in the maintenance of many important habitat features required by Bull Trout and other fish species. However, riparian vegetation is frequently removed as a result of development activities within a watershed, and this loss has significant negative impacts on fish habitat. Riparian vegetation:

- Provides a source of short- and long-term LWD recruitment, which is a key component in the creation of optimal salmonid habitat such as pools and cover (Chilibeck et al. 1992);
- Maintains lower water temperatures by shading the channel—a critical habitat factor for Bull Trout (Scruton et al. 1998; Maloney et al. 1999);
- Increases bank stability and maintains integrity of channel morphology (Robison and Beschta 1990; Chilibeck et al. 1992; Bragg et al. 2000);
- Provides a substrate for many terrestrial insects, which are in turn an important aquatic food source, and provides organic matter (in the form of leaf litter) that supports the aquatic food chain (Chilibeck et al. 1992; Wipfli 1997); and
- Acts as a buffer zone to intercept runoff and filter for sediment and pollutants (Chilibeck et al. 1992).

As for other fish and aquatic organisms, climate change and associated global warming are predicted to reduce Bull Trout habitat by leading to increased water temperatures and leaving even more areas unsuitable for all life stages of this cold water specialist (Kelehar and Rahel 1992; Mullan et al. 1992).

Legal Protection and Habitat Conservation

Bull Trout in British Columbia are protected under the provincial *Wildlife Act*, the provincial *Fish Protection Act*, and the federal *Fisheries Act*. The *Wildlife Act* enables provincial authorities to license anglers and angling guides, and to supply scientific fish collection permits, and the *Fish Protection Act* provides the legislative authority for water managers to consider impacts on fish and fish habitats before approving new water licences or amendments to existing licences, or issuing approvals for works in and about streams. However, the *Fish Protection Act* cannot be used to supercede activities authorized under the provincial *Forest Act*, or where the Forest Practices Code or its successor, the *Forest and Range Practices Act*, applies (see Section 7(7), *Fish Protection Act*).

The federal *Fisheries Act* delegates authority to the Province to establish and enforce fishing regulations under the British Columbia Sport Fishing Regulations. These Regulations incorporate a variety of measures to protect fish stocks, including stream and lake closures, catch and release fisheries, size and catch limits, and gear restrictions.

In addition, Section 35(1) of the federal *Fisheries Act* prohibits activities that may result "in the harmful alteration, disruption, or destruction of fish habitat." Similarly, Section 36(3) of the Act prohibits the deposition of a "deleterious substance of any type" into waters frequented by fish.

Also of note is the fish habitat policy of the federal Department of Fisheries and Oceans, which includes a goal of "… no net loss of the productive capacity of fish habitat", which is designed to maintain the maximum natural fisheries capacity of streams (Chilibeck et al. 1992).

The provincial system of parks and protected areas, and the federal system of parks, provide some level of protection for certain populations, or portions of populations, of Bull Trout. However, given the wide distribution of this species, most of its habitat in British Columbia does not lie within the boundaries of a protected area.

Provisions enabled under the Forest Practices Code (FPC) or its successor, the *Forest and Range Practices Act* (FRPA), that may help maintain habitat for this species include: ungulate winter range areas; old growth management areas; riparian management areas; community watersheds; coarse woody debris retention, visual quality objectives; and the wildlife habitat feature designation. All of these, except community watersheds, have the ability to protect relatively small portions of streamside vegetation (i.e., a few hundred hectares) along a stream; community watersheds have the potential to protect an entire population of a stream resident form.

However, for Bull Trout, these provision are considered to be coarse filters only and thus inadequate to conserve Bull Trout, as this species is more sensitive to habitat disturbances than most other fish species. For example, one potential problem with these provisions is that the current Riparian Management Area (RMA) guidelines do not require retention of a reserve zone on S4 streams (small, fish-bearing; <1.5 m wide), only a 30 m management zone (MOF and MOELP 1995). Given Bull Trout's preference for cool water systems and their use of smaller headwater systems, these guidelines may be inconsistent with the goal of protecting Bull Trout critical habitat.

Provisions exist within FRPA to allow watersheds to be designated as having significant fisheries values, and streams to be designated as being temperature sensitive. The former designation could lead to requirements to consider cumulative hydrologic impacts, while the latter could have implications with regard to riparian retention on S4 and S5 streams. However, notwithstanding that significant fisheries watersheds are as yet undefined, both provisions will require a proactive designation by MWLAP before the provisions would be available to protect and conserve Bull Trout habitat.

The data necessary for such value judgments by the Ministry is not widely available. Furthermore, the impact to the overall temperature regime of individual watersheds, and thus on any downstream fisheries values, as a result of logging small headwater tributaries to their stream banks is poorly understood.

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

Due to the wide distribution of Bull Trout in the province, the varying migratory patterns of the species, and the species' use of a variety of sparsely distributed habitats, wildlife habitat areas (WHAs) cannot address all aspects of the Bull Trout's life history requirements. In addition, as this species is especially sensitive to habitat degradation, its requirements must be addressed at the landscape level, in order to effectively manage for the maintenance of populations.

In sub-basins where Bull Trout are present, and where forest development is planned for the next 5-year period, any of the following are recommended as supplementary triggers for the watershed assessment procedure (WAP):

- more than 10% of the watershed has been logged in the 20 years prior to the start of the proposed development plan, or will be logged in the 25 years prior to the end of the proposed development plan;
- a "significant" number of mass-wasting events are known to have occurred in the watershed (i.e., more than one event/km^2 and more than two events reaching the mainstem);
- the presence in the watershed of either high stream channel density (i.e., more than 1 km of channel/km^2), high road density (i.e., more than 150 m of road length/km^2), or a siginificant number of stream crossings (i.e., more than 0.6/km^2 in the interior or more than 1.4 km^2 on the coast); or
- evidence of significant stream channel stability problems.

The objective of the WAP is to avoid cumulative hydrologic impacts that may affect channel stability or structure. If the WAP determines that the watershed is sensitive to disturbance (a rating of Medium or High in the Hazard Category), Bull Trout populations are at risk. In such sensitive watersheds, the following conservation measures, based on the metapopulation concept, should be demonstrated by strategic and operational planning processes, and reflected in the temporal and spatial layout of cutblocks, road layout and design, and hydrologic green-up and recovery standards:

- Minimization of upstream and upslope disturbances to prevent siltation, temperature, and hydrologic impacts (including disruptions of groundwater flows) in areas influencing critical reaches of Bull Trout habitat;
- Minimization of road networks, total road length, and number of stream crossings, and avoidance of linear road developments adjacent to stream channels, where practical from an engineering perspective;
- Maintenance of riparian habitats in a properly functioning condition, to ensure LWD recruitment is based on life expectancy and decay periods of naturally occurring adjacent tree species;
- Minimization of obstructions to movements, and isolation of populations (e.g., ensure stream crossings will pass migrating Bull Trout at all flows and life history stages, etc.);
- Minimize road construction within 0.5 km of known Bull Trout congregations; and
- Maintain riparian reserves on S4 streams with or suspected to have Bull Trout, or S5 and S6 streams that are tributary to streams with Bull Trout, where local managers deem necessary to protect natural stream processes and limit erosion and sedimentation.

General wildlife measures

Apply general wildlife measure to "identified fisheries sensitive watersheds," as defined by MWLAP, where Bull Trout were part of the rationale for the designation *or* at and above S4 streams with Bull Trout congregations. A congregation is defined as a significant portion of a run. A significant portion will generally be >20% of the adult population of a run, depending on professional judgement. True congregations will be intuitively obvious at critical times of the year. They should be based on a ground survey or aerial redd count that identifies a significant portion of the run accumulating at a specific location/habitat that will be reasonably stable over several years.

Goals

1. Prevent or minimize access to Bull Trout congregations.
2. Prevent or minimize detrimental alterations to Bull Trout habitat, including sedimentation.
3. Maintain important habitat features including cover, substrate quality, pool depth and volume, groundwater flow, water quality, temperature, channel structure, and hydrologic characteristics of the site.
4. Ensure large woody debris recruitment based on life expectancy and decay periods of naturally occurring adjacent tree species.
5. Maintain migration corridors and prevent isolation of Bull Trout population.
6. Maintain or rehabilitate to a properly functioning condition.

Measures

Access

- Do not construct roads and excavated or bladed trails. Where there is no alternative to road or trail development, close to public during staging and spawning times and rehabilitate as soon as possible. Ensure that roads do not impact stream channel integrity, water quality, groundwater flow, substrate composition, cover, and natural temperature regimes.
- Avoid stream crossings at Bull Trout concentrations. Stream crossings should be built to the highest standards to minimize the risk of sediment input or impacts to the channel.

Harvesting and silviculture

- Plan harvest to meet goals of maintaining stream channel integrity, water quality, groundwater flow, and substrate composition; and to minimizing disturbance.

Range

- Do not place livestock attractants within 500 m of known congregations.

Recreation

- Do not develop recreational trails, facilities, or structures within 500 m of known congregations.

Additional Management Considerations

Place roads as far as practicable from critical Bull Trout habitat.

Avoid development of recreational trails, facilities, or structures immediately adjacent to WHAs.

Information Needs

1. Biology, ecology, and limiting factors of the anadromous form of Bull Trout in British Columbia (e.g., factors limiting juvenile recruitment, juvenile migratory patterns and habitat use, dispersal mechanisms, and rates).
2. Knowledge of distribution and stock status is inadequate in most areas of the province.
3. Effects of sustained forest harvesting on the quality and quantity of groundwater supplies in Bull Trout watersheds.

Cross References

Grizzly Bear, "Westslope" Cutthroat Trout

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Amphibians

Coastal Tailed Frog

Ascaphus truei

Original[1] prepared by Agi Mallory

Species Information

Taxonomy

Phylogenetic studies have determined that tailed frogs belong in their own monotypic family, Ascaphidae (Green et al. 1989; Jamieson et al. 1993). Recent phylogeographic analysis has determined that coastal and inland assemblages of the tailed frog are sufficiently divergent as to warrant designation as two distinct species: *Ascaphus truei* (coastal) and *Ascaphus montanus* (Rocky Mountain) (Ritland et al. 2000; Nielson et al. 2001). The divergence of coastal and inland populations is likely attributable to isolation in refugia in response to the rise of the Cascade Mountains during the late Miocene to early Pliocene (Nielson et al. 2001).

The Coastal Tailed Frog and Rocky Mountain Tailed Frog are the only members of the family Ascaphidae and are considered the most primitive frogs in the world, representing the basal lineage of the anurans (Nielson et al. 2001).

Description

Tailed frogs have unique morphological adaptations to life in fast-flowing mountain streams. They are the only frog species in North America that breed in cold mountain streams. Adults and juveniles are small (2.2–5.1 cm) with a large head, a vertical pupil, and broad and flattened outer hind toes. They lack tympana (ear membranes) and the ability to vocalize, presumably adaptations to the constant sound of rushing water. The species is commonly known as the tailed frog because males have a short, conical "tail" with which to inseminate females. Adults have a grainy skin that can vary in colour from tan, to chocolate brown, to olive green (Metter 1964; L.A. Dupuis, pers. comm.); fine black speckling generally occurs on paler individuals. There is often a distinct copper bar or triangle between the eyes and snout, with green undertones (Metter 1964).

Tadpoles are roughly 11 mm in length upon hatching, and can reach up to 65 mm long prior to metamorphosis (Brown 1990). They possess a wide flattened oral disc modified into a suction mouth for clinging to rocks in swift currents and grazing periphyton (Metter 1964, 1967; Nussbaum et al. 1983), a ventrally flattened body, and a laterally compressed tail bordered by a low dorsal fin. They are black or light brownish-grey, often with fine black speckling; lighter flecks may or may not be present (L.A. Dupuis, pers. comm.). The tadpoles usually possess a white dot (ocellus) on the tip of the tail and often have a distinct copper-coloured bar or triangle between the eyes and snout. Hatchlings lack pigmentation, and are most easily characterized by the large, conspicuous yolk sac in the abdomen.

Distribution

Global

The Coastal Tailed Frog occurs from northwestern California to Portland Canal and Nass River, north of Prince Rupert, British Columbia throughout the temperate Coast Mountains (Corkran and Thoms 1996; Dupuis and Bunnell 1997).

British Columbia

In British Columbia, the Coastal Tailed Frog is restricted to cool permanent mountain streams within the windward and leeward drainages of the Coast Mountains. The distribution extends from the

1 Volume 1 account prepared by L. Dupuis.

Coastal Tailed Frog
(Ascaphus truei)

Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on several ecosystem classifications (Ecoregion, Biogeoclimatic and Broad Ecosystem Inventory) as well as current knowledge of the species' habitat preferences. This species may or may not occur in all areas indicated.

Lower Mainland in the Fraser Basin to Portland Canal and the Nass River on the north coast (Dupuis and Bunnell 1997; Dupuis et al. 2000). Occurrences become scattered and tadpole densities decrease north of latitude 54° N. The most westerly occurrences are from islands on the mid- and northern coast of British Columbia, and from Namu and Boswell Inlet in the Hecate Lowlands (Dupuis et al. 2000). The most easterly occurrences are from the Cayoosh Ranges between Pemberton and Lillooet, Cathedral Provincial Park, south of Princeton, and Penticton (Dupuis et al. 2000; Gyug 2000). In the eastern portion of its range, cold creek temperatures limit distribution (Dupuis and Friele 2003).

Forest regions and districts

Coast: Campbell River (mainland), Chilliwack, North Coast, North Island (mainland), Squamish, Sunshine Coast

Northern Interior: Kalum, Skeena Stikine

Southern Interior: Cascades, Okanagan Shuswap (Penticton)

Ecoprovinces and ecosections

COM: CPR, EPR, HEL, KIM, KIR, NAM, NPR, NWC, OUF, SBR, SPR

GED: FRL, GEL

SOI: HOR, LPR, OKR, PAR, SCR, STU

Biogeoclimatic units

AT: p

CWH: dm, ds1, ds2, ms1, ms2, vh1, vh2, vm, vm1, vm2, wm, ws1, ws2, xm1

ESSF: dc2, mw, wv, xc

ICH: mc2

IDF: dk2, ww, xh1

MH: mm1, mm2

MS: dm2

Broad ecosystem units

CB, CR, FS, RR, RS, SM, SR, YB

CH, CW, FR, HS, MF – on south-facing slopes only

AV, RR, WR, (SS in IDFdk2, IDFww)

SF (into MSdm2 in OKR, STU)

Elevation

From sea level to 2140 m

Life History

Diet and foraging behaviour

Adults and juveniles forage primarily at night along the creek on a variety of items, including spiders and other terrestrial arthropods such as ticks, mites, collembolans (snow fleas), and various insects as well as snails (Metter 1964). Unlike most frogs and toads, tailed frogs do not have their tongue attached at the front of their mouth and therefore lack the ability to flip it out to catch prey (Green and Campbell 1984).

Tailed frog tadpoles are primary consumers that feed largely on diatoms that they scrape from submerged rocks (Metter 1964; Bury and Corn 1988). Other components of their diet include conifer pollen and small quantities of filamentous algae. In some streams, tailed frog tadpoles may function as the dominant herbivore (Lamberti et al. 1992).

Reproduction

Tailed frogs are the longest lived anuran species (15–20 years), and have the longest larval period and longest time to sexual maturity of all North American frogs (Brown 1975, 1989). They reach sexual maturity at 8 or 9 years of age (Daugherty and Sheldon 1982). Courtship takes place in the water in early fall (September–October). Tailed frogs are among the few frog species worldwide with internal fertilization (Green and Campbell 1984). The sperm stays viable in the female's oviducts until egg laying in June or early July. Each female produces a double strand of 44–85 colourless, pea-sized eggs that she attaches to the underside of a large rock or bolder in the stream in late summer (Metter 1964; Nussbaum et al. 1983). Although eggs are difficult to find, previous studies have shown that eggs are generally found close to headwaters (Brown 1975; Adams 1993).

The embryos emerge approximately 6 weeks after the eggs are deposited. They feed on a yolk sac which sustains them through the winter in the natal pool until their suctorial mouth is fully developed, after which they become more mobile (Metter 1964; Brown 1975). The tadpole stage lasts between 2 to 4 years prior to metamorphosis (Metter 1964; Brown 1990). However, 1-year larval cycles have been observed for the Coastal Tailed Frog in northern California (Wallace and Diller 1998). Variation in the age at metamorphosis appears to reflect differences in climatic conditions throughout the species range (Bury and Adams 1999).

Home range

Home range is not known. A study on age-specific movement patterns of Rocky Mountain Tailed Frogs found that adults remain closely associated with their natal stream throughout their lives, often not moving more than 20 m per year and between years (Daugherty and Sheldon 1982). In the Coast Range, adults have been reported several hundred metres from a stream's edge during wet weather (Bury and Corn 1988; Dupuis et al. 1995; Gomez and Anthony 1996; Wahbe et al. 2000). Climatic conditions likely favourable for tailed frogs (e.g., high humidity, extended periods of rain) along the coast may enable adults to occupy larger home ranges or move longer distances.

Movements and dispersal

Data on movement and dispersal of Coastal Tailed Frogs for all life history stages are limited. Tadpoles are relatively sedentary but movements of up to 65 m have been recorded in old-growth streams in the Squamish area (Wahbe 1996). Given that eggs are generally deposited in the headwaters near the source of the stream (Brown 1975; Adams 1993), larval movement is thought to be primarily downstream (Wahbe et al. 2000). Tadpoles can be either nocturnal or diurnal, and may alter their behaviour to avoid detection by predators such as the Coast Giant Salamander (Feminella and Hawkins 1994).

Adults generally remain close to stream banks, and may move upstream either for refuge during the summer months or to lay eggs. A recent study in the Chilliwack Valley found Coastal Tailed Frogs in mature forests primarily within 5 m of the streamside, with a maximum distance of 45 m (Matsuda 2001). This study showed that, in clearcut sites, a higher proportion of frogs were caught at distances >45 m away, suggesting that frogs move beyond riparian zones in disturbed habitats when climatic conditions are favourable. A recent study in the Merritt area found only adult males or immature females on streams without larvae during September, which indicates that adult females are less likely to disperse during the breeding season (Gyug 2000).

Some evidence shows that newly metamorphosed tailed frogs represent the life history stage that migrates farthest away from the stream. Preliminary results from movement studies in the Squamish area found newly metamorphosed tailed frogs 100 m from the nearest stream during the fall (Wahbe et al. 2000). Bury and Corn (1987, 1988) also captured numerous recently metamorphosed tailed frogs in pitfall traps set in forested stands, in the fall.

Habitat

Structural stage

6: mature forest (100–140 years)
7: old forest (>140 years)

Important habitats and habitat features

The presence of intrusive or metamorphic bedrock formations, moderate annual rainfall with a relatively high proportion of it occurring during the summer, and watersheds with low or moderate previous levels of harvest appear to be large-scale regional features in predicting the presence of *Ascaphus* (Wilkins and Peterson 2000).

Terrestrial

Little work has been done on post-metamorphic and adult habitat associations. Coastal Tailed Frogs are more prone to desiccation than most anuran species due to their dependence on vascularized skin for respiration (Claussen 1973b).

Forested riparian areas can benefit tailed frog larvae by moderating stream and ambient temperatures. Forested buffers also help to maintain bank stability and channel characteristics (Kelsey 1995; Dupuis and Friele 1996; Dupuis and Steventon 1999).

Aquatic

The Coastal Tailed Frog inhabits mountain streams with step-pool morphologies, and overall gradients that are not too low or excessively steep (Dupuis et al. 2000). Larvae typically occur in creeks draining basins <50 km^2 but abundance is greatest in basins <10 km^2 (Dupuis and Friele 2003). Step-pools of cool, permanent streams adjacent to old forest with significant understorey are most suitable for this species. The species will also inhabit pool-riffle habitats characteristic of Coast Giant Salamander and fish-bearing streams.

Due to a long larval development period, tadpoles require stable perennial streams. Stable mountain streams are characterized by regularly spaced pools and interlocked cobble/boulder (or wood) steps that withstand moderate floods and sediment pulses (Chin 1998). Creeks composed of coarse substrates (boulders and large cobbles) and granodiorite bedrock that breaks down into coarse rock may maintain a higher density of tadpoles (Dupuis and Friele 1996; Diller and Wallace 1999). Coarse substrates allow for interstitial spaces that can serve as egg-laying and over-wintering sites, and cover in the event of flooding or small bedload movements. This is critical as tailed frogs have been shown to be negatively associated with the amount of fine sediments in streams (Bull and Carter 1996; Welsh and Ollivier 1998; Dupuis and Steventon 1999).

Tadpoles prefer smooth-surfaced substrates with a minimum diameter of 55 mm (Altig and Brodie 1972). Clear water is critical to allow for light penetration which stimulates algal growth, and also to minimize sedimentation which fills the interstitial spaces and results in scouring of periphyton from rocks. Tadpoles prefer rocks in turbulent water, and require interstitial spaces between rocks for both forage and cover (Altig and Brodie 1972). Juveniles and adults forage along the stream channel and in the riparian area and require riparian vegetation, boulders, and coarse woody debris for cover.

The creeks must remain cool throughout the summer as the species has a narrow temperature tolerance. However, at the northern limit of their range cold temperatures (<6°C) are considered limiting. The eggs require temperatures of 5–18°C to survive (Brown 1975). Stream temperatures and food resources during the growing season are probably the most important environmental variables influencing tadpole growth (Brown 1990).

Conservation and Management

Status

The Coastal Tailed Frog is on the provincial *Blue List* in British Columbia. It is designated as a species of *Special Concern* in Canada (COSEWIC 2002).

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

BC	CA	OR	WA	Canada	Global
S3S4	S2S3	S3	S4	N3N4	G4

Trends

Population trends

The Coastal Tailed Frog is moderately widespread and locally common. Populations are remarkably discrete within streams. There is no estimated population size for the Coastal Tailed Frog in British Columbia. A recent study showed that Coastal Tailed Frogs occurred in 40–60% of creeks surveyed on the coast of British Columbia, but only 10% near the northern limit of the range (Dupuis et al. 2000).

Habitat trends

Headwater streams have historically been viewed as less important than salmonid streams, and have received little or no protection in British Columbia. Suitable habitat for the Coastal Tailed Frog is declining in British Columbia, particularly in areas that have been clearcut at higher elevations. According to Environment Canada's status report, about 75% of the tailed frog's habitat in British Columbia has been at least partially developed (Environment Canada 2001).

Threats

Population threats

Factors that contribute to the vulnerability of Coastal Tailed Frog populations include its specialized habitat requirements, long larval period, potentially limited dispersal capabilities, low reproductive rates, and low tolerance of warm temperatures. Tadpoles are vulnerable to local extirpations or population declines from massive bedload (boulders, logs, and debris) movements in the creeks. Survival to the adult stage appears to be particularly low in second-growth forests, which are predominant in its range.

Habitat threats

Coastal Tailed Frogs are habitat specialists and occur only in suitable mountain streams. Due to these specialized habitat requirements, the Coastal Tailed Frog is vulnerable to habitat loss and alteration associated with logging. Logging impacts include stream exposure (e.g., Holtby 1988), increased sedimentation (e.g., Beschta 1978; Reid and Dunne 1984), bank erosion (e.g., Beschta 1978), and windfall, as well as reduced summer flow rates and increased peak discharges (Jones and Grant 1996). Sedimentation fills the spaces between rocks, reducing the availability of refuge sites used to escape floods, bedload movements, predation, and warm temperatures. Large-scale habitat disturbance, loss, and fragmentation through road building and timber harvesting are also likely to be detrimental to the species.

Livestock grazing may impact stream habitats where livestock grazing occurs.

Legal Protection and Habitat Conservation

The Coastal Tailed Frog is protected, in that it cannot be killed, collected or held in captivity without special permits, under the provincial *Wildlife Act*. If salmonid habitat exists downstream, some level of protection may be provided through the *Fisheries Act*.

Some populations occur in provincial parks and ecological reserves, such as Cypress Provincial Park, Pinecone Burke Provincial Park, Cathedral Provincial Park, Mount Elphinstone, Garibaldi Provincial Park, and the Kitlope Heritage Conservancy.

The results based code may provide protection through the establishment of old growth management areas (OGMAs), provided these overlap with known sites or suitable habitat. In addition, riparian management guidelines provide a measure of protection for riparian habitats, particularly for streams with game fish. However, since most populations of the Coastal Tailed Frog are found in small streams without fish, they are not protected by FRPA riparian management recommendations. These recommendations do not recommend retention of a riparian reserve zone on small streams where "game" fish are not present. However, they do recommend that forest practices in management zones adjacent to streams classified as S4–S6 (small fish or non fish bearing) be planned and implemented to meet riparian objectives. These objectives can include retaining sufficient vegetation to provide shade, reduce microclimatic changes, maintain bank stability and, where specified, may include objectives for wildlife, fish habitat, channel stability, and downstream water quality.

Finally, some additional protection of Coastal Tailed Frog habitat may come through the creation of special resource management zones (SRMZs) and protected areas for other species, such as the Spotted Owl, and Grizzly Bear.

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

In landscapes or portions of landscapes documented to contain tailed frog populations, consider the following recommendations:

- ❖ Establish OGMAs to protect known tailed frog occurrences and suitable riparian habitats (see "Important habitats and habitat features").

- ❖ Maximize connectivity of riparian habitats. Wherever possible, increase retention on streams classified as S5 or S6.
- ❖ Maintain water quality and flow characteristics (i.e., timing and quantity).
- ❖ Minimize use of chemical applications (e.g., dust-palliative polymer stabilizers and soil binders that can be sprayed within ditch lines).
- ❖ Avoid cross-stream yarding on suitable streams.

Wildlife habitat area

Goal

Maintain important streams and suitable breeding areas.

Feature

Establish WHAs on important streams and breeding areas. These streams/stream reaches are generally characterized by (1) presence of tadpoles, (2) year-round flow (perennial streams or gullies), (3) intermediate gradient (to allow formation of step-pool morphology), (4) coarse substrates, (5) stable channel beds, and (6) forest cover.

Size

Approximately 20 ha but will depend on site-specific factors including the number and length of stream reach included. Larger WHAs may be appropriate in watersheds with unstable terrain (class IV or V), or when WHAs are established to capture strategic metapopulations.

Design

A WHA should include at least two streams or stream reaches (e.g., S5 or S6) with evidence of presence of tailed frogs. The boundaries of a WHA should be designed to maintain stream conditions (substrate, temperature, macro-invertebrate, and algae communities). The WHA should include a 30 m core area and 20 m management zone on both sides or larger in areas of unstable terrain or to capture strategic metapopulations. Where slopes exceed 60%, the WHA should extend to the top of the inner gorge.

Where several streams with these characteristics occur, priority should be given to sites adjacent to mature or old forest, sites with the greatest potential to establish and maintain mature forest connectivity, sites closest to the headwaters, or sites with high density of tadpoles. In general, WHAs should be established in watersheds with low or moderate levels of historical harvest and on several streams/stream reaches in a drainage to ensure that at least one will maintain a viable subpopulation (Sutherland 2000).

General wildlife measures

Goals

1. Maintain clean and stable cobble/boulder gravel substrates, natural step-pool channel morphology, stream temperatures within tolerance limits.
2. Maintain microclimatic, hydrological, and sedimentation regimes to (1) limit the frequency of occurrence of extreme discharge events, (2) limit the mortality rate of tailed frogs during floods, and (3) meet foraging and dispersal requirements of the adults and metamorphs.
3. Maintain riparian forest.
4. Maintain important structural elements (e.g., coarse woody debris).
5. Maintain water quality and naturally dispersed water flows.
6. Minimize risk of windthrow.

Measures

Access

- Minimize roads or stream crossings within the core area. When roads are determined to be necessary, minimize length and construct narrow roads to minimize site disturbance and reduce groundwater interception in the cutslope; use sediment-control measures in cut-and-fill slopes (e.g., grass-seeding, armouring ditch lines, and culvert outfalls); deactivate roads but minimize digging and disturbance to adjacent roadside habitat; minimize site disturbance during harvesting, especially in terrain polygons with high sediment transfer potential to natal streams; and fall and yard away from, or bridging, all other stream channels (ephemeral or perennial) within the WHA, to reduce channel disturbance and slash loading.

- Where stream crossings are required, ensure the type of crossing structure and any associated roads are designed and installed in a way that minimizes impacts to tailed frog instream and riparian habitats. Use temporary clear span bridges where practicable.

Harvesting and silviculture

- Do not harvest in the core area. Use partial harvesting systems in the management zone that maintain 70% basal area with the appropriate structure necessary to achieve the goals of the GWM.
- Where management zones exceed 20 m, develop a management plan that is consistent with the goals of the GWM.
- No salvage should be carried out.
- Avoid cross-stream yarding.
- Do not use chemical applications (e.g., dust-palliative polymer stabilizers and soil binders that can be sprayed within ditch lines).

Pesticides

- Do not use pesticides.

Range

- Where livestock grazing occurs, follow recommended target conditions for range use in stream riparian areas. Fencing may be required by the statutory decision maker to ahcieve goals.

Additional Management Considerations

Wherever possible and practicable, augment management zone using wildlife tree retention areas.

Manage stream reaches adjacent to WHA according to riparian management recommendations.

Prevent fish introductions and rechannelization of areas supporting tailed frog populations.

Maintain slash-free headwater creeks and forested riparian buffers, especially within fragmented areas.

Information Needs

1. Age-specific movement and dispersal patterns and home range.
2. Demographic responses of Coastal Tailed Frogs to habitat change (e.g., age-class distribution, reproductive success, movement, and dispersal).
3. Opportunity to use variable retention and partial harvesting without degrading habitat suitability.

Cross References

Coastal Giant Salamander, Marbled Murrelet, Pacific Water Shrew

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Birds

Short-eared Owl

Asio flammeus flammeus

Original prepared by John M. Cooper and Suzanne M. Beauchesne

Species Information

Taxonomy

One subspecies, *Asio flammeus flammeus*, is recognized over most of this species' range including British Columbia (AOU 1957; Cannings 1998). Eight or nine other subspecies occur in disjunct populations in South America and on islands elsewhere in the world (Holt and Leasure 1993).

Description

The Short-eared Owl is a medium-sized owl with small ear tufts. At a distance it appears to be a pale buff colour, with black "wrist" patches on the wing. Its flight is moth-like, with erratic wing beats, typically carrying it low over the ground. When perched, it sits slantwise, rather than vertical, as do most other owls of its size.

Distribution

Global

Short-eared Owls breed across subarctic and temperate North America and Eurasia as well as on the grasslands of South America and some islands including Hawaii, the Galapagos, the Falkland Islands, Cuba, Puerto Rico, Borneo, and the Philippines. Some populations are resident; however, the northernmost populations are migratory. In North America, birds winter from extreme southern Canada, south to central Mexico. Eurasian birds winter in the Mediterranean region of Europe, Northern Africa, and southern Asia to Malaysia (Holt and Leasure 1993).

British Columbia

Short-eared Owls breed locally on the south mainland coast, through the Fraser River delta east to Fort Langley, in the south and central Interior north through the Thompson and Chilcotin-Cariboo basins to Prince George, and in the Peace Lowland. It is an uncommon migrant throughout the province. The Fraser River delta is the main wintering area in the province although a few birds winter on southeastern Vancouver Island and in the southern Interior (Campbell et al. 1990).

Forest regions and districts

Coast: Campbell River, Chilliwack, North Island, South Island

Northern Interior: Fort Nelson, Peace (Mackenzie probable), Prince George, Skeena Stikine

Southern Interior: 100 Mile House, Arrow Boundary, Central Cariboo, Chilcotin, Columbia (possible), Kamloops, Kootenay Lake, Okanagan Shuswap, Quesnel, Rocky Mountain

Ecoprovinces and ecosections

BOP: KIP, PEL

CEI: CAB, CCR, CHP, FRB, QUL

COM: NIM, WIM

GED: FRL, GEL, LIM, NAL

NBM: TAB

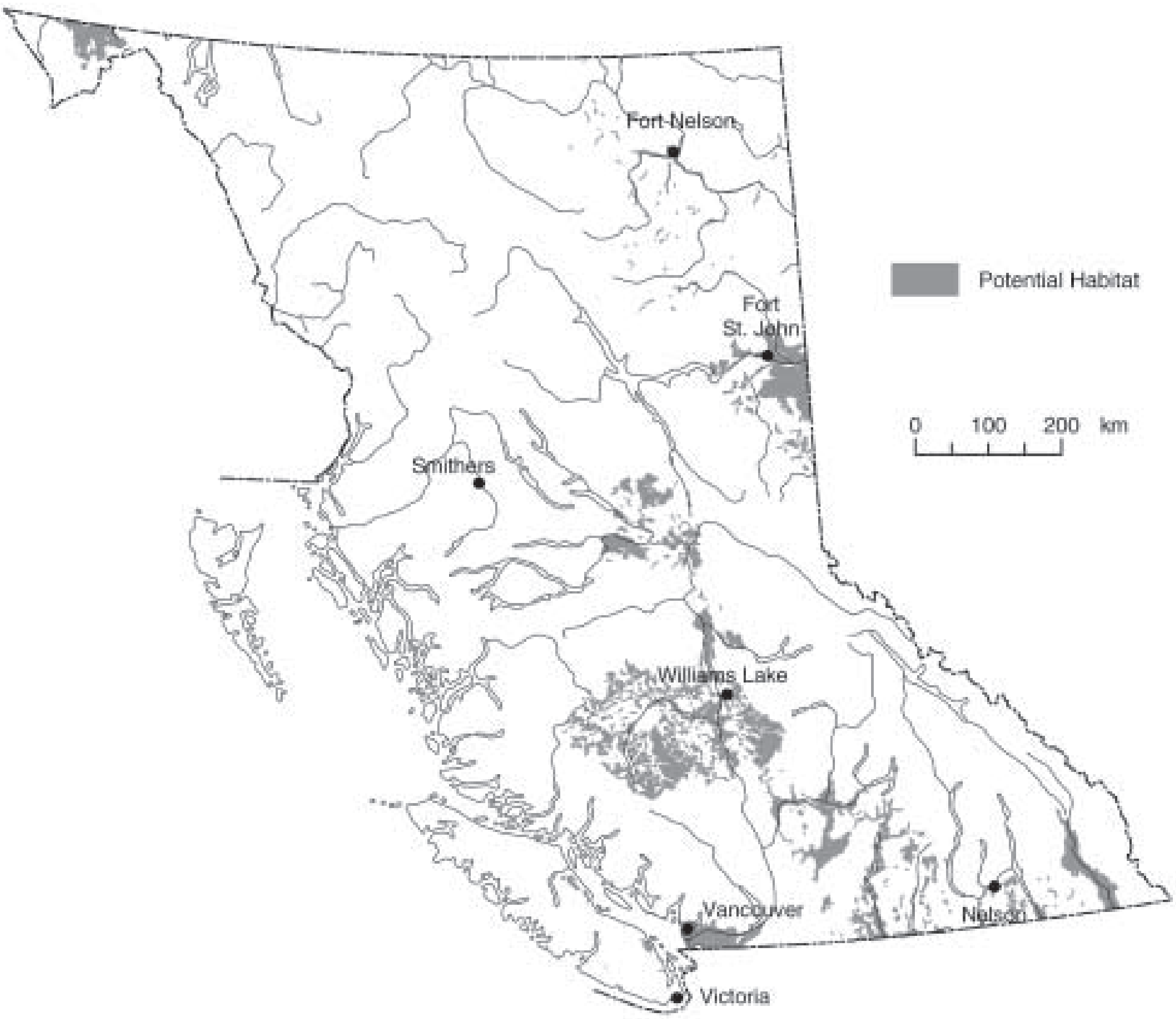
SBI: NEL

SIM: EKT, SCM, SFH, SPM

SOI: GUU, NIB, NOB, NOH, OKR, SHB, SOB, SOH, STU, THB, TRU

TAP: FNL, MUF, MUP

Short-eared Owl
(Asio flammeus)



Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on several ecosystem classifications (Ecoregion, Biogeoclimatic and Broad Ecosystem Inventory) as well as current knowledge of the species' habitat preferences. This species may or may not occur in all areas indicated. More detailed maps are available for this species from the Ministry of Sustainable Resource Management.

Biogeoclimatic units

BG: xh1, xh2, xh3, xw, xw1, xw2

BWBS: dk1, mw1

CDF: mm

CWH: dm, vm1, xm1, xm2

ICH: mw2, xw

IDF: dk1, dk1a, dk3, dk4, dm, mw1, mw2, un, xh1, xh1a, xh2, xh2a, xm, xw

PP: dh1, dh2, xh1, xh1a, xh2

SBS: mh, mk1

SWB: dk

Broad ecosystem units

AB, BS, CF, DF, DP, ES, GO, ME, MS, OV, PP, RR, SM, SS, UR, WG, WL, WP, WR, YB

Elevation

Near sea level to 975 m, occurrence up to 2165 m (Campbell et al. 1990)

Life History

Diet and foraging behaviour

Short-eared Owls are prey specialists, concentrating on small rodents (primarily microtines), which undergo regular population cycles (Wiebe 1991; Sullivan 1992; Holt and Leasure 1993). When microtine populations crash in one area, Short-eared Owl populations must move to find a new prey supply. Other small mammals, insects, and birds are taken in lesser quantities.

Short-eared Owls usually hunt in a low flight path over grasslands, marshes, fallow fields, and other open areas. They also hover or hunt from a perch (Wiebe 1987; Holt and Leasure 1993).

Reproduction

Monogamous pair bonds are formed in the late winter and likely last only for a single season (Holt and Leasure 1993). Nesting may begin as early as late March, although late April to early May is more common in British Columbia (Campbell et al. 1990). In British Columbia, clutch size ranges up to 13 eggs, but six or seven eggs are most common (Campbell et al. 1990). Clutch sizes are larger in times of greater prey abundance (Johnsgard 1988). The female alone incubates the eggs for 24–28 days. Incubation begins before the clutch is completed, resulting in asynchronous hatching of young. The male brings food to the incubating and brooding female. Nestlings leave the nest after about 12–16 days but are unable to fly for another 10–12 days (Holt and Leasure 1993).

Short-eared Owls begin breeding at one year of age. One brood is probably raised annually. Some researchers believe that a second brood may be raised during years of extremely abundant prey, although conclusive evidence is lacking. Restarts after nest failure have been documented (Johnsgard 1988; Holt and Leasure 1993).

Nests are placed in open areas such as fallow fields, dry marshes, or grasslands with sufficient ground cover to conceal nests. This species is unusual among owls in that it builds its own nest, rather than using the nest of another bird species (Johnsgard 1988). Nests are built on the ground, in a scrape lined with vegetation and feathers (Campbell et al. 1990; Holt 1992; Semenchuk 1992; Holt and Leasure 1993). Nests are usually on dry, raised ground, although wet areas may also be used (Holt and Leasure 1993).

Site fidelity

Nest sites are infrequently reused in subsequent years; however, it is uncertain whether this is by the same or different individuals (Bent 1938). In general, nest site fidelity is not strong, presumably because this species is nomadic. Roosts may be used year after year.

Home range

Although Short-eared Owls are territorial during the breeding season, they have been documented nesting close to one another in good habitat where prey is abundant (Johnsgard 1988). Densities of breeding pairs have been as high as 1 pair/5.5 ha (Holt and Leasure 1993). In Manitoba, mean size of five territories was 73.9 ha (Clark 1975). Territory size may decrease with increasing prey densities (Clark 1975).

In winter, this species is non-territorial, congregating where there is suitable habitat and a good prey supply. In British Columbia, roosts with up to 110 birds have been documented in the Fraser River delta (Campbell et al. 1990).

Dispersal and migration

In British Columbia, the Short-eared Owl is primarily a migratory species, with most individuals breeding in the Interior then moving southward in the fall. Populations in the northern breeding range of British Columbia begin fall migration in late October (Campbell et al. 1990). Some individuals, particularly in the Fraser River delta, are resident (Campbell et al. 1990; Sullivan 1992). It is possible that this species only migrates in search of food, and that more owls do not migrate in years when prey is abundant (Cadman 1994).

Habitat

Structural stage

Breeding

2–3 or old-growth field

Wintering

2–3a and old-growth field (multi-year crop rotation)

Important habitats and habitat features

Foraging

The Short-eared Owl requires ample, accessible prey near the nest site. Open areas with patchy vegetation provide suitable forage for small mammal prey species and opportunities for the owls to access their prey.

Nesting

Extensive open areas such as grasslands, savannahs, rangeland, or marshes with an abundant prey base, suitable nest sites, and adequate roosting sites are important breeding habitats (Cannings et al. 1987; Campbell et al. 1990). In British Columbia, most of the nests reported in Campbell et al. (1990) were found in shrubby, grassy fields adjacent to agricultural areas (e.g., pastures, fallow fields, and cultivated fields). Other sites, in order of frequency, included airport fields, marshes, open rangeland, sagebrush plains, and hayfields. In the Peace Lowlands (B.C.), uncultivated edges around wetlands are also used (M. Phinney, pers. comm.). Elsewhere, Short-eared Owls have been documented using newly cleared forests (Johnsgard 1988; Semenchuk 1992; Holt and Leasure 1993). Nests are usually situated on a raised, dry site within low, concealing vegetation (Holt and Leasure 1993).

Wintering

It is likely that the availability of suitable winter habitat with a sufficient prey base and adequate roost sites is the limiting factor for wintering populations in British Columbia (Butler and Campbell 1987; Campbell et al. 1990). Open areas such as marine foreshores, estuaries, marshes, grasslands, fallow fields, hay fields, pastures, airports, and golf courses are used by this owl (Cannings et al. 1987; Johnsgard 1988, Semenchuk 1992; Holt and Leasure 1993). In the Fraser River delta, Short-eared Owls have been reported to favour "old-field" habitat characterized by variable grass heights and shrub patches (Campbell et al. 1990; Searing and Cooper 1992; Sullivan 1992).

Prey abundance and accessibility are critical factors for wintering Short-eared Owls, both of which seem to be strongly linked with old-field habitat. In the Fraser River Valley, Townsend's Vole (*Microtus townsendii*) is the most abundant microtine and their highest densities are in old-field habitat. Small mammals also tend to be more accessible to owls in old-field habitat rather than in the uniform vegetation of cultivated fields (Cadman 1994).

Roosting

Winter roost sites must be close to hunting areas, provide protection from the weather and concealment from predators and mobbing birds, and be relatively free from human disturbance. This owl typically roosts on the ground within tall grass or shrubs, or in hedgerows (Holt and Leasure 1993). On Sea Island (British Columbia), roosts often occur in patches of Scotch broom (*Cytisus scoparius*). They will also roost in trees when snow depths exceed 5 cm (Johnsgard 1988).

Migration

Habitat requirements are probably similar to breeding season, although smaller open habitats may be used (Holt and Leasure 1993).

Conservation and Management

Status

The Short-eared Owl is on the provincial *Blue List* in British Columbia. It is considered a species of *Special Concern* in Canada (COSEWIC 2002). (See Summary of ABI status in BC and adjacent jurisdictions at bottom of page.)

Trends

Population trends

Population size and trends are difficult to assess because this owl is cyclic and nomadic, an unknown portion of the population nests in remote, unsurveyed regions, and even within easily accessible, known owl habitat, there has been a lack of consistent standardized census effort (Holt and Leasure 1993, Cadman 1994). Although these owls are occasionally active during the day, they are easily overlooked when roosting because they roost in heavy cover on the ground, and are usually well camouflaged. Estimating population size is further complicated by migration patterns because wintering, migrating and resident bird populations overlap (Cannings et al. 1987). During the breeding season, females are reluctant to flush off nests, making nests difficult to locate and breeding status difficult to determine (Holt and Leasure 1993).

At this time there is insufficient data to assess the overall population trend in British Columbia. However, Munro and Cowan (1947) suggested an apparent province-wide decline over the previous 15–20 years. In the Fraser River delta, evidence suggests that the local population has been in decline for the last few decades (Campbell et al. 1990). In addition, Christmas Bird Count data from the Lower Mainland show a steady reduction in peak number of Short-eared Owls from 1984 to 1990 (Campbell et al. 1990). In the 1960s, several hundred Short-eared Owls were banded on Sea Island (Campbell et al. 1990), but it is unlikely that the reduced amount of habitat on Sea Island today could support such numbers now.

Habitat trends

This species relies on winter habitat that has been significantly reduced and is further threatened (Tate 1986; Fraser et al. 1999). Habitat at lower elevations is undoubtedly less abundant than in the past. In the Southern Interior Mountains Ecoprovince, most low elevation grassland has been converted to agricultural lands and marshes have been drained. In the Central Interior Ecoprovince, and likely elsewhere (e.g., East Kootenay Trench ecosection), potential breeding and foraging habitat is being lost as grasslands are reduced by forest encroachment due to fire suppression (Hooper and Pitt 1995).

On the coast, estuarine marshes have been eliminated by industrial development and fallow fields have been converted to housing, industry or more intensive agricultural practices.

Threats

Population threats

As a ground nesting species, hazards to nests and nestlings include fire, flooding of marsh or coastal

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

BC	AK	CA	ID	MT	OR	WA	Canada	Global
S3B, S2N	S3N, S5B	S3	S5	S4	S4?	S4B, S4N	N4N, N5B	G5

habitat, farm machinery, and predators (Campbell et al. 1990; Cadman 1994). Mortality in adults has also been attributed to shooting; collisions with cars, aircraft, and other machinery; and entanglement with barbed wire and hip chain (Holt and Leasure 1993; Cadman 1994).

Elsewhere in North America, Short-eared Owls have been extirpated from areas that still contain apparently suitable habitat. Holt and Leasure (1993) speculate that mammalian predation of eggs and nestlings could be the cause. An increase in populations of feral cats and dogs or coyotes, in combination with urbanization, likely seriously impacts this species reproductive success. These factors may be influencing local breeding populations near Boundary Bay and on Sea Island as both areas are popular with dog owners, and coyotes are now established at both locations.

Habitat threats

In British Columbia, the primary threat to this species is loss or degradation of old-field winter habitat (Butler and Campbell 1987; Campbell et al. 1990). The Fraser River delta supports the largest winter population of Short-eared Owls in the province. However, this area has been, and continues to be, modified through urbanization and increasingly intensive agricultural practices (Campbell et al. 1990). Habitat loss leads directly to a reduction in food availability causing an increase in intra- and interspecific competition (e.g., with Northern Harriers). Ongoing loss and fragmentation of habitat make new prey supplies harder to find (Cadman 1994).

Although the Short-eared Owl's breeding range in British Columbia is more widespread than its winter range, loss of nesting habitat can have an impact on local populations. Nesting habitat is especially subject to pressure from urbanization and modern agricultural practices in the Fraser and Okanagan valleys (Campbell et al. 1990). In more remote areas, nesting habitat may be degraded from overgrazing by livestock, or nests may be destroyed by mowing of meadows for hay.

Legal Protection and Habitat Conservation

The Short-eared Owl, its nests, and its eggs are protected from direct persecution in British Columbia under the provincial *Wildlife Act*.

Breeding habitat in British Columbia is associated with agricultural areas in the lower Fraser River Valley, Okanagan Valley, Thompson, and Peace lowlands. Undoubtedly, these owls also breed locally in more remote areas as well. Although a small area of wintering and breeding habitat in the lower Fraser River Valley is protected in the Alaksen National Wildlife Area, Boundary Bay Reserves, and Centennial Park (all in Delta), most of the wintering habitat in the lower Fraser River Valley, Okanagan Valley and Thompson is on private land. Delta farmers (Delta Farmland and Wildlife Trust) have an old-field management program that they operate in co-operation with the Canadian Wildlife Service; this program may help provide suitable habitat for this species on private agricultural land. Conservation of habitat on Crown land may be partially addressed by range use guidelines.

Identified Wildlife Provisions

Wildlife habitat area

Goal

Maintain important habitat features (i.e., tall grass) at traditional winter, roosting, or nesting locations.

Feature

Although Short-eared Owls tend to be nomadic, they may traditionally use areas for breeding, roosting, or wintering. Establish WHAs at traditional communal (>8 owls) roosting sites, traditional nest, or winter areas.

Size

WHAs for traditional (used for several years) roost sites will generally be 5 ha and WHAs for traditional nest sites or wintering sites will generally be 10 ha but will depend on site-specific factors.

Design

The WHA is not intended to encompass the entire area used by the owls but rather is intended to maintain key areas used for nesting, roosting, or foraging. Where appropriate, centre WHA on the known nest or roost sites.

General wildlife measure

Goals

1. Minimize human and livestock disturbance to active winter roosts and nest sites.
2. Maintain important structural features. For example, maintain a range of mid-height to tall grasses with some low shrub cover for nesting.

Measures

Access

- Do not construct roads.

Pesticides

- Do not use pesticides.

Range

- Plan livestock grazing to maintain the desired structure of plant community (i.e., tall grass), desired stubble height and browse utilization. Establish a key area to monitor structure, height, and utilization. If damage from livestock is found to be degrading the vegetative structure, fencing may be required. Consult MWLAP for fencing arrangements.
- Maintain grass structure (i.e., 50 cm or depending on the site's potential).
- Delay burning or mowing until after the breeding season (1 August).

Additional Management Considerations

Where possible, control forest encroachment into natural grassland habitat with controlled prescribed burning or other methods. Use prescribed burning in forest clearings where Short-eared Owls are nesting. Burning should occur outside of the breeding season.

In agricultural areas:

- Increase percentage of fields left fallow within winter range.
- Leave patches of shrubs and hedgerows between fields.
- Minimize disturbance by people and dogs during critical times (i.e., April through May; December through February).
- Enhance habitat for voles and other microtines, wherever possible.
- Consider fencing high use areas or known nesting areas to protect from management activities such as haying.

Old-field habitat is usually on private land. Due to the importance of old-field winter habitat for this species, landowners should be encouraged to retain or rotate fields in such a way as to maintain as much of this habitat as possible. Fields known to be used by Short-eared Owls should be managed to minimize negative impacts of disturbance by humans, vehicular traffic, and domestic animals.

Grassland, marshes, rangeland, and estuaries suitable for Short-eared Owl winter or nesting habitat should have appropriate vegetation characteristics retained and should be protected from undue disturbance by human activities.

In grassland areas, meadows should not be burned or mowed until >1 August to protect eggs and unfledged young.

Maintain a mosaic of grassland and old field habitat in suitable condition to ensure a continued supply of nesting and wintering habitat.

Information Needs

1. Status of breeding and wintering localities.
2. Impacts of human recreational use of nesting areas on reproductive success.
3. Suitability of clearcuts for foraging and nesting habitat.

Cross References

Sandhill Crane

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Marbled Murrelet

Brachyramphus marmoratus

Original[1] prepared by Alan Burger

Species Information

Taxonomy

The Marbled Murrelet, *Brachyramphus marmoratus,* is a member of the auk family (Alcidae). No subspecies are recognized in North America (AOU 1997). Some intraspecific morphological and molecular variation has been found among populations of Marbled Murrelets (reviewed in Burger 2002). The small population in the western Aleutian Islands, Alaska, shows some genetic differences from the rest of the North American population, but samples from British Columbia, southeastern Alaska, Washington, and Oregon showed no consistent genetic differences or evidence of subspecies.

Description

Small seabird (length 24–25 cm; mass 190–270 g; Nelson 1997). There is no sexual size or colour dimorphism. Adults in breeding plumage have a marbled grey-brown plumage that provides good camouflage at nest sites. The non-breeding (basic) and juvenile plumages are black and white, typical of most seabirds.

Marbled Murrelets forage by diving, using its wings for underwater propulsion (Gaston and Jones 1998). Adaptations for this mode of foraging include increased flight muscles and reduced wing area, resulting in high wing-loading. The consequences are that Marbled Murrelets need to fly fast (generally more than 70 km/h), are not very maneuvrable in flight, and have difficulty landing and taking off. This in turn affects their choice of nest site and vulnerability to terrestrial predators (details below).

Distribution

Global

The Marbled Murrelet occurs from the Aleutian Islands, Alaska, along the southern coast of Alaska south to central California.

British Columbia

Murrelets are likely to be found anywhere along the coast of British Columbia within 30 km of the Pacific coast. A few birds venture farther inland, up to 80 km from the coast. At sea, they tend to remain within sheltered waters or within 500 m of exposed open coasts.

Forest regions and districts

Coast: Campbell River, Chilliwack, North Coast, North Island, Queen Charlotte Islands, South Island, Squamish, Sunshine Coast

Northern Interior: Kalum, Skeena Stikine

Ecoprovinces and ecosections

Terrestrial:

COM: CBR, EPR, HEL, KIR, MEM, NAB, NAR, NBR, NIM, NPR, NWC, NWL, OUF, QCL, SBR, SKP, SPR, WQC, WIM

GED: FRL, GEL, LIM, NAL, SGI, SOG

Marine:

COM: DIE, HES, QCS, QCT, VIS

GED: JDF

Biogeoclimatic units

CDF, CWH, MH

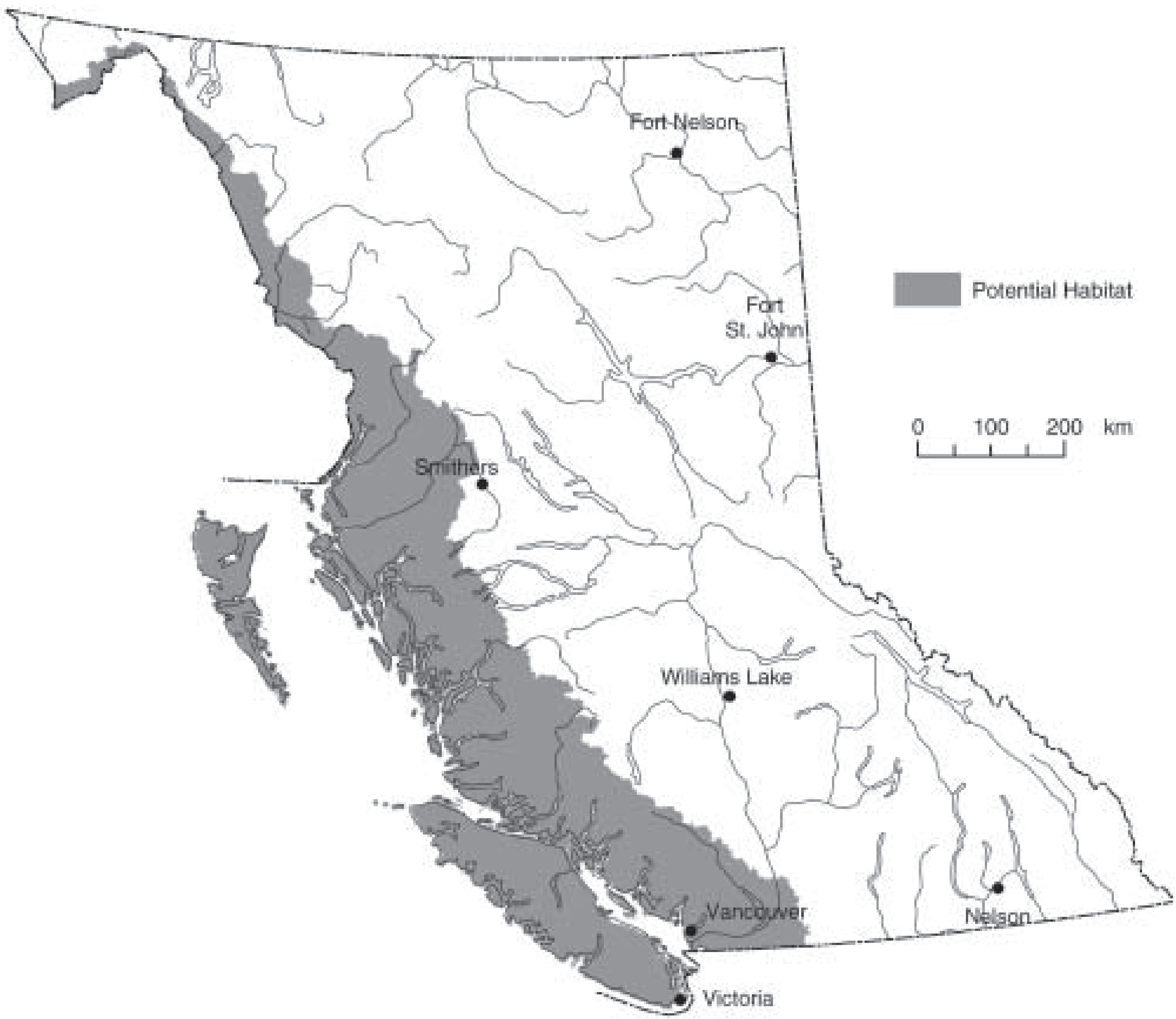
Broad ecosystem units

Terrestrial:

CD, CG, CH, CP, CS, CW, DA, FR, HB, HL, HS, MF, RR, SR, YM

1 Volume 1 account prepared by A. Derocher and others.

Marbled Murrelet
(Brachyramphus marmoratus)



Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on several ecosystem classifications (Ecoregion, Biogeoclimatic and Broad Ecosystem Inventory) as well as current knowledge of the species' habitat preferences. This species may or may not occur in all areas indicated. More detailed maps are available for this species from the Ministry of Sustainable Resource Management.

Aquatic:
ES, IM, LL, LS

Elevation

0–~1500 m (but see "Habitat" below for preferred elevations)

Life History

Diet and foraging behaviour

Murrelets eat small schooling fish (predominantly Pacific Sand Lance *Ammodytes hexapterus*, and immature Pacific Herring *Clupea harengus*), and large pelagic crustaceans (euphausiids, mysids, amphipods) (Burger 2002). In many areas the distribution, abundance, and movements of murrelets at sea seem closely linked to those of sand lance, especially during the murrelet's breeding season.

The Marbled Murrelet forages by diving, using its wings for underwater propulsion. Adaptations for this mode of foraging include increased flight muscles and reduced wing area (Gaston and Jones 1998). Most murrelets forage in relatively shallow water (<30 m deep), either in sheltered sea or within 500 m of exposed shores. They tend to avoid the centres of deep fjords and channels. Adults eat a range of prey types, but select a larger fish (e.g., mature sand lance) to carry back to the nestling. Proximity to good foraging sites is likely to influence selection of inland nest sites. Most nests were within 50 km of foraging sites, although breeding murrelets are known to commute 100 km or more to feed at prey concentrations (Whitworth et al. 2000; Hull et al. 2001; Burger 2002).

Reproduction

Reproduction and demography are reviewed in Ralph et al. (editors, 1995), Nelson (1997), and Burger (2002). Breeding probably begins at age 2–5 years, and the generation time was estimated to be about 10 years. Estimates of the proportion of mature adults in the population range from 55 to 95%, and are more likely near the upper part of this range. In common with most seabirds, murrelets have low reproductive recruitment (fecundity), balanced by high adult survival. Fecundity (number of female fledglings raised per female of breeding age) ranged from 0.17 to 0.22 from studies of nesting success and radio-telemetry, and was 0.13 based on adjusted counts of juveniles and adults at sea. Mark-recapture studies in Desolation Sound indicate local annual adult survival of 0.83–0.92 (Cam et al., in press).

The breeding season is prolonged (late-April through early September) and some failed breeders may lay a replacement egg (McFarlane Tranquilla 2001; Lougheed et al. 2002b). Most nests are on platforms (limbs or deformities >15 cm diameter) in old conifers (details below), but a few are on mossy cliff-ledges and one has been found in a deciduous tree (Burger 2002). The nest is a simple depression in the moss or duff. The clutch is a single egg. Both sexes incubate the egg and feed the chick. The incubation period is ~30 days and chicks fledge when 30–40 days old. Adults exchange incubation shifts and deliver most meals to the chick in dark twilight before dawn. Some meals are also delivered at dusk and a few in daylight hours. Chicks fledge by flying to the sea and are not attended by parents after fledging.

Site fidelity

Site fidelity is not well known, but evidence suggests that suitable stands will be repeatedly used for nesting (Manley 1999; Burger 2002; Simon Fraser Univ., unpubl. data). Nests and nest trees are generally not re-used in subsequent seasons, but a few radio-tagged birds returned to nest in different trees within the same stand. A few trees have been found with more than one nest from different seasons. One banded bird that bred in Desolation Sound, British Columbia, wintered in the San Juan Islands, Washington, but was re-captured in Desolation Sound in the following breeding season (Beauchamp et al. 1999). Watersheds generally support similar numbers of murrelets from year to year, but there might be some interannual movement by murrelets among adjacent watersheds (Burger 2001, 2002).

Home range

Most nests in British Columbia were within 30–50 km of marine capture sites (for radio-telemetry studies) and foraging aggregations (reviewed by Burger 2002). In some situations, such as nest sites inland of long, deep fjords, murrelets commute large distances (occasionally >100 km) to feed at prey concentrations. Murrelets show diurnal and seasonal movements among foraging sites, but often aggregate predictably at favoured sites. Unlike most other seabirds, murrelets are not colonial; nest sites appear to be scattered across suitable forest habitat. Some individuals breeding on Vancouver Island foraged in both Clayoquot Sound and the Strait of Georgia within the same season (Simon Fraser Univ., unpubl. data).

Movement and dispersal

Marbled Murrelets are somewhat migratory, and in many parts of British Columbia both adults and newly fledged juveniles tend to move away from breeding grounds at the end of the breeding season, from late July through September (Burger 2002; Lougheed et al. 2002a). A portion of the population often remains near the breeding grounds through winter. Beauchamp et al. (1999) provided the only proof of migration, between Desolation Sound and the San Juan Islands, Washington (see previous section). Other marked murrelets from Desolation Sound, however, seemed to remain there after breeding (Beauchamp et al. 1999). Migration between the breeding areas on the outer west coast of Vancouver Island to more sheltered wintering areas in the Strait of Georgia and Puget Sound seems to occur (Burger 2002).

Habitat

Structural stage

7: old forest (>250 yr – age class 9, but 8 is acceptable if older forest is not present and the age class 8 provides platform limbs and other nest attributes; see Tables 1 and 3 below).

Important habitats and habitat features

Nesting

In the *Conservation Assessment of Marbled Murrelets in British Columbia: A Review of the Biology, Populations, Habitat Associations, and Conservation*, suitable nesting habitat is defined as the habitat in which Marbled Murrelets nesting in British Columbia are likely to nest successfully. In general, suitable habitat is old seral stage coniferous forest, providing large trees with suitable platforms (limbs or deformities >15 cm diameter), and a variable canopy structure allowing access to the platforms. More detailed descriptions of the tree and stand attributes are given below. Some Marbled Murrelet nests in British Columbia have been found in habitat that differs somewhat from the defined suitable habitat (e.g., cliffs, a deciduous tree, isolated veterans in stunted stands), but inclusion of all the possible habitat types likely to be used by murrelets becomes unworkable. This account focuses on forest habitat most likely to be occupied by nesting murrelets.

Over 200 nests have been found in British Columbia, with the vast majority in old conifers (Nelson 1997; Burger 2002; Simon Fraser Univ., unpubl. data). About 3% of nests found in Desolation Sound were on mossy cliff-ledges (Bradley and Cooke 2001), and similar sites have been found near Clayoquot Sound. One Desolation Sound nest was in a large red alder (*Alnus rubra)* (Bradley and Cooke 2001). Most B.C. nests were found in yellow-cedar (*Chamaecyparis nootkatensis*), western hemlock (*Tsuga heterophylla*), Sitka spruce (*Picea sitchensis*), Douglas-fir (*Pseudotsuga menziesii*), and western redcedar (*Thuja plicata*), with fewer in mountain hemlock (*Tsuga mertensiana*) and amabilis fir (*Abies amabilis)* (Burger 2002). It is unlikely that murrelets select particular tree species, but certain species are more likely to provide large horizontal platforms suitable for nesting, and this varies regionally and with elevation.

Microhabitat requirements for Marbled Murrelet nest sites are summarized in Table 1. The first four conditions are commonly found in dominant old forest trees which explains the overwhelming majority of nests in such trees. Most nest trees in British Columbia were >200 years old (Burger 2002). In Oregon, a few nests have been found in younger western hemlock trees deformed by mistletoe (Nelson 1997), but no nests have been found in such sites in British Columbia.

Two studies in British Columbia compared forest patches containing nests with adjacent randomly selected patches. Manley (1999) found that nest patches had significantly more large trees (>60 cm diameter) and more trees with platforms (limbs with diameter >15 cm including epiphytes) than random patches. Waterhouse et al. (2002) found that forest polygons with murrelet nests were significantly older, and had taller trees, larger mean basal area, and greater vertical complexity than adjacent randomly selected treed polygons. Numerous other studies involving audiovisual surveys, vegetation analysis, tree climbing, and radio-telemetry have confirmed the association of nesting murrelets with a combination of large old trees, availability of large moss-covered limbs providing nest platforms, and variable canopy structure with gaps providing access to the platform limbs (Burger 2002).

In British Columbia, murrelet nests have been found from sea level to about 1500 m in elevation (Nelson 1997; Burger 2002). Among 138 nests found by telemetry in British Columbia, 84% were found below 1000 m, and there was a rapid drop-off in nests with increasing elevation above 1000 m (Burger 2002; Simon Fraser Univ., unpubl. data). Where low elevation forests with suitable nesting habitat were still plentiful, 64% of nests were below 600 m, and 93% were below 900 m (n = 55 telemetry nests). In Desolation Sound nesting success increased with increasing elevation, which was probably due to reduced densities of predators at higher elevations (Bradley 2002). There are no comparative studies of nest success versus elevation from elsewhere. In contrast, audiovisual surveys showed declining evidence of stand occupancy by murrelets with increasing elevation, and stand level and micro-habitat features important for nesting (e.g., large trees, presence of potential platform limbs, and epiphyte cover on branches) usually declined with increasing elevation (Burger 2002). In general, preferred nesting habitat in British Columbia is likely to be found at 0–900 m elevation

Table 1. Key microhabitat characteristics for Marbled Murrelets nest site in British Columbia (for more details see Hamer and Nelson 1995; Nelson 1997; Burger 2002)

Murrelet requirements	Key habitat attributes
Sufficient height to allow stall-landings and jump-off departures	Nest trees are typically >40 m tall (range 15–80 m), and nest heights are typically >30 m (range 11–54 m); nest trees are often larger than the stand average.
Openings in the canopy for unobstructed flight access	Small gaps in the canopy are typically found next to nest trees, and vertical complexity of the canopy is higher in stands with nests than in other nearby stands.
Sufficient platform diameter to provide a nest site and landing pad	Nests are typically on large branches or branches with deformities, usually with added moss cover; nest limbs range from 15 to 74 cm in diameter; nests typically located within 1 m of the vertical tree trunk.
Soft substrate to provide a nest cup	Moss and other epiphytes provide thick pads at most nest sites, but duff and leaf litter are used in drier areas.
Overhead cover to provide shelter and reduce detection by predators	Most nests are overhung by branches.

(perhaps 0–600 m in watersheds with more intact old stands), with less suitable conditions at 900–1500 m, and areas above 1500 m are unlikely to be used. In all cases elevation should not be the sole criterion for establishing suitability, and evidence of nesting, occupancy, and/or suitable habitat (e.g., potential nest platforms) is needed for establishing habitat suitability.

Marbled Murrelets readily nest on steep slopes, and many nests found with telemetry were on steep slopes (30–70°) (Burger 2002; Simon Fraser Univ., unpubl. data). In Desolation Sound, nest success was positively correlated with slope (Bradley 2002). Slopes appear to enhance access to nest sites in tree canopies and perhaps reduce predation risk.

Steep slopes are not essential for nesting if forest canopies are non-uniform with small gaps, as typically found in old forest stands. Several studies showed negative or neutral effects of slope on rates of occupied detections and measures of nest habitat quality (Burger 2002). Slope should be treated as a neutral variable in habitat management; suitable habitat is selected regardless of slope. Aspect does not appear to have a strong effect on the placement or success of nests, although south-facing slopes in drier areas appear to have fewer mossy platforms than other aspects (Burger 2002).

Foraging

Marbled Murrelets forage at sea. Important habitats include shallow nearshore and sheltered waters, especially those known to support foraging aggregations, concentrations of prey schools, or marine habitats likely to support prey (e.g., the sand and gravel subtidal substrates in which sand lance bury themselves). It is important to maintain inland breeding habitat associated with known concentrations of murrelets at sea (MMRT 2003).

Wintering

Marbled Murrelets winter at sea. Important habitats are as described for foraging, but are generally more sheltered than those used in summer.

Conservation and Management

Status

The Marbled Murrelet is on the *Red List* in British Columbia. It is designated as *Threatened* in Canada (COSEWIC 2002).

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

AK	BC	CA	OR	WA	Canada	Global
S2S3	S2B, S4N	S1	S2	S3	N2	G3G4

Trends

Population trends

The population in 2002 was estimated to be 54 700–77 700 birds of all ages (median 66 000 birds, or 56 000 adults if 85% are mature adults) based on extrapolations from radar and at-sea counts (Burger 2002). Large parts of the range have no counts and there is considerable uncertainty around these population estimates. There are few long-term data to assess population trends, but most data and anecdotal accounts indicate declining populations in some parts of British Columbia, especially in eastern Vancouver Island and the southern mainland (Burger 2002). At-sea surveys in Clayoquot and Barkley sounds on the west of Vancouver Island indicate declines of 20–40% between 1979 and1982 and the mid-1990s, but these trends are complicated by negative responses by murrelets to unusually warm oceans in the 1990s and by the variability in at-sea census data (Burger 2002).

Habitat trends

Accurate assessments of the amount of nesting habitat lost to industrial logging are not yet available, because of the difficulties in defining suitable habitat and mapping such habitat across coastal British Columbia. Preliminary mapping by the B.C. Ministry of Forests and by Demarchi and Button

(2001a, 2001b; see Burger 2002) suggests that the amount of potential (capable) murrelet habitat lost by 2000, since the onset of industrial logging, was in the order of 35–49%. Large declines in capable habitat were evident in the following former forest districts: Port Alberni, Campbell River, Duncan, Port McNeill, and Sunshine Coast (Demarchi and Button 2001a, 2001b). The reduction of habitat within the Georgia Depression (southeast Vancouver Island and the southern mainland) is of particular concern (Kaiser et al. 1994; MMRT 2003).

Threats

Population threats

Demographic models indicate that murrelet populations are most sensitive to adult survival, followed by survival of immatures and then fecundity (Beissinger and Nur 1997; Cam et al., in press). The most likely direct threats to adults are from oil spills and entanglement in fishing gear (Burger 2002). Predation of adults (at sea and inland) and disturbance at foraging areas due to boat traffic and aquaculture have also been identified as threats, but their effects are not known (Burger 2002).

Habitat threats

Reduced recruitment due to loss of nesting habitat is widely accepted as the major threat throughout the species' range (Ralph et al. 1995; Nelson 1997; Hull 1999). Radar studies in five regions of British Columbia show significant correlations between numbers of murrelets and existing areas of apparently suitable nesting habitat (Burger 2002). In addition, a radar study in Clayoquot Sound showed reduced populations in watersheds subjected to intensive logging and concluded that murrelets did not pack into remaining old forest patches in higher densities (Burger 2001). For these reasons, breeding populations of murrelets are expected to decline as areas of suitable nesting habitat decrease. The effects on murrelets of habitat fragmentation and creation of forest edges by clearcut logging are less clear.

Populations of murrelets seem more dependent on the area and quality of available nesting habitat than on the size and shape of habitat patches and edge-effects. Risk modelling suggested that edge effects were clearly secondary (but not trivial) to amount and quality of nesting habitat in determining population persistence in British Columbia (Steventon et al., in press). The effects of small patches, forest edges, and fragmentation of habitat on nesting Marbled Murrelets are still unclear, and field data are somewhat contradictory (Burger 2002). Reduced nest success within 50 m of forest edges, attributed to increased predation risk, was reported in one range-wide review (Manley and Nelson 1999). In contrast, nests in Desolation Sound located by telemetry showed no difference in success between edge and interior sites, perhaps because nests proximal to edges predominated at higher altitudes where predation was less prevalent (Bradley 2002). Some common nest predators, such as Steller's Jay (*Cyanocitta stelleri*), favour forest edges bordering clearcuts and roads (Masselink 2001), but a comprehensive study on the Olympic Peninsula, Washington, showed that many potential predators of murrelet nests were not edge-loving species and that other factors affected predation risk, notably proximity to human activities (attracting corvids) and successional stage of vegetation bordering old forest edges (Raphael et al. 2002). Loss of habitat through windthrow along forest edges and roads, and changes to canopy microclimates near forest edges are also likely (Burger 2002). Altered microclimates might affect nesting murrelets directly through thermal stress, or indirectly through removal or inhibition of epiphyte mats used as nest substrates, but there are no field data to test these hypotheses. Edge effects are most likely to occur at "hard" edges, defined as old forest (>250 yr) bordered by clearcuts or young regenerating forest <40 years old, and any negative effects are likely to be greatest within 50 m of such edges (Burger 2002).

The effects of roads on murrelets and their nesting habitat have not been fully investigated. Roads potentially create both benefits (enhanced access to canopy platforms) and risks (attracting predators such as ravens and jays, increasing windthrow, and altering canopy microclimates).

Five radar studies in British Columbia and one on the Olympic Peninsula, Washington, showed significant positive correlations between numbers of murrelets and areas of large-tree old seral habitat per watershed (Burger 2002). These data indicate that watershed populations of Marbled Murrelets are directly proportional to the areas of nesting habitat available. Densities (murrelets per area of habitat) were significantly higher on the west coast of Vancouver Island (0.082 ± 0.034 SD birds per ha) than on the B.C. mainland coast (0.028 ± 0.019 birds per ha) when the habitat classified as *good* was considered in each study (Burger 2002). The underlying cause of this regional difference is not known.

Risk modelling of B.C. populations indicated that the certainty of population outcome was affected by management choices of how much and what type of old forest to maintain (Steventon et al., in press). The modelling also indicated that rate of decline of nesting habitat had little influence on long-term population outcome, but the eventual nesting capacity (area and quality of habitat) when it did stabilize was important.

Legal Protection and Habitat Conservation

Marbled Murrelets and their nests and eggs are protected from direct persecution under the Canadian *Migratory Birds Convention Act*, *1994*, and the provincial *Wildlife Act* (Section 34). As a federally listed species the Marbled Murrelet will come under the jurisdiction of the *Species at Risk Act* (SARA).

Several protected areas are important for the conservation of the Marbled Murrelet including Carmanah-Walbran Provincial Park, Pacific Rim National Park, Strathcona Provincial Park and other coastal protected areas in Clayoquot Sound, Gwaii Haanas National Park Reserve, and several of the larger protected areas on the central mainland coast. Smaller areas of habitat in the water-supply catchments for the cities of Vancouver and Victoria are also important, because surrounding habitat areas have been greatly depleted.

Marbled Murrelets were listed as *Threatened* by the Committee on Status of Endangered Wildlife in Canada (COSEWIC) in 1990. The Marbled Murrelet Recovery Team published the first Recovery Plan (Kaiser et al. 1994), which focused on data gaps and research priorities. Following a second review (Hull 1999), the Threatened status was confirmed in 2000, primarily on the basis of low reproductive rate and continued evidence of declining nesting habitat (D. Fraser, pers. comm.). A revised recovery strategy and action plan are being drafted by the recovery team, based upon the 2001–2002 Conservation Assessment (Hooper 2001; Burger 2002; Steventon et al., in press). The main conservation and management points have already been identified (MMRT 2003).

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

Over the last two years, the provincial ministries and the national Marbled Murrelet Recovery Team (MMRT) have collaborated on a conservation assessment of the Marble Murrelet. Part A[2] of the assessment has recently been published, Part B[3] has been released by the MMRT, and Part C[4] is in press. These documents incorporate the latest science on this species and represent the consensus of the multi-stakeholder MMRT, which has members from government, industry, academia, and ENGOs. The conservation assessment documents will be used by the MMRT in preparing a Recovery Strategy for the

2 Burger, A.E. 2002. Conservation assessment of Marbled Murrelets in British Columbia: a review of the biology, populations, habitat associations and conservation. CWS, Pacific and Yukon Region, British Columbia. Tech. Rep. Ser. No. 387.

3 Canadian Marbled Murrelet Recovery Team. 2003. Marbled Murrelet Conservation Assessment 2003, Part B: Marbled Murrelet Recovery Team Advisory Document on Conservation and Management. Canadian Marbled Murrelet Recovery Team Working Document No. 1.

4 Steventon, D. *et al*. In press. Analysis of Long-term Risks to Regional Marbled Murrelet *(Brachyramphus marmoratus)* Populations Under Alternative Forest Management Policies on Coastal British Columbia.

species as required under the federal *Species At Risk Act*. The completed Recovery Strategy is expected by March 2004.

The conclusions and recommendations contained in Parts B and C of the Conservation Assessment have not been adopted as government policy. Therefore, until there is a new government decision on the management of Marbled Murrelet, government agencies (MSRM, MOF and MWLAP) will continue to work with industry to develop Marbled Murrelet WHAs through policies established since 1999 regarding WHA impacts; that is, overlapping WHAs with old growth management areas (OGMAs) through landscape unit planning and with other constrained areas such as ungulate winter ranges and visual resource management areas, use of a portion of the IWMS one percent timber supply impact cap on the timber harvesting land base (THLB), and establishment of other WHAs on the non-contributing land base (NCLB). Part B of the Conservation Assessment can be consulted for information on the suitable size and characteristics (shape, habitat suitability) of individual WHAs, but the amount of habitat to be established as WHAs remains constrained by existing policy. This direction applies to all areas where WHA establishment is taking place unless new objectives are approved by government.

Forest licensees are encouraged to continue working with agency staff to propose WHAs in accordance with the current policy direction. It is also recognized that, under the *Forest and Range Practices Act*, licensees will have the option of proposing alternative strategies for managing Marbled Murrelet habitat.

Three of the Marbled Murrelet conservation regions identified by the Conservation Assessment – the Central Mainland Coast, the Northern Mainland Coast and the Queen Charlotte Islands) – fall under strategic land use planning exercises (SLUPs). While the current policy direction on Marbled Murrelet habitat applies to all areas in the species' range, it is not intended to impede, delay, or constrain negotiations or forthcoming recommendations of the three coastal SLUPS.

Table 2. Estimates of current (2002) populations of Marbled Murrelets in each conservation region, and Marbled Murrelet Recovery Team recommendations for maximum declines in population and habitat per region by 2032, assuming a decline of no more than 30% in population size and habitat area for all of British Columbia, and having less reduction in regions already thought to have depleted populations (MMRT 2003)

Conservation region	Estimated population in 2002 (birds)[a]	Maximum allowable decline of population and habitat[b] by 2032 (%)
West & North Vancouver Island	19 400–24 500	31
East Vancouver Island[c]	700–1 000	0–10
Southern Mainland Coast	6 000–7 000	15
Central Mainland Coast	10 000–21 000	31
Northern Mainland Coast	10 100–14 600	31
Haida Gwaii (QCI)	8 500–9 500	31
Total for British Columbia	**54 700–77 600**	**30**

a Range indicates the pessimistic and optimistic population estimates. Population estimates are made using birds and not breeding pairs or nests because the at-sea and radar counts used to derive population estimates do not distinguish between breeding and non-breeding birds. Birds are therefore the unit of population measure throughout this account.

b Note that a small proportion of nesting birds may breed outside areas of habitat that are able to be identified through air photo interpretation or helicopter surveys (L. Waterhouse, pers. comm.).

c The Marbled Murrelet Recovery Team (2003) recommended that, if possible, no further habitat reduction should occur in this region, and if that was not possible then the population should decline by no more than 10% in 2002–2032.

Wildlife habitat area

Because of the unique nature of Marbled Murrelet management direction in British Columbia (i.e., historical reliance primarily on OGMAs for establishing WHAs to protect nesting habitat), the following paragraph is provided as context for Marbled Murrelet WHA development.

To the degree possible within government policy direction limiting impacts on timber supply, areas of suitable Marbled Murrelet habitat (Table 3) should be maintained and protected, in combination with other constrained areas, to achieve the habitat objectives of Table 2 and the spatial distribution recommended for each conservation region by the Marbled Murrelet Recovery Team (MMRT 2003). When calculating total areas of maintained habitat in each conservation region or landscape unit, apply the same habitat selection criteria to protected and to non-protected areas.

Goal

Maintain suitable Marbled Murrelet nesting habitat (Table 3).

Features

Establish WHAs in suitable Marbled Murrelet nesting habitat, as defined in Table 3 and the text below. *Each habitat feature should not be used in isolation but in combination with others to ensure selection of suitable habitat.* Ideally WHAs should be established in habitats identified as "Most Likely" to contain suitable features. Habitat rated as "Moderately Likely" may be considered for WHAs but will require confirmation as suitable habitat using approved methods of ground or helicopter surveys. Areas rated as "Least Likely" should only be considered if there is evidence of nesting (nests, eggshells, or occupied detections), or strong evidence that the particular site provides the necessary microhabitat attributes (Table 1), such as platform limbs (>15 cm diameter including epiphytes) and variable canopy structure, and is within commuting distance of likely foraging areas at sea.

The CWH and CDF biogeoclimatic zones are preferred over MH (Burger 2002). Fine-scale biogeoclimatic attributes are best applied through selection of site index productivity classes (Green and Klinka 1994). Stands classified as age class 8 (140–250 yr) might provide suitable habitat but this needs to be confirmed through ground truthing; stands of age class 7 or less (<140 yr) are unlikely to provide suitable habitat, unless there are suitable old seral veteran trees or other trees with suitable platforms present. Most nests have been found in height class 5 or larger (>37 m tall), but smaller trees can provide suitable habitat especially in higher elevations and latitudes. Height classes on forest cover maps generally reflect average conditions in a polygon and might not be accurate for all parts of a polygon. Some multi-layered polygons with low height class ratings (e.g., class 2 with a veteran layer) might provide suitable trees, but these need to be confirmed by field assessments before accepting such polygons as suitable habitat.

Canopy vertical complexity is an important habitat attribute and is generally a better predictor of suitable habitat than crown closure. Aerial photographs can be used to assess and rank vertical complexity. Slope should be regarded as a neutral feature at the landscape scale, but topographic variability provided by slopes, small rock outcrops, avalanche chutes, gullies, riparian zones, and small ridges are hypothesized to improve forest value as nest habitat by breaking up the continuity of the forest canopy and improving access to the canopy for murrelets.

Aspect, moisture regimes, and exposure to wind and sea-spray need to be considered if there is evidence that these affect the availability of nesting platforms by inhibiting moss development on tree limbs.

Size

Within managed forests, maintain a balanced range of patch sizes. Patch size composition will vary depending on the existing habitat options. Until the effects of patch size are better understood, the Recovery Team recommends maintaining a mix of large (>200 ha), medium (50–200 ha), and small (<50 ha) patches within managed forests.

Table 3. Features of Marbled Murrelet nesting habitat to consider during selection and design of WHAs and other maintained habitat patches. The features are grouped by the likelihood that polygons with these features will contain a large proportion of suitable nesting habitat. Additional features are described in the text. Features should not be used in isolation but in combination with other features.

Feature	Most likely	Moderately likely	Least likely
Distance from saltwater (km): all regions	0.5–30	0–0.5 & 30–50	>50
Elevation (m):			
Central & Northern Mainland Coast	0–600	600–900	>900
Haida Gwaii (QCI)	0–500	500–800	>800
All other regions	0–900	900–1500	>1500
Stand age class: all regions	9 (>250 yr)	8 (140–250 yr)	<8 (<140 yr)
Site index productivity classes: all regions [a]	Class I & II (site index 20+)	Class III (site index 15–19)	Class IV (site index <15)
Tree height class: all regions[b]	4–7 (>28.5 m)	3 (19.5–28.4 m)	<3 (<19.5 m)
Canopy closure class: all regions	Classes 4, 5, & 6	Classes 3 & 7	Classes 2 & 8
Vertical canopy complexity: all regions[c]	MU, NU, & VNU	U	VU

a Productivity classes as defined in Green and Klinka (1994, p. 197); approximate 50-year site index values also given – application of these indices might vary with different tree species and across regions.

b Nests have been found in polygons ranked height class 1 or 2 but the nests were in larger trees than the polygon average.

c Vertical complexity ranked from least to highest (see Waterhouse et al. 2002). VU = very uniform (<11% height difference leading trees and average canopy, no evidence of canopy gaps or recent disturbance). U = uniform (11–20% height difference, few canopy gaps visible, little or no evidence of disturbance. MU = moderately uniform (21–30% height difference, some canopy gaps visible, evidence of past disturbance, stocking may be patchy or irregular. NU = non-uniform (31–40% height difference, canopy gaps often visible due to past disturbance, stocking typically patchy or irregular). VNU = very non-uniform (>40% difference, very irregular canopy, stocking very patchy or irregular).

Design

Where possible, follow the steps in Table 4 for selecting nesting habitat for WHAs.

As much as possible, minimize edge effects in WHAs by avoiding elongated or amoeboid shapes with large "hard" edges (defined above), and by establishing WHA boundaries along natural forest edges or with buffers of older second growth. Maintain windfirm boundaries to WHAs (Stathers et al. 1994) but minimize edge-feathering and topping that might remove potential nesting habitat. WHAs bordered entirely by natural edges (e.g., between avalanche chutes or rivers) need not be restricted by shape or size.

Wherever possible buffer the effects of roads, clearcuts, human communities, logging camps, and recreation sites, by leaving borders of maturing forest (>40 yr) around the old seral nesting habitat.

If there has to be a trade-off between maintaining suitable nesting habitat for WHAs or maintaining maturing buffer zones around WHAs, select the nesting habitat. An exception might be made if there is strong evidence that the buffer zone will mature into old forest with more favourable attributes as nesting habitat than other existing old forest available for WHAs in the same landscape unit cluster.

Forests within 0.5 km of shores that are exposed to open ocean or have high densities of shoreline predators (e.g., corvids) are generally considered less suitable habitat (Burger 2002), but they should be included within a WHA to buffer against wind and sea spray.

General wildlife measures

Goals

1. Maintain important habitat features such as adequate large trees providing suitable nest platforms and vertical canopy complexity.
2. Minimize activities and habitat modifications that might attract predators (e.g., recreational sites may attract nest predators, such as crows, ravens, jays, or squirrels).
3. Minimize "hard edges" (defined in "Habitat threats" section) that might attract edge predators, allow windthrow, or adversely affect canopy microclimates.
4. Minimize disturbance to nesting birds during the breeding season (late-April through early September).

Measures

Access

- Do not construct or widen roads unless there is no other practicable option.

Harvesting and silviculture

- Do not harvest except for salvage.

Pesticides

- Do not use pesticides.

Recreation

- Do not develop recreational structures, trails, or facilities.

Table 4. Recommended steps in selecting WHAs and other maintained nesting habitat for Marbled Murrelets

Goals for each step	Tools and procedures
1. Identify habitat polygons to be considered for WHAs and other maintained nesting habitat	Apply regionally specific habitat algorithms and recognized habitat indicators (see Tables 1 and 3, and associated text) to forest cover maps, or similar recognized GIS databases. See also strategic planning section above.
2. Assess and rank the polygons based on evidence of suitable canopy structure and stand features.	Air photo interpretation (Donaldson, in press), focusing on vertical complexity, tree height, stand age, and other regionally relevant parameters in Tables 1 and 3.
3. Confirm that the ranked polygons are suitable habitat	One or more of the following:(a) evidence of nesting (nests, eggshells); (b) evidence of stand occupancy using audio-visual surveys (RIC 2001); (c) evidence of suitable microhabitat features (Table 1) using ground transects or plots (RIC 2001); (d) evidence of suitable microhabitat features (Table 1) from low-level helicopter surveys (Burger et al., in press).
4. Select among the polygons classified as suitable habitat sufficient to meet the area requirements for the specific landscape unit, landscape unit cluster, or other management unit under consideration.	Maintained habitat can be a combination of polygons classified as Most Likely or Moderately Likely that is confirmed to have nesting, occupancy or suitable habitat. Polygons ranked Least Likely should only be included if there is recent evidence of murrelet nests or occupancy by murrelets likely to be breeding, or strong evidence of suitable canopy attributes within commuting distance of marine feeding sites.

Additional Management Considerations

Partial retention harvesting should not be undertaken in WHAs until its effects on murrelets are known.

Information Needs

1. Criteria and methods for identifying and mapping suitable nesting habitat need to be refined. Standard protocols for using aerial photographs and low-level helicopter reconnaissance to identify suitable habitat need to be confirmed.
2. The distribution and area of suitable habitat across coastal British Columbia need to be accurately mapped.
3. Better information is needed on the size, distribution, and habitat use of regional populations to refine habitat requirements in each conservation region.
4. The effects of forest edges and patch size on nest-site selection and breeding success need to be measured in a wide range of habitats.
5. The effects of partial retention harvesting and roads on nesting Marbled Murrelets need to be investigated.

Refer to the Marbled Murrelet Recovery Team for updates on research priorities.

Cross References

Great Blue Heron, Grizzly Bear, Keen's Long-eared Myotis, "Queen Charlotte" Goshawk, "Queen Charlotte" Northern Saw-whet Owl

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Bay-breasted Warbler

Dendroica castanea

Original prepared by John M. Cooper and Suzanne M. Beauchesne

Species Information

Taxonomy

The Bay-breasted Warbler is a neotropical migrant songbird. It is one of 12 species of warbler in the genus *Dendroica* that breed in British Columbia (Campbell et al. 2001). No subspecies are recognized (AOU 1957; Cannings 1998). It seems to be closely related to the Blackpoll Warbler (*Dendroica striata*), with which it overlaps in range, as there have been three records of hybridization (Williams 1996).

Description

A small songbird about 14 cm in length. In breeding plumage, the male has a black face; chestnut crown, throat, and sides; cream-coloured patch on the sides of the neck; a cream-coloured belly; and two bold white wing stripes contrasting with the otherwise dark olive, streaked upperparts. The female is similar in pattern but is significantly duller in colour. In the fall, adult males, females, and young of year have olive green upperparts with two white wing bars and dull yellowish underparts.

Distribution

Global

The Bay-breasted Warbler breeds from the southeastern Yukon, southwestern Mackenzie and northeastern British Columbia, across Canada throughout the boreal forest to southwestern Newfoundland, and south into the United States from northern Minnesota east to Maine. This species winters mainly in the Panama as well as south into northern Colombia and western Venezuela (AOU 1983; Campbell et al. 2001).

British Columbia

In British Columbia, Bay-breasted Warblers have been reported primarily in the Taiga Plains and Boreal Plains ecoprovinces, from near Kwokullie Lake and along the Liard River, at Mile 513 of the Alaska Highway, south through Moberly and One Island lakes (Cooper et al. 1997). Extralimital records include Tetana Lake, Yoho National Park, and Indianpoint Lake (Godfrey 1986), and west end of Williston Lake (Price 1993).

Forest regions and districts

Northern Interior: Fort Nelson, Peace

Ecoprovinces and ecosections

TAP: ETP, FNL
BOP: HAP, KIP, PEL
NBM: HYH, LIP

Biogeoclimatic units

BWBS: mw1, mw2

Broad ecosystem units

BA, PR

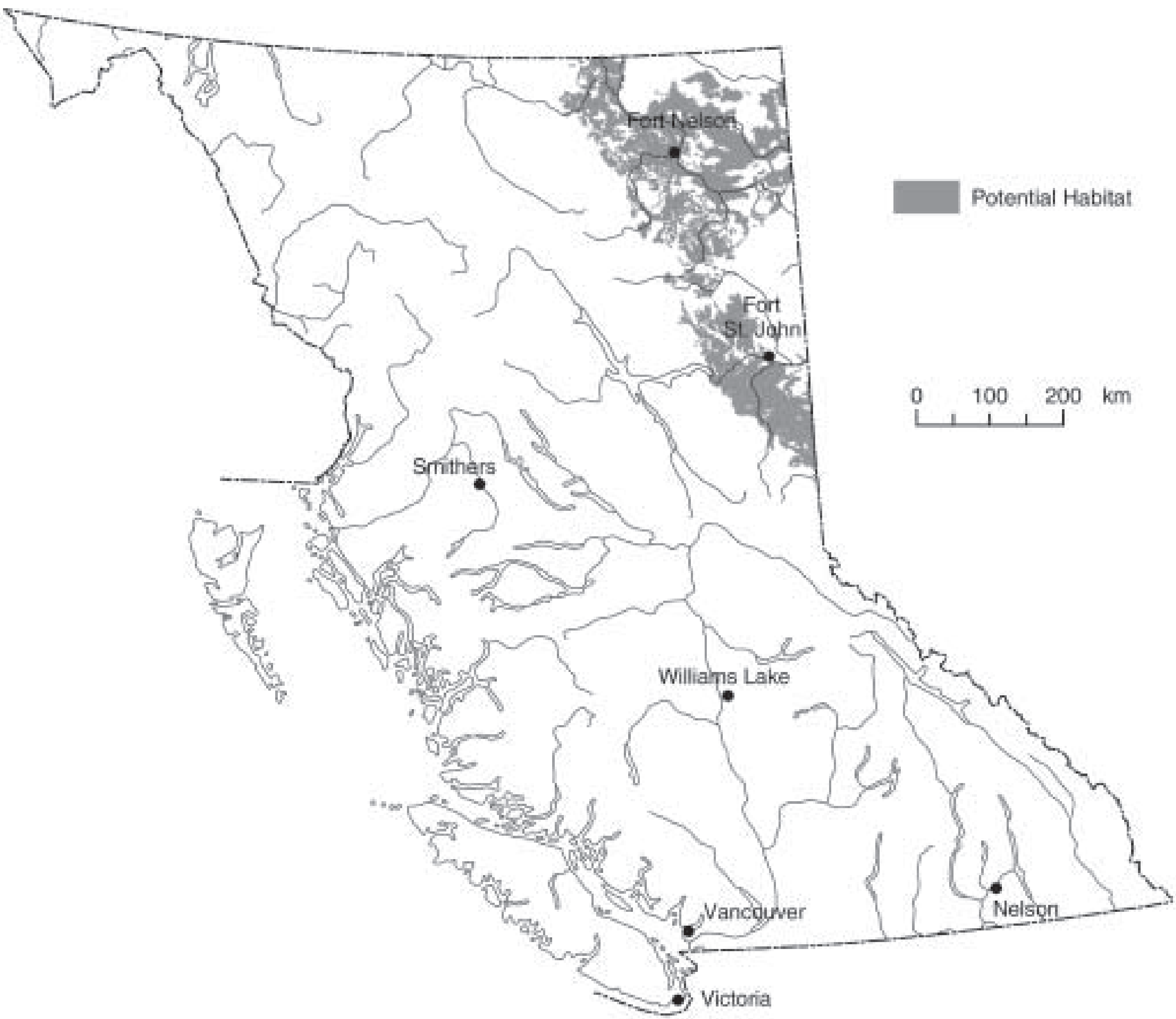
Elevation

230–760 m (Bennett and Enns 1996; Campbell et al. 2001)

Life History

Very little is known about the ecology of the Bay-breasted Warbler in British Columbia, therefore most of the following information is inferred from studies in other areas.

Bay-breasted Warbler
(Dendroica castanea)



Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on several ecosystem classifications (Ecoregion, Biogeoclimatic and Broad Ecosystem Inventory) as well as current knowledge of the species' habitat preferences. This species may or may not occur in all areas indicated.

Diet and foraging behaviour

During the breeding season, the Bay-breasted Warbler is a specialized forager, spending most of its time in the shady, interior branches of the middle and upper coniferous canopy (Bent 1953; MacArthur 1958). Morse (1978) also noted Bay-breasted Warblers in deciduous habitats, foraging at medium to medium-low heights. Its diet is mainly insectivorous, composed of a variety of adult and larval insects, spiders, and spider and insect eggs (Bent 1953; MacArthur 1958; Sealy 1979; Morse 1980). Lepidopteran larvae (e.g., spruce budworms) are the primary food source during the breeding season (Morse 1978). The diet switches to mainly fruit during the winter in the tropics when insects are scarce (Rappole 1995; Williams 1996).

Reproduction

The Bay-breasted Warbler is probably seasonally monogamous although mate-switching is possible (Sealy 1979; Williams 1996). Upon arriving on the breeding grounds, males select nesting territories, defending them from conspecific males. The female builds the nest with some assistance from the male (Baicich and Harrison 1997). Clutch size ranges from three to seven eggs and is strongly influenced by food supply with larger clutches (six or seven eggs) typical during periods of high food abundance (Bent 1953; Morse 1978; 1989; Peck and James 1987). In northeastern British Columbia, egg laying probably begins in mid-June (Campbell et al. 2001). Eggs are incubated by the female for 12–13 days, nestlings fledge after 10–12 days, and both parents continue to feed young for several days, post-fledging (Bent 1953; Baicich and Harrison 1997). A single brood is likely raised annually in British Columbia, as is usual for neotropical migrants (Morse 1989).

Site fidelity

Bay-breasted Warblers respond to budworm out-breaks and may become super-abundant during infestations and then decline or disappear entirely from area within a few years after the outbreak (Morse 1980). Thus, site fidelity is likely low, lasting roughly as long as the outbreak period.

Home range/territory size

There are no data for nesting territory size or breeding density in British Columbia, but this warbler is one of the least abundant warblers in British Columbia (Cooper et al. 1997). Elsewhere, most density data are for periods of budworm outbreak, including one study in Ontario, where densities of up to 230 pairs/km^2 were recorded (Williams 1996).

Dispersal and movements

Spring migrants enter northeastern British Columbia through Alberta and begin arriving in mid- to late May, with the majority probably arriving in late May and early June (Pinel et al. 1993).

After nesting is completed, adults probably begin to migrate south in mid- to late July, followed by juveniles through August (Salt 1973; Pinel et al. 1993).

Habitat

Structural stage[1]

6: mature forest (80–140 yr)
7: old growth (>140 yr)

Important habitats and habitat features

Nesting

In northeastern British Columbia, Bay-breasted Warblers are found almost exclusively in mature white spruce forest, either in pure stands or mixed with clumps of aspens (*Populus tremuloides*), birch (*Betula papyrifera*), and balsam poplar (*Populus balsamifera*) (McTaggart-Cowan 1939, Erskine and Davidson 1976; Siddle 1992; Enns and Siddle 1992). This species also uses riparian coniferous or mixedwood corridors with multi-layered canopy and frequent openings (Campbell et al. 2001).

Some common characteristics of nesting habitat include a high proportion of old spruce (wildlife tree classes 3–5) with dead lower branches, a relatively closed upper canopy, a sparse but patchy sub-canopy, and an understorey dominated by highbush-cranberry (*Viburnum edule*), paper birch (*Betula*

1 Suitability increases with age.

occidentalis), dogwood (*Cornus nuttallii*), or Sitka alder (*Alnus viridis* ssp. *fruticosa)* (Cooper et al. 1997; Campbell et al. 2001).

Bay-breasted Warblers usually nest in coniferous trees; preferring spruce or fir, although they also occasionally nest in deciduous trees or shrubs (Bent 1953; Sealy 1979; Peck and James 1987). Nests are bulky cups of grass, small twigs, and caterpillar webs lined with fine rootlets and hair (Baicich and Harrison 1997). Nests are usually placed on a horizontal branch, near the trunk or along a main branch, and may be 2–18 m above ground, although 4.6–7.6 m is most common (Bent 1953; Peck and James 1987; Baicich and Harrison 1997). Only one nest has been documented for British Columbia, and its location on a spruce branch, 8 m above the ground, is consistent with nest microhabitat found elsewhere (Campbell et al. 2001).

An abundant prey base is an essential nesting habitat feature. Breeding distribution and abundance is strongly tied to presence of eastern spruce budworm (*Choristoneura fumiferana*) (MacArthur 1958; Morse 1978, 1989; Welsh 1987).

Foraging

Birds probably forage mainly within the nesting habitat, therefore feeding and nesting habitat requirements are the same.

Conservation and Management

Status

The Bay-breasted Warbler is on the provincial *Red List* in British Columbia. Its status in Canada has not been determined (COSEWIC 2002).

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

BC	AB	AK	NWT	Canada	Global
S2B, S2N	S2S3B	SR	S?	N5B	G5

Trends

Population trends

Throughout this species range, local population trends are closely correlated with outbreaks of the eastern spruce budworm and, therefore fluctuate dramatically (Bennett and Enns1996; Williams 1996; Cooper et al. 1997). In eastern North America, several studies have shown stable long-term trends, but significant recent short-term declines (Hill and Hagan 1991; Hagan and Johnston 1992). Across Canada, Breeding Bird Survey data suggest populations are declining (Erskine et al. 1992).

Overall Bay-breasted Warbler populations may be declining slightly (Williams 1996). Although there are no population trend data for British Columbia, considering the widespread population declines of many neotropical migrants (Morton and Greenberg 1989; Terborgh 1989; Finch 1991), the limited number of records for Bay-breasted Warblers in British Columbia, and the fact that this species relies on a habitat in decline, it is probable that populations are stable or declining (Cooper et al. 1997; Fraser et al. 1999), rather than increasing.

Habitat trends

Pure stands of large spruce, the preferred habitat of Bay-breasted Warbler, are relatively rare in the northeast and are being harvested at rates that the B.C. Ministry of Forests has described as non-sustainable (MOF 1992).

Threats

Population threats

Bay-breasted Warblers are rarely parasitized by Brown-headed Cowbird (Williams 1996); however, the impact of nest parasitism can be severe on neotropical migrants, especially in fragmented forests (Brittingham and Temple 1983; Askins et al. 1990; Finch and Stangel [editors] 1993). The lack of parasitism on this species is undoubtedly because it typically breeds in boreal forests away from cowbird concentrations. Brown-headed Cowbird parasitism will undoubtedly increase with habitat fragmentation.

Fragmentation of habitat increases edge habitat favoured by predatory species such as jays, crows, magpies, and some small mammals. Because the probability of predation on forest songbird nests increases with increasing forest fragmentation, it is probable that Bay-breasted Warblers will face increasing predation intensity as forests are cleared (Wilcove 1985; Yahner and Scott 1988; Askins et al. 1990; Cooper et al. 1997).

Rappole (1995) lists Bay-breasted Warbler amongst the neotropical migrants with a high probability of declining in the next decade, with winter being the most vulnerable period due to habitat loss within a relatively restricted winter range.

Migrating warblers suffer mortality from natural environmental factors such as inclement weather and from human-related factors such as collision with light towers (Williams 1996). It is expected that predation of nestlings by small mammals and birds, particularly corvid species, impacts reproductive success (Morse 1989; Williams 1996; Cooper et al. 1997).

Habitat threats

The primary threat to the Bay-breasted Warbler in British Columbia is the harvesting of mature and old-growth white spruce stands within its restricted range in the Boreal Plains and Taiga Plains ecoprovinces. Loss or deterioration of forest habitat has been widely blamed for declines in breeding populations of many forest warbler species (Titterington et al. 1979; Askins and Philbrick 1987; Terborgh 1989; Saunders et al. 1991; Hagan and Johnston 1992; Maurer and Heywood 1993). There is no evidence to suggest that the Bay-breasted Warblers will respond differently (Cooper et al. 1997).

Bay-breasted Warblers have been observed in British Columbia in stands that have been logged selectively for very large spruce with substantial, but unquantified, amounts of moderate-sized spruce remaining; this finding suggests that a certain amount of selective logging may be compatible with this warbler (Enns and Siddle 1992).

Stands favoured by Bay-breasted Warblers are often targeted for salvage or sanitation logging and, once harvested, require considerable time (>100 years) before they regenerate to a stage suitable for this species. Fire is also more likely to occur in selectively logged upland areas with optimal Bay-breasted Warbler habitat due to high fuel accumulation and site-related factors such as slope and aspect (Parminter 1983; Cooper et al. 1997).

Habitat is also lost or fragmented by other activities such as clearing for agriculture, road building, transmission lines, and oil and gas exploration (Cooper et al. 1997). In addition, the use of pesticides to control budworm outbreaks may threaten the quality of habitat (Williams 1996; Cooper et al. 1997).

Legal Protection and Habitat Conservation

The Bay-breasted Warbler, its nests, and its eggs are protected from direct persecution in Canada by the *Migratory Birds Convention Act*. In British Columbia, the same are protected under the provincial *Wildlife Act*.

Several Class A parks, such as Taylor Landing (2.4 ha) and Kiskatinaw River (154 ha), are within the known range and habitat type of Bay-breasted Warbler, although none include significant amounts of old-growth white spruce forest. One ecological reserve, Fort Nelson River, may have small amounts of suitable habitat for Bay-breasted Warbler and the Andy Bailey Recreation Area (196 ha) contains some black and white spruce riparian forest.

Most other nesting habitat is on Crown land; therefore, habitat conservation may be partially addressed by the old forest retention targets (old growth management areas), riparian reserves, and wildlife tree retention areas as required under the results based code.

Since Cape May and Bay-breasted Warblers use similar habitats, reserves for one species will likely be useful for the other.

Identified Wildlife Provisions

Habitat management for this species is best conducted at the landscape level. Because populations are very local, are dispersed in a large geographic area, and respond so directly to prey availability, old growth management areas, riparian management areas, and protected areas scattered throughout the BWBS may be the best approach to managing habitat for this species.

Sustainable resource management and planning recommendations

- ❖ Maintain suitable nesting habitat by maintaining old spruce forest.
- ❖ Incorporate old spruce into (1) old growth management areas (OGMAs); (2) areas constrained for other management objectives (e.g., visual quality, recreation, ungulate winter range, terrain concerns); or (3) stand level reserves such as wildlife tree retention areas and riparian management areas.
- ❖ Areas selected should include spruce forests with evidence of declining health for their potential for future spruce budworm outbreaks. Other characteristics of good habitat are stands of old-growth black or white spruce >140 years, a relatively closed upper canopy, open patches in mid-canopy, and an understorey dominated by highbush-cranberry, paper birch, dogwood, or Sitka alder.
- ❖ Specific wildlife tree and old forest retention objectives for this species should be considered in the BWBSmw1 and BWBSmw2 in Fort Nelson, and Peace forest districts. Blocks should be assessed to identify potentially suitable WTR areas. The attributes listed in Table 1 should be used to design suitable WTR areas for this species.

Table 1. Preferred WTR area characteristics for the Bay-breasted Warbler

Attributes	Characteristics
Size (ha)	≥5 ha
Location	BWBSmw1, BWBSmw2
Features	trees with dead lower branches; understorey dominated by highbush-cranberry, paper birch, dogwood, or Sitka alder
Tree species	white spruce
Age/structure	≥80 years; structural stages 6–7
Wildlife tree class	3–5

- ❖ Restrict salvage or harvest and avoid insecticide use.
- ❖ Maintain WTR area over the long term.

Wildlife habitat area

Goal

Although this species is likely best managed at the landscape level, it may be appropriate to establish WHAs where strategic level planning objectives cannot address critical areas for the species.

Feature

Establish WHAs only within highly suitable nesting habitat (i.e., in mature or old spruce forest) where concentrations (>3 pairs/10 ha) of Bay-breasted Warblers regularly occur.

Size

Typically between 10 and 30 ha but will depend on site-specific factors.

Design

WHAs should include old spruce forest on flat topography with a relatively closed upper canopy, open patches in mid-canopy and an understorey dominated by highbush-cranberry, paper birch, dogwood, or Sitka alder. Minimize edge habitat wherever possible.

General wildlife measure

Goals

1. Ensure WHA is windfirm.
2. Maximize interior forest conditions.
3. Minimize disturbance during the nesting season (1 June to 31 July).

Measures

Access

- Do not construct roads, trails, or other access routes.

Harvesting and silviculture

- Do not harvest.

Pesticides

- Do not use pesticides.

Additional Management Considerations

Forestry practices that promote microhabitat diversity by providing uneven-aged forests may benefit this species.

Avoid prime Bay-breasted Warbler habitat when planning seismic explorations, transmission lines, and other access routes.

Information Needs

1. Distribution.
2. Habitat use preferences.
3. Population estimates and trends.

Cross References

Cape May Warbler

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Black-throated Green Warbler

Dendroica virens

Original prepared by John M. Cooper
and Suzanne M. Beauchesne

Species Information

Taxonomy

The Black-throated Green Warbler is part of a superspecies complex with closely related *Dendroica* warblers (Hermit, Golden-cheeked, and Townsend's) (AOU 1983). Hybridization between Black-throated Green and Townsend's Warblers (*Dendroica townsendi*) has been reported from the Rocky Mountains of British Columbia where the breeding ranges of these two species overlap (Rohwer 1994). Two subspecies of Black-throated Green Warblers are recognized, of which only the nominate race, *D. virens virens*, occurs in British Columbia (Morse 1993; Cannings 1998). The other race, *D. virens waynei* occurs in the southeastern United States (Morse 1993).

Description

A small songbird about 13 cm in length. In breeding plumage, the male has a black throat and sides of breast, yellow face with olive green ear coverts, unstreaked olive green crown and upper parts, two white wing bars, and a white belly. The female has similar markings but is duller, the chin is yellow, and there is less black on the lower throat and sides of breast. Juveniles are significantly duller still with very little or no black on the chin and throat, which is, instead, white or pale yellow (Pyle 1997).

Distribution

Global

The Black-throated Green Warbler breeds from northeastern British Columbia, across boreal Canada east to Newfoundland and Labrador and south in the United States, from Minnesota in the west across to Alabama and Georgia. This species winters primarily in Mexico and Central America, south to Panama although some birds may be found in the United States along the Gulf of Mexico, in the Caribbean, and in northern South America (AOU 1983; Morse 1993).

British Columbia

Black-throated Green Warblers were not known to occur in British Columbia during the first half of this century (Munro and and McTaggart-Cowan 1947; Godfrey 1986). The first documented record for the province was in 1965 (Salt 1966). Morse (1993) speculates that it has undergone a recent range expansion into northeastern British Columbia where it reaches the northwestern extreme of its range.

The Black-throated Green Warbler occurs mainly in the Boreal Plains Ecoprovince, with most records coming from the Peace Lowland (Campbell et al. 2001). Enns and Siddle (1992) reported this species west to Moberly Lake, north to Blueberry Creek and south to near the headwaters of the Kiskatinaw River. Recent records from the Tuchodi River extend its known range significantly northward, into the Taiga Plains Ecoprovince. It has recently been found to occur rarely in the Fort Nelson Forest District of the Taiga Plains (Bennett et al. 2000). There is one known record in the Sub-Boreal Interior Ecoprovince (Cooper et al. 1997).

Forest regions and districts

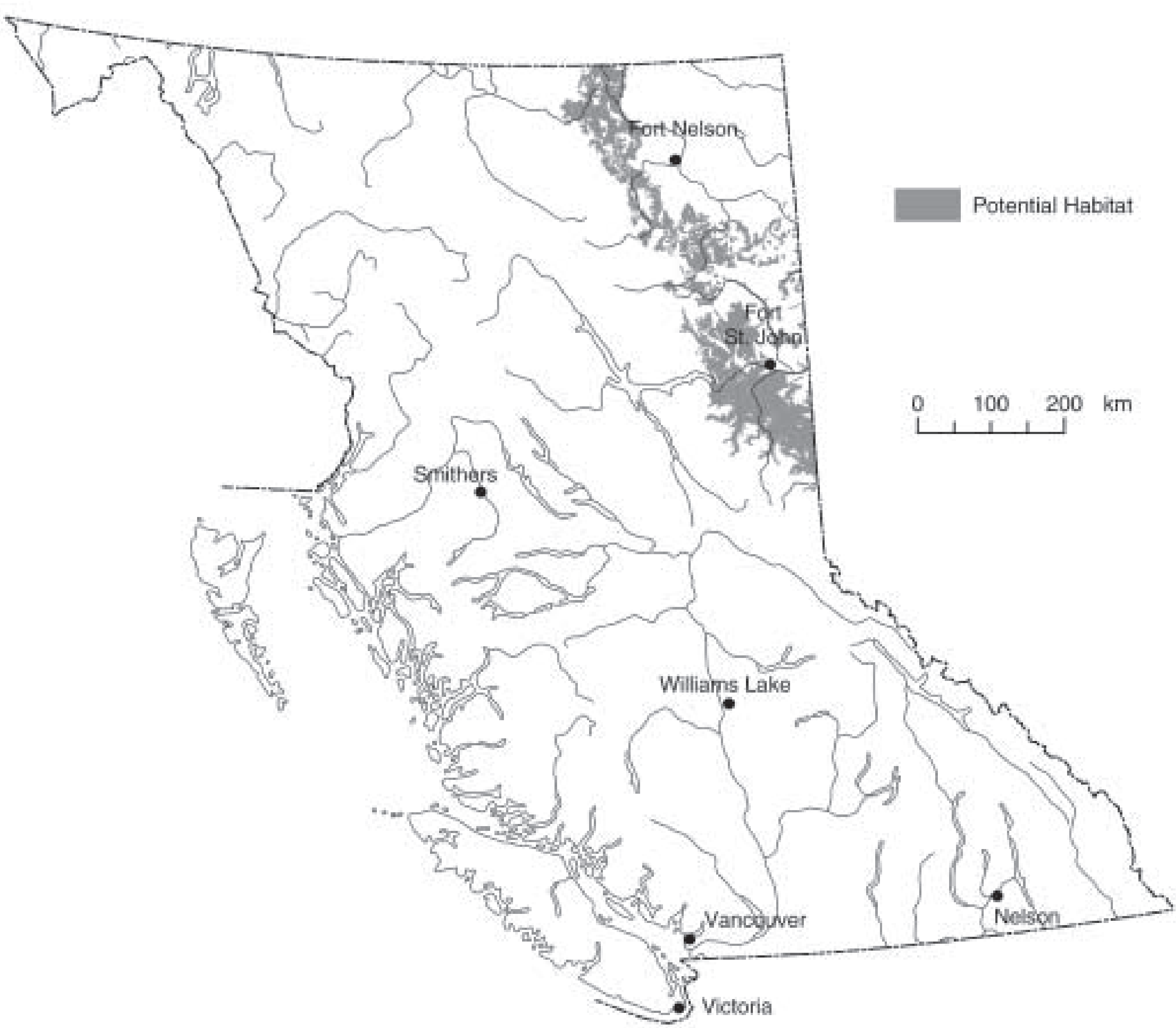
Northern Interior: Fort Nelson, Peace

Ecoprovinces and ecosections

BOP: CLH, HAP, KIP, PEL
TAP: MUP
SBI: HAF

Black-throated Green Warbler

(Dendroica virens)



Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on several ecosystem classifications (Ecoregion, Biogeoclimatic and Broad Ecosystem Inventory) as well as current knowledge of the species' habitat preferences. This species may or may not occur in all areas indicated.

Biogeoclimatic units

BWBS: mw1, mw2

Broad ecosystem units

BA, PR

Elevation

Breeding – 650–1100 m in the northeast
Migration – sea level to 1800 m (Campbell et al. 2001).

Life History

Very little is known about the ecology of the Black-throated Green Warbler in British Columbia, therefore much of the following information is inferred from studies in other areas.

Diet and foraging behaviour

The Black-throated Green Warbler is primarily insectivorous. Lepidopteran caterpillars contribute the greatest volume to its diet, but a wide range of prey is taken including beetles, bugs, gnats, ants, spiders, mites, and plant lice (Bent 1953; Morse 1976; Robinson and Holmes 1982; Morse 1993). Gleaning small branches and foliage of conifers is the main foraging technique although this species also hovers to glean the underside of foliage and terminal tips of branches and hawks insects in flight (MacArthur 1958; Morse 1968). In British Columbia, as elsewhere, most foraging is done within the mid- to upper canopy (Sabo and Holmes 1983; Morse 1993). In migration, berries are added to the diet (Morse 1993).

Reproduction

Upon arriving on the breeding grounds, male Black-throated Green Warblers select breeding territories, defending them from conspecific males, then pair with a mate after females arrive. Both sexes contribute to nest building (Morse 1993). Clutches usually contain four eggs, however three to five egg clutches have been recorded (Bent 1953; MacArthur 1958; Peck and James 1987; Baicich and Harrison 1997). Egg-laying probably occurs mainly in mid- to late June in northeastern British Columbia (Campbell et al. 2001). Eggs are incubated by the female alone for about 12 days (Baicich and Harrison 1997). Nestlings fledge after 9–11 days (Bent 1953; Morse 1993; Baicich and Harrison 1997). Both parents continue to feed young for several days, post-fledging, often separating at this point, each taking part of the brood (Morse 1993; Baicich and Harrison 1997). Siddle (1981) reported a fledgling being fed by an adult at Kiskatinaw Park on 30 June. A single brood is likely raised by each pair annually in British Columbia, as is usual for neotropical migrants (Morse 1989).

Site fidelity

Unlike Bay-breasted (*Dendroica castanea*) and Cape May Warblers (*Dendroica tigrina*), the Black-throated Green Warbler is known to have a high degree of site fidelity to breeding and wintering sites (Morse 1971, 1993).

Home range

Breeding territories are small (0.3–0.55 ha); and territory size is inversely related to density and food supply (Morse 1976, 1977). Densities of populations breeding in the eastern United States ranged from 0.6 to 2.2 pairs/ha (Morse 1976, 1989, 1993; Holmes 1986). Densities may actually decline during periods of budworm outbreaks, probably because of competition with the larger Bay-breasted and Cape May Warblers, which increase in density during outbreaks (Kendeigh 1947; Morse 1993). In west-central Alberta, densities of territorial males were 4.2–5.6/100 ha in 60- to 80-year-old aspen-dominated forest (Westworth and Telfer 1993). In British Columbia, one 19 ha island in the Peace River contained three territorial males (Penner 1976).

Movements and dispersal (migration)

In British Columbia, male Black-throated Green Warblers reach the breeding grounds a few days earlier than females, consistent with a general pattern for many bird species (Francis and Cooke 1986; Morse 1993). This species enters northeastern British Columbia through northern Alberta, beginning in mid- to late May, with most probably arriving in late May and early June. After nesting is completed, adults probably begin to migrate south in the second half of July, followed by juveniles in August (Cooper et al. 1997). The species has been recorded in northeastern British Columbia between 9 May and early September (Penner 1976; Campbell et al. 2001).

During migration this warbler uses a variety of habitats (Keast and Morton 1980) including, in British Columbia, willow/alder edge habitat (Enns and Siddle 1992).

Habitat

Structural stage

6: mature forest (80–140 yr)
7: old forest (>140 yr)

Important habitats and habitat features

Nesting

Throughout its range, Black-throated Green Warbler nesting habitat varies from pure coniferous through to pure deciduous forests, although almost all sites have at least some conifer component (Collins 1983; Peck and James 1987; Morse 1989). This species prefers old forests but has also been recorded breeding in middle and late seral stage forests (Morse 1976).

In northeastern British Columbia, Black-throated Green Warbler nesting habitat includes mature riparian white spruce (*Picea glauca*) or mixedwood (spruce [*Picea* spp.], trembling aspen [*Populus tremuloides*], balsam poplar [*Populus balsamifera balsamifera*) forests, similar to that documented in Alberta (Penner 1976; Enns and Siddle 1992; Siddle 1992; Lance and Phinney 1994). Stands tended to be mesic, with rose (*Rosa* spp.), baneberry (*Actaea rubra*), highbush cranberry (*Viburnum edule*), bunchberry (*Cornus canadensis*), fireweed (*Epilobium angustifolium*), kinnikinnick (*Arctostaphylos uva-ursi*), mosses, peavine (*Lathyrus* spp.), and American vetch (*Vicia americana*) in the understorey (Cooper et al. 1997). Siddle (1981, 1992) stressed the importance of riparian forest along the south bank of the Peace River and along smaller streams. Pure deciduous forests are rarely used in this province; however, even a small clump of mature spruce within an otherwise pure aspen stand attracts Black-throated Green Warblers (Cooper et al. 1997).

No Black-throated Green Warblers nests have been found in British Columbia (Campbell et al. 2001). Elsewhere, nest site microhabitat is not highly specialized; however, mature rather than juvenile trees are preferred and nests are usually found in coniferous trees, although deciduous trees are also used (Baicich and Harrison 1997). Nests are usually 2–8 m above ground but have been recorded as high as 20 m (Bent 1953; Peck and James 1987). Nests are sometimes built in the lower canopy or understorey. Nests are compact cups of grass, moss, and twigs, lined with hair and feathers, and are placed against the trunk on a supporting branch or further out on a branch fork.

Foraging

Birds probably forage mainly within the nesting habitat; therefore, feeding and nesting habitat requirements are the same.

Conservation and Management

Status

The Black-throated Green Warbler is on the provincial *Blue List* in British Columbia. Its status in Canada has not been determined (COSEWIC 2002).

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

BC	AB	WA	Canada	Global
S3B, S2N	S3S4B	S?	N5B	G5

Trends

Population trends

There are no population trend data for British Columbia, although some authors believe all northeastern warblers are currently in decline (Siddle 1992). This warbler appears to have expanded its range westward into northeastern British Columbia in the last few decades, suggesting that populations overall may have increased during that time (Morse 1993; Cooper et al. 1997). In a study of warbler habitat associations in northeastern British Columbia, where various habitat types were sampled from Pine Pass north to the Yukon border, Black-throated Green Warblers accounted for 15.1% of 332 songbird sightings (Enns and Siddle 1992). In British Columbia, Black-throated Green Warblers may be locally common in good habitat (Cooper et al. 1997).

In eastern and central North America, various analyses revealed no, or very slight, changes in population indicating an overall stable trend for this species (Morse 1976; Holmes and Sherry 1988; Hill and Hagan 1991, Hagan and Johnston 1992; Morse 1993). In southern Ontario, long-term trends were stable (1961–1988), but there was a significant decline (-8.2% annually) between 1979 and 1988 (Hagan and Johnston 1992).

Generally, neotropical migrants are thought to be suffering widespread population declines (Morton and Greenberg 1989; Terborgh 1989; Finch 1991). Morse (1993) and Rappole (1995) both forecast a population decline for this species due to loss of wintering habitat.

Habitat trends

Late seral mixedwood stands, the preferred habitat of the Black-throated Green Warbler, are being harvested in the Peace Lowland, reducing the amount of habitat available to this species.

Threats

Population threats

Nest parasitism by Brown-head Cowbirds can severely impact neotropical migrant songbird populations (Brittingham and Temple 1983; Askins et al. 1990; Finch and Stangel 1993). In British Columbia, there is a single record of a Brown-headed Cowbird fledgling being fed by a Black-throated Green Warbler (Siddle 1992). Elsewhere, parasitism has frequently been reported with rates of up to 34% documented (Friedmann 1963; Peck and James 1987; Morse 1993). Parasitism is more prevalent along edge habitat (Morse 1993), which suggests that the rate of parasitism will increase in British Columbia with increasing fragmentation of northeastern forests (Cooper et al. 1997).

Forest fragmentation increases edge habitat favoured by predatory species such as jays, crows, and magpies. Because the probability of predation on forest songbird nests increases with increasing forest fragmentation (Wilcove 1985; Yahner and Scott 1988; Askins et al. 1990), Black-throated Green Warblers will likely face greater predation intensity as forests are cleared.

In other regions, large-scale spraying of insecticides in coniferous forest habitat, to control insect outbreaks, could reduce the insect prey base, and cause indirect mortality in this species (Morse 1993). Populations elsewhere are known to have declined after application of fenitrothion (Pearce et al. 1979).

This species also has a restricted range in British Columbia (Cooper et al. 1997; Fraser et al. 1999).

Migration is probably the period of highest mortality for both adults and juveniles. Migrating warblers suffer mortality from natural environmental factors such as inclement weather and from human-related factors such as collision with light towers (Morse 1993).

Late snowstorms are known to cause severe mortality of migrants and breeders, and July rainstorms kill many fledglings, both events that may depress local breeding populations for several years (Morse 1976). Populations in Wisconsin and Michigan declined precipitously during years of drought (Hagan and Johnston 1992), suggesting a response to presumed lower food supplies during dry springs. Populations are not known to increase in response to spruce budworm outbreaks; in fact, they may decline, probably due to competition with other warbler species that increase in number dramatically (Morse 1993).

Habitat threats

The primary threat to Black-throated Green Warbler populations in British Columbia is the harvesting of late seral mixedwood stands within its restricted range in the Peace Lowland. Loss or deterioration of forest habitat has been widely blamed for declines in breeding populations of many warbler species (Titterington et al. 1979; Burgess and Sharpe 1981; Askins and Philbrick 1987; Terborgh 1989; Saunders et al. 1991; Hagan and Johnston 1992; Maurer and Heywood 1993). There is no evidence to suggest that Black-throated Green Warblers will respond differently (Cooper et al. 1997).

In northeastern British Columbia, clearcutting of mature to old-growth white spruce and mixedwood forests removes suitable nesting habitat for this species. Selective logging also severely reduces habitat quality if forests are thinned by 40–75% (Webb et al. 1977; Freedman et al. 1981). Strip cuts of 20–30 m are also known to negatively impact habitat in the short to medium term (Freedman et al. 1981).

Local extirpations of this warbler have been documented in severely fragmented forests (Askins and Philbrick 1987; Hagan and Johnston 1992) and forests where mature conifers have been removed (Salt 1973). Other studies have documented this species nesting in middle seral stage, second-growth forests in eastern North America where this warbler is known as a pioneering species, rapidly occupying new habitats as they become suitable (Morse 1993). However, these traits have not yet been observed in British Columbia where virtually all reports are from mature and older forests. Additional research is needed to determine the use of younger-aged forests before the impact of timber harvesting in British Columbia on use can be adequately addressed (Cooper et al. 1997).

The trend in northeastern British Columbia toward intensive silviculture for short rotations of mixedwood (Peterson et al. 1989) prevents regeneration of good quality Black-throated Green Warbler nesting habitat after it has been lost to harvesting. Techniques that alter the shrub component, debris structure, and the eventual plant species distribution in mixedwood stands may also reduce habitat suitability of habitat (Cooper et al. 1997).

Habitat is also lost or fragmented by other activities such as clearing for agriculture, road building, transmission lines, and oil and gas exploration (Askins 1994). In the Dawson Creek Timber Supply Area, many of the pure stands of large aspen and cottonwood occur on private land adjacent to agricultural fields. Harvesting is currently taking place on private land with an unknown area being converted to agricultural fields. This area is unlikely to revert to a mixedwood forest in the future (Cooper et al. 1997). In addition, potential hydroelectric projects on the Peace River (e.g., Sites C and E) would flood substantial amounts of good Black-throated Green Warbler habitat (Penner 1976).

Grazing may reduce the quality of habitat for this warbler through damage to the understorey and because Brown-headed Cowbirds are attracted to livestock. In the northeast, livestock grazing is more prevalent in mixed aspen stands, which have higher forage production, than in pure coniferous stands (Pitt 1984).

Within its wintering range, deforestation for timber production, agricultural clearing, and urban development continue to reduce the quantity of habitat available (Rappole 1995). The Black-throated Green Warbler may be less affected than many other neotropical migrants by deforestation of tropical regions because this species has a relatively large wintering range, uses a broad range of winter habitats, and is a generalist in foraging (Hagan and Johnston 1992). However, there is cause for concern for any species with a concentration of migrants from a huge breeding distribution funnelled into a relatively small winter range (Keast and Morton 1980).

Legal Protection and Habitat Conservation

The Black-throated Green Warbler, its nests, and its eggs are protected from direct persecution in Canada by the *Migratory Birds Convention Act*. In British Columbia, the same are protected under the provincial *Wildlife Act*.

In British Columbia, Beatton Park (312 ha), Moberly Lake Park (98 ha), Kiskatinaw River Park (154 ha), Peace Boudreau Protected Area, and Peace River Corridor (2014 ha), all relatively small provincial parks, are the only existing reserves where Black-throated Green Warblers have consistently been recorded (Siddle 1992). Other Class A parks, such as Taylor Landing (2.4 ha), are within the known range and habitat type of this species, although records may be lacking. Prophet River Wayside Park (113 ha), Andy Bailey Park (196 ha), Sikanni Old Growth Park (1439 ha), and Butler Ridge Park (6024 ha) may protect suitable habitat.

Most other nesting habitat is on Crown land; therefore, habitat conservation may be partially addressed by old forest retention targets (old growth management areas), riparian reserves, and wildlife tree retention areas or other wildlife habitat areas required under the results based code.

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

- Maintain suitable nesting habitat.
- Incorporate suitable nesting habitat into (1) old growth management areas; (2) areas constrained for other management objectives (e.g., visual quality, recreation, ungulate winter range, terrain concerns); or (3) stand level reserves such as wildlife tree retention (WTR) areas and riparian management areas.
- In general, the shape and size of forest reserves should be designed to minimize edge habitat and isolation of populations. In addition, habitat corridors that connect patches of forest are proving to be an important factor in retaining bird community diversity in isolated patches (MacClintock et al. 1977). Creating such corridors of forest habitat suitable for Black-throated Green Warblers between mature mixedwoods may reduce the impact of timber harvesting on this species (Cooper et al. 1997).
- Consider greater WTR area retention levels in mature and old spruce or mixedwood forest where this species is known to occur. Blocks should be assessed to identify potentially suitable WTR areas. Table 1 provides attributes that should be used to design suitable WTR areas for this species.
- Restrict salvage or harvest and avoid insecticide use.
- Maintain WTR areas over the long term.

Table 1. Preferred WTR area characteristics for the Black-throated Green Warbler

Attributes	Characteristics
Size (ha)	≥2–10 ha
Location	BWBSmw1, BWBSmw2
Features	patches of mature spruce within deciduous-leading.
Tree species	white spruce or mixedwood (spruce, trembling aspen, balsam poplar)
Age/structure	≥80 years; structural stages 6–7

Wildlife habitat area

Goal

Maintain suitable nesting habitats. Consider size and shape of the WHA to minimize edge habitat.

Feature

Establish WHAs within highly suitable nesting habitat (mature or old mixedwoods) where concentrations (>3 pairs) of Black-throated Green Warblers regularly occur.

Size

Typically between 10 and 30 ha but will depend on site-specific factors.

Design

Consider locating adjacent to other reserves such as riparian management areas wherever possible. If stands are deciduous leading types, they must include clumps of mature spruces. Minimize edge habitats wherever possible and minimize/avoid agricultural areas (M. Phinney, pers. comm.)

General wildlife measure

Goals

1. Ensure windfirmness.
2. Maximize interior forest conditions.
3. Maximize mature riparian forest reserves.
4. Minimize disturbance during the nesting season (15 May–31 July).

Measures

Access

- Do not construct roads, trails, or other access routes.

Harvesting and silviculture

- Do not harvest.

Pesticides

- Do not use pesticides.

Range

- Plan livestock grazing (i.e., timing and browse utilization) to minimize negative impacts to this species. The "desired plant community," including seral stage mix, species composition, and structural characteristics (i.e., understorey vegetation) should be maintained.
- Grazing after the nesting season (after 31 July) is preferable.
- Do not place livestock attractants within WHA.

Additional Management Considerations

Avoid prime Black-throated Green Warbler habitat when planning seismic explorations, oil and gas development, transmission lines, and other access routes.

Information Needs

1. Inventory to identify local concentrations of this species and monitor known populations to keep current on the effects of silviculture practices.
2. Habitat mapping in core areas.
3. Population estimates and trends.

Cross References

Bay-breasted Warbler, Cape May Warbler

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Cape May Warbler

Dendroica tigrina

Original prepared by John M. Cooper and Suzanne M. Beauchesne

Species Information

Taxonomy

The Cape May Warbler is one of 12 species of warbler in the genus *Dendroica* that breed in British Columbia (Campbell et al. 2001). It may be most closely related to the Blackpoll (*Dendroica striata*) and Bay-breasted Warblers (*Dendroica castanea*), based on morphology, behaviour, and ecology (Baltz and Latta 1998). No subspecies of Cape May Warbler are recognized (AOU 1957; Cannings 1998).

Description

The Cape May Warbler is a small (~13 cm in length) songbird. In the breeding season, the male has a chestnut ear patch bordered by a distinct yellow hindneck and throat, an indistinct black eye stripe, and an olive crown and nape, heavily streaked with black. The upperparts are predominantly olive with some black streaking, white wing patch, and a yellow rump. The underparts are yellow with bold black streaking on the breast. The breeding female is similar but significantly duller in colour, the wing patch is replaced by a narrow white wing bar, and the chestnut ear patch is lacking. Immature birds are duller still (Pyle 1997).

Distribution

Global

The Cape May Warbler breeds from the south-western Northwest Territories and northeastern British Columbia, across Canada east to Nova Scotia, and in the northern United States from the Great Lakes east to Maine (Godfrey 1986). Local and regional breeding distributions and populations are influenced by outbreaks of eastern spruce budworm (*Choristoneura fumiferana*) (Kendeigh 1947; MacArthur 1958; Morse 1978). It winters primarily in the West Indies, although a few have also been found in Central America and northern South America (AOU 1983; Baltz and Latta 1998).

British Columbia

The Cape May Warbler occurs almost exclusively in the Taiga Plains and Boreal Plains ecoprovinces. Most records are from a small area near Dawson Creek, Pouce Coupe, and Tupper, in the Boreal Plains with another cluster of reports coming from the Fort Nelson Lowland in the Taiga Plains (Siddle et al. 1991; Enns and Siddle 1992). There is evidence of breeding in both areas (Siddle et al. 1991).

Forest regions and districts

Northern Interior: Fort Nelson, Peace

Ecoprovinces and ecosections

TAP: FNL, MUP

BOP: KIP, HAP, PEL

Biogeoclimatic units

BWBS: mw1, mw2

Broad ecosystem units

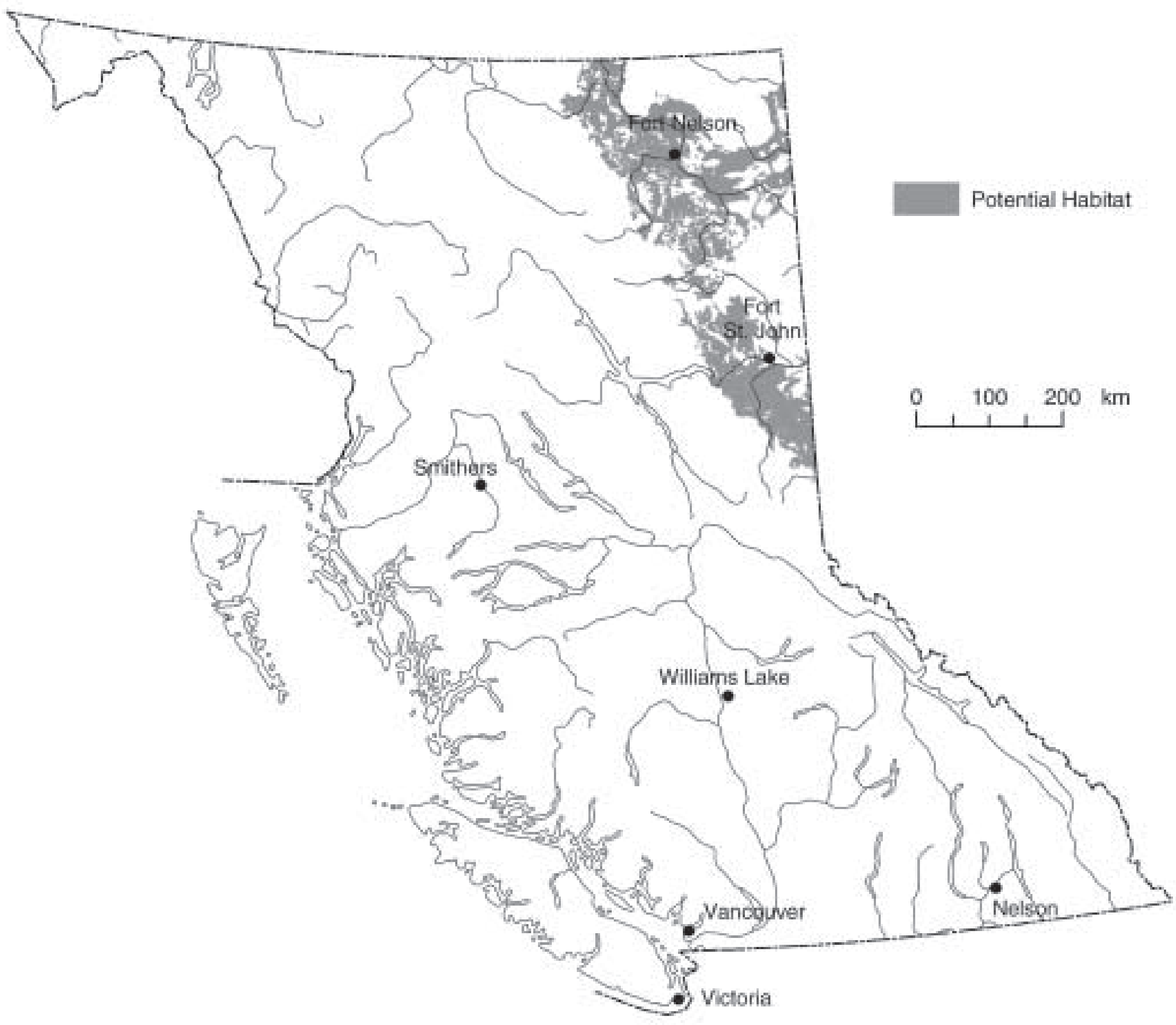
BA, PR

Elevation

Breeding: 420–660 m (Bennett and Enns 1996, Campbell et al. 2001)

Migration: 230–760 m (Campbell et al. 2001)

Cape May Warbler
(Dendroica tigrina)



Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on several ecosystem classifications (Ecoregion, Biogeoclimatic and Broad Ecosystem Inventory) as well as current knowledge of the species' habitat preferences. This species may or may not occur in all areas indicated.

Life History

Very little is known about the ecology of the Cape May Warbler in British Columbia, and many details are lacking from elsewhere in its range. Most of the following information is inferred from studies in other areas.

Diet and foraging behaviour

During the breeding season, the Cape May Warbler is a spruce budworm specialist (Crawford and Jennings 1989; Baltz and Latta 1998). It feeds mainly by gleaning prey from tree foliage, primarily along branches, but also hawks, hovers, or fly-catches (Morse 1978; Baltz and Latta 1998). In British Columbia, as reported elsewhere, most foraging is done within the upper canopy (MacArthur 1958; Enns and Siddle 1992). This warbler also opportunistically takes advantage of a variety of small adult and larval insects, spiders, eggs, of spiders and insects, as well as berries, and seeds (Bent 1953; Morse 1978; Sealy 1989). Nectar, pollen, and tree sap are important food sources during spring migration (Bent 1953; Sealy 1989). In the winter, the Cape May Warbler may feed mainly on nectar, although invertebrates are also taken, if available (Terborgh 1989; Baltz and Latta 1998).

Reproduction

There is no information on pair formation. The female alone builds the nest (Baltz and Latta 1998). Nests are bulky cups of grass, small twigs, and moss lined with hair, feathers, and fur (Baicich and Harrison 1997). Clutch size ranges from four to nine eggs and is strongly influenced by food supply, with larger clutches typical during periods of high food abundance (Bent 1953, Morse 1978, 1989). In northeastern British Columbia, egg laying probably begins in mid- to late June (Cooper et al. 1997). Incubation, by the female alone, is for an unknown period, although 11–13 days is likely, based on the incubation period of other members of this genus. The nestling period is also unknown, but is probably between 9 and 12 days, also based on other congeneric warblers. Nestlings are likely present from late June through mid-July in northeastern British Columbia (Campbell et al. 2001). Both parents feed nestlings (Baltz and Latta 1998). A pair probably raises a single brood each year in British Columbia, a widespread pattern in warblers (Morse 1989; Baltz and Latta 1998). There are no data for Cape May Warblers on hatching success, survival of nestlings, or fledging success; however, through increased clutch sizes, Cape May Warblers are undoubtedly able to produce more young in years and regions with high food supplies (Baltz and Latta 1998).

Site fidelity

Cape May Warblers are known to respond dramatically, in breeding distribution and population size, to changes in abundance of spruce budworms (Kendeigh 1947; MacArthur 1958; Morse 1978; Saunders et al. 1985; Welsh 1987; Morse 1989), a correlation that has been noted in British Columbia (Bennett and Enns 1996; Cooper et al. 1997). They may become super-abundant during infestations and then decline or disappear entirely from an area within a few years after the outbreak (Baltz and Latta 1998). Thus, site fidelity is likely low.

Home range/territory size

There are no data on territory size for British Columbia; however, an average territory size of 0.4 ha/pair has been recorded in Ontario (Kendeigh 1947). Local densities in northeastern British Columbia have ranged from about 0.1 to 0.5 pairs/ha (Bennett et al. 2000). In Ontario, densities fluctuated dramatically, from 370 pairs/km^2 in the early 1980s to almost none in 1986, in response to a spruce budworm infestation and subsequent decline (Baltz and Latta 1998).

Dispersal and movements

The Cape May Warbler is a neotropical migrant songbird and one of the first warblers to arrive in Canada in spring and last to leave in late summer (Francis and Cooke 1986). During spring migration, males arrive slightly earlier than females, a general pattern in many neotropical migrants (Francis and Cooke 1986). Spring migrants begin arriving in northeastern British Columbia in mid-May with most probably arriving in late May and early June (Siddle et al. 1991; Campbell et al. 2001).

After nesting is completed, adults probably begin to migrate south in mid- to late July followed by juveniles in August although the fall movement is difficult to discern because of small populations (Campbell et al. 2001). Cape May Warblers occur regularly in northeast British Columbia between 19 May and 21 August; however, there is a late record of 22 October at Prince George (Campbell et al. 2001).

Habitat

Structural stage[1]

6: mature forest (80–140 years)
7: old forest (>140 years)

Important habitats and habitat features

Nesting

Throughout its range, the Cape May Warbler relies mainly on mature to old, coniferous-dominated forests for nesting habitat (B.C.: Bennett et al. 2000, Bennett and Enns 1996; Alberta: Semenchuk 1992; Ontario: Welsh 1987; general: Baltz and Latta 1998). In northeastern British Columbia, Cape May Warblers are found almost exclusively in mature white spruce (*Picea glauca*) forest, either pure stands or mixed with balsam poplar (*Populus balsamifera*), aspens (*Populus tremuloides*), birch (*Betula papyrifera*), willow (*Salix* spp.), alder (*Alnus rubra*), and lodgepole pine (*Pinus contorta*) (McTaggart-Cowan 1939; Siddle et al. 1991; Enns and Siddle 1992). Very few data are vailable on the use of different successional stages by Cape May Warblers, although one study in Maine found no use of early or mid-seral stages (Titterington et al. 1979). The effects of forest fragmentation or selective logging are not well known. However, Enns and Siddle (1992) found this warbler in selectively logged stands in the northeast and use of spruce in overgrown pastures in Maine has been documented (Palmer 1949), suggesting some tolerance for thinning of forests.

Only one nest has been found in British Columbia (Campbell et al. 2001). Elsewhere, Cape May Warblers nest in coniferous (mainly spruce) trees, 10–20 m above ground. Nests are placed on a horizontal branch, often near the trunk, on the short branches at the top (Bent 1953; Baicich and Harrison 1997).

Some common characteristics of Cape May Warbler habitat in British Columbia include tall stands of white spruce that are fairly dense but have frequent openings. Relatively tall conifers, extending above the main canopy, are used by males as singing perches and are, apparently, important nesting habitat components (Baltz and Latta 1998). Sites are usually on flat ground with an open, mossy (*Dicranum* spp., *Pleurozium* spp., *Rhytidiopsus* spp.) ground cover and understorey plants include highbush cranberry (*Viburnum edule*), horsetail (*Equisetum* spp.), bunchberry (*Cornus canadensis*), palmate coltsfoot (*Petasites frigidus* var. *palmatus*), twinflower (*Linnea borealis*), and willow (Cooper et al. 1997).

An abundant prey base is an also essential breeding season resource feature. Breeding distribution and abundance are strongly tied to presence of spruce budworm (MacArthur 1958; Morse 1978; Welsh 1987; Morse 1989).

Foraging

Birds probably forage mainly within the nesting habitat; therefore, feeding and nesting habitat requirements are the same.

Conservation and Management

Status

The Cape May Warbler is on the provincial *Red List* in British Columbia. Its status in Canada has not been determined (COSEWIC 2002).

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

BC	AB	NWT	Canada	Global
S2B, S2N	S2B	S?	N5B	G5

1 Suitability increases with age.

Trends

Population trends

There are no data on population trends for Cape May Warblers in British Columbia, although some authors believe all northeastern warblers are in decline (Siddle et al. 1991; Siddle 1992). The Cape May Warbler was first documented in British Columbia in 1938 when a single bird was collected during fieldwork in the Peace Lowland (McTaggart-Cowan 1939). It was not recorded again until 1971 and has only been infrequently documented since. For example, only one bird was recorded from the Fort Nelson Lowland during two summers fieldwork in the mid-1970s (Erskine and Davidson 1976) and one bird was found during 1 month of fieldwork in 1982 near Kwokullie Lake (Cooper et al. 1997). More recently, the Cape May Warbler was considered one of the least abundant warblers in northeastern British Columbia (Enns and Siddle 1992; Siddle 1992). Lance and Phinney (1994) found no individuals during their study south of Dawson Creek in mixedwood forest, results that reinforce the relationship between Cape May Warblers and mature white spruce stands. In the late 1990s, however, Cape May Warblers were relatively more common at several sites in the northeast (Bennett et al. 2000). The Cape May Warbler is very sparsely and locally distributed in northern Alberta according to recent atlas surveys (Semenchuk 1992); few data indicate that its long-term population status is different in British Columbia.

In eastern North America, Breeding Bird Surveys reveal no significant long-term population trends for Cape May Warbler (1966–1988, Robbins et al. 1989, Hagan and Johnston 1992), or Canada (Environment Canada 2001). A constant-effort mist-netting program in Massachusetts found a significant long-term (1970–1988) decline in migrating populations, as did an analysis of 53 years (1937–1989) of field notes from eastern Massachusetts (Hill and Hagan 1991; Hagan and Johnston 1992). Local declines in some Caribbean wintering areas have also been documented (Hagan and Johnston 1992).

Based on the widespread population declines experienced by many neotropical migrants (Morton and Greenberg 1989; Terborgh 1989, Finch 1991), and because of the limited number of records of Cape May Warblers from British Columbia, a species that relies on a habitat in decline, it is probable that populations are stable or decreasing, and improbable that populations are increasing (Cooper et al. 1997).

Habitat trends

Mature to old-growth, spruce-dominated forests, the preferred habitat of Cape May Warbler, are relatively rare in the northeast. Because of the high commercial value of large spruce, it is inevitable that most accessible stands will be harvested (MOF 1994), and that most high quality Cape May Warbler habitat in British Columbia will eventually be lost.

Cape May Warblers have been observed in selectively logged stands; however, these areas had access roads suggesting that they may be further thinned or cleared in the future (Enns and Siddle 1992). The extent to which mature forest may be thinned and still provide suitable habitat for Cape May Warblers has yet to be determined (Cooper et al. 1997).

Threats

Population threats

Nest parasitism by Brown-headed Cowbirds (*Molothrus ater*) can severely impact neotropical migrant songbird populations (Brittingham and Temple 1983; Askins et al. 1990; Finch and Stangel 1993). In British Columbia, there is a single record of a recently fledged Brown-headed Cowbird being fed by an adult Cape May Warbler (Siddle 1992). Elsewhere, parasitism of Cape May Warblers has only infrequently been reported (Friedmann 1963; Baltz and Latta 1998). However, although it is unlikely that cowbird parasitism is a major factor in British Columbia at present, the lack of parasitism on this species is undoubtedly related to the fact that it typically breeds in boreal forests away from cowbird concentrations and the lack of nest observations. Therefore, it is likely that the rate of parasitism will increase with increasing fragmentation of northeastern forests (Cooper et al. 1997).

Forest fragmentation also increases edge habitat favoured by predatory species such as jays, crows, and magpies. Although there is only limited data for predation on Cape May Warblers, all forest songbirds face greater predation intensity as forests are cleared (Wilcove 1985; Yahner and Scott 1988; Askins et al. 1990).

Migration is typically the period of highest mortality for both adult and juvenile warblers. Cape May Warblers are particularly vulnerable to storms because their migratory path includes a considerable distance over water. Collision with light towers also kills hundreds of migrating Cape May Warblers annually in the eastern United States (Baltz and Latta 1998). Historical aerial spraying practices for spruce budworm were fatal for large numbers of warblers on the breeding ground (Pearce et al. 1979). Band return data also suggest that many are killed by domestic cats, and shot on the winter ground (Baltz and Latta 1998).

Habitat threats

The primary threat to the Cape May Warbler in British Columbia is the harvesting of mature to old-growth white spruce dominated stands within its restricted range in the Boreal Plains and Taiga Plains ecoprovinces. Loss or deterioration of forest habitat has been widely blamed for declines in breeding populations of many forest warbler species (Titterington et al. 1979; Burgess and Sharpe [editors] 1981; Askins and Philbrick 1987; Terborgh 1989; Hagan and Johnston 1992; Maurer and Heywood 1993). There is no evidence to suggest that the Cape May Warbler will respond differently (Cooper et al. 1997).

Habitat is also lost or fragmented by other activities such as clearing for agriculture, road building, transmission lines, and oil and gas exploration (Cooper et al. 1997).

Once harvested, it is estimated that clearcuts will require >100 years to regenerate to a stage suitable for Cape May Warblers (Cooper et al. 1997). In the northeast, the general forest management trend toward intensive silviculture for shorter rotations (Peterson et al. 1989) precludes regeneration of the highest quality nesting habitat (old growth >140 years) after a block has been harvested. In some tree farm licences (e.g., TFL 48 in Dawson Creek Forest District), the percentage of old-growth coniferous forests may be increasing as fire suppression reduces large-scale fire disturbances and younger stands continue to age faster than old-growth stands are logged or burned (A. de Vries, pers. comm.).

Large-scale spraying of insecticides, to control budworm outbreaks in coniferous forest habitat, inevitably reduces insect prey base (Freedman et al. 1981; Cooper et al. 1997; Baltz and Latta 1998).

The Cape May Warbler may be somewhat less affected than many other neotropical migrants by deforestation of tropical regions because this species uses a broad range of winter habitats where it is a foraging generalist (Baltz and Latta 1998). However, there is cause for concern for any species with a concentration of migrants from a huge breeding distribution funnelled into a relatively small winter range (Keast and Morton 1980). Therefore, Cape May Warbler populations are considered highly vulnerable to tropical deforestation in the main wintering range in the Bahamas and Greater Antilles (Terborgh 1989; Hagan and Johnston 1992; Rappole 1995). This may be important because it is usually populations at the edge of a species range, as in British Columbia, that are the first to decline when overall numbers decline (Wilcove and Terborgh 1984).

Legal Protection and Habitat Conservation

The Cape May Warbler, its nests, and its eggs are protected from direct persecution in Canada by the *Migratory Birds Convention Act*. In British Columbia, the same are protected under the provincial *Wildlife Act*.

Several Class A parks, ecological reserves, recreation areas, and proposed protected areas are within the range of the Cape May Warbler, although none include significant amounts of old-growth white spruce forest. Most nesting habitat is on Crown land; therefore, habitat conservation may be partially addressed by the old forest retention targets (old growth management areas), riparian reserves, and wildlife tree retention (WTR) areas in the results based code.

Since Cape May and Bay-breasted Warblers use similar habitats, areas (i.e., WHAs, OGMAs, WTR areas) established for one species will likely be useful for the other.

Identified Wildlife Provisions

Habitat management for this species is best conducted at the landscape level. Because populations are very local, are dispersed in a large geographic area, and respond so directly to prey availability, old growth management areas, riparian management areas, and protected areas scattered throughout the BWBS may be the best approach to managing habitat for this species.

Sustainable resource management and planning recommendations

- Maintain suitable nesting habitat. Consider greater old forest retention in forests with abundant large-stem spruce trees and recorded concentrations of Cape May Warblers.
- Incorporate old spruce into (1) old growth management areas (OGMAs); (2) areas constrained for other management objectives (e.g., visual quality, recreation, ungulate winter range, terrain concerns); or (3) stand level reserves such as wildlife tree retention areas and riparian management areas. Areas selected should include spruce forests with evidence of declining health for potential future spruce budworm outbreaks. Other characteristics of good habitat are stands of old-growth black or white spruce >140 years, flat topography, and open moss-dominated understoreys.
- Plan rotation age to ensure sufficient mature and old forest is maintained.
- Consider wildlife tree and old forest retention objectives for this species in the BWBSmw1 and BWBSmw2 in Fort Nelson and Peace forest districts. Blocks should be assessed to identify potentially suitable WTR areas. The following attributes should be used to design suitable WTR areas or OGMAs for this species (Table 1).
- Restrict salvage or harvest and avoid insecticide use.
- Maintain WTR area over the long term.

Table 1. Preferred WTR area characteristics for the Cape May Warbler

Attributes	Characteristics
Size (ha)	≥5 ha; larger are preferred
Location	BWBSmw1, BWBSmw2; flat topography
Features	open moss-dominated understoreys
Tree species	white spruce; coniferous species preferred
Age/structure	>140 years; structural stage >6

Wildlife habitat area

Goal

Although this species is likely best managed at the landscape level, where landscape level planning objectives cannot address critical areas for these species, then it may be appropriate to establish WHAs.

Feature

Establish WHAs only within highly suitable nesting habitat (i.e., in mature or old spruce forest) where concentrations (>3 pairs/10 ha) of Cape May Warblers regularly occur.

Size

Typically between 10 and 30 ha but will depend on site-specific factors.

Design

WHAs should include old spruce forest on flat topography with open moss-dominated understoreys. Minimize edge habitat wherever possible.

General wildlife measure

Goals

1. Ensure WHA is windfirm.
2. Maximize interior forest conditions.
3. Minimize disturbance during the nesting season (1 June to 15 July).

Measures

Access

- Do not construct roads, trails, or other access routes.

Harvesting and silviculture

- Do not harvest.

Pesticides

- Do not use pesticides.

Additional Management Considerations

Avoid prime Cape May Warbler habitat when planning seismic explorations, transmission lines, and other access routes.

Information Needs

1. Distribution.
2. Habitat use preferences.
3. Population estimates and trends.

Cross References

Bay-breasted Warbler, Black-throated Green Warbler

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Connecticut Warbler

Oporornis agilis

Original prepared by John M. Cooper
and Suzanne M. Beauchesne

Species Information

Taxonomy

The Connecticut Warbler is a neotropical migrant songbird and one of three species of warbler in the genus *Oporornis* that breeds in British Columbia (Campbell et al. 2001). No subspecies of Connecticut Warbler are recognized (Pitocchelli et al. 1997; Cannings 1998).

Description

A small (13–15 cm) songbird, adapted for life on or near the forest floor, which is reflected in relatively long legs on a stout body. In breeding plumage, the male has a grey hood extending to the lower throat; a complete whitish eye ring; olive to olive brown, unstreaked upper parts; and yellowish under parts. Females are similar but duller, and immatures are duller still, with a brownish hood. The primary distinguishing feature, separating Connecticut Warbler from Mourning and McGillivray's warblers, is the complete whitish eye ring, which is present in both sexes, all age classes, and at all times of year (Pyle 1997). Males are distinguished from Mourning and McGillivray's warblers by lack of black on upper breast.

Distribution

Global

The Connecticut Warbler breeds in a narrow band across Canada from southwestern Northwest Territories (Machtans 2000) east to western Quebec and, in the United States, in northern Minnesota, Wisconsin, and Michigan (Godfrey 1986). Most of the breeding range is in Canada. This species winter range is poorly known; however, it has wintered in the Amazon River basin (Colombia to Brazil) (AOU 1983; Pitocchelli et al. 1997).

British Columbia

The Connecticut Warbler reaches the northwestern extreme of its breeding range in northeastern British Columbia where it occurs mainly in the Peace Lowland and Kiskatinaw Plateau ecosections of the Boreal Plains Ecoprovince (Campbell et al. 2001). Small numbers have been reported from the Fort Nelson Lowland near Fort Nelson (Erskine and Davidson 1976; Campbell et al. 2001).

Forest regions and districts

Northern Interior: Fort Nelson, Peace

Ecoprovinces and ecosections

TAP: FNL
BOP: CLH, HAP, KIP, PEL

Biogeoclimatic units

BWBS: mw1, mw2

Broad ecosystem units

BA, PR

Elevation

400–1100 m (Campbell et al. 2001)

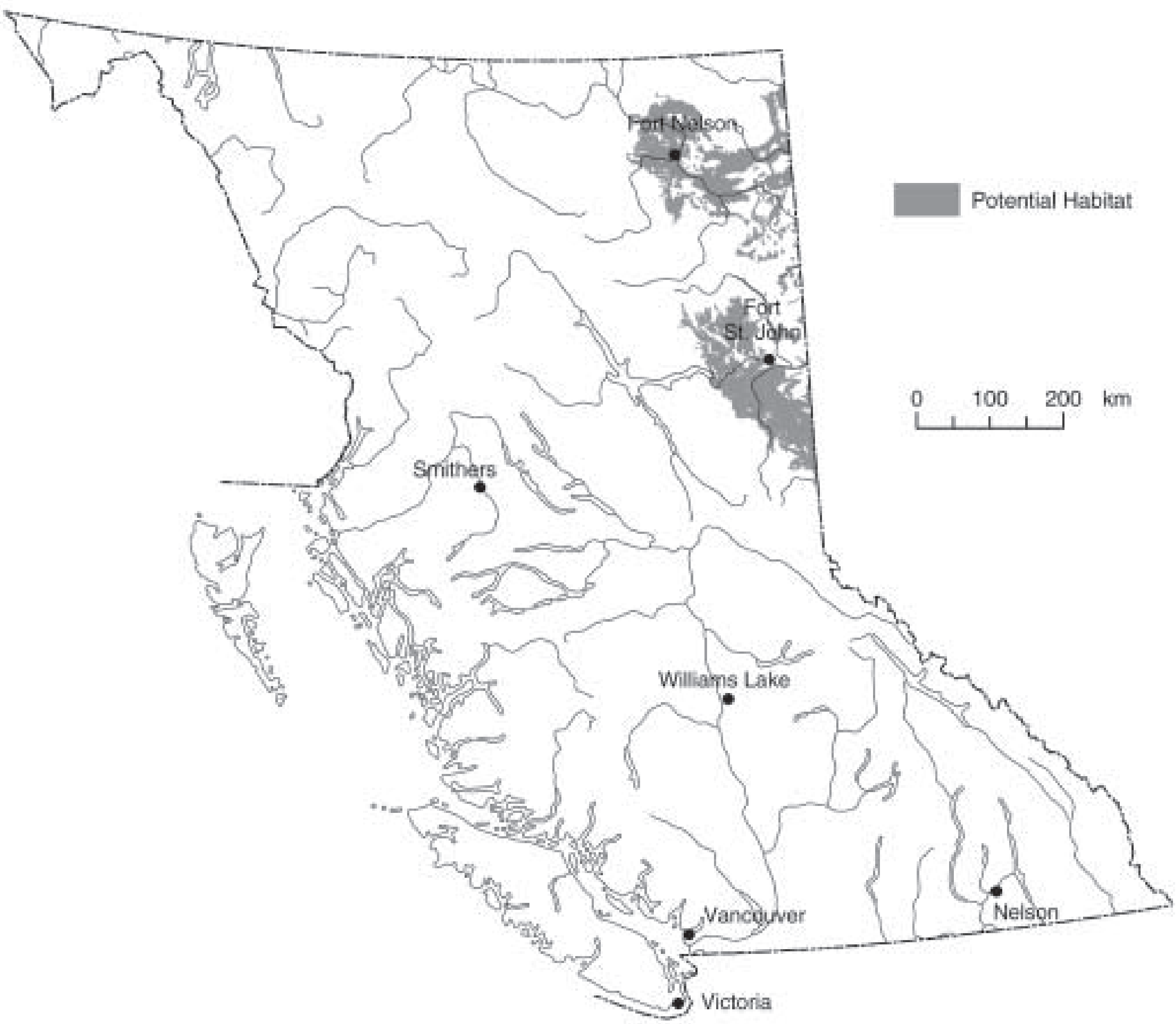
Life History

Very little is known about the specifics of the ecology of the Connecticut Warbler in British Columbia and many details are lacking from elsewhere in its range. Much of the following information is inferred from observations from eastern North America, except where noted.

Diet and foraging behaviour

The Connecticut Warbler is primarily an insectivorous bird that eats a variety of small insects, spiders, snails, eggs of spiders and insects, berries, and seeds (Bent 1953). It feeds mainly by gleaning prey from the ground, along fallen logs, and from

Connecticut Warbler
(Oporornis agilis)



Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on several ecosystem classifications (Ecoregion, Biogeoclimatic and Broad Ecosystem Inventory) as well as current knowledge of the species' habitat preferences. This species may or may not occur in all areas indicated.

foliage of low shrubs and herbs (Bent 1953; Griscom and Sprunt 1957; Curson et al. 1994). In British Columbia, most foraging is done within the shrub layer or along the ground (Enns and Siddle 1992).

Reproduction

Upon arriving on the breeding grounds, males select nesting territories and defend them from other conspecific males. Pairs form soon after and are presumably monogamous (Ehrlich et al. 1988; Pitocchelli et al. 1997). Information is lacking on nest construction (Pitocchelli et al. 1997). Nests are compact, deep cups of fine grass and rootlets lined with finer grass and hair (Baicich and Harrison 1997). Clutches contain three to five eggs (Bent 1953; Baicich and Harrison 1997). Egg-laying likely occurs mainly in mid- to late June in northeastern British Columbia (Campbell et al. 2001). The female alone incubates the eggs for an estimated 12–13 days (Bent 1953; Baicich and Harrison 1997). The nestling period is unknown, but is probably similar to the Kentucky Warbler, whose nestlings leave the nest after 8–10 days (Bent 1953; Baicich and Harrison 1997). Both parents feed the nestlings, landing with food 10–15 m from the nest and walking through the underbrush the remaining distance. Fledglings probably cannot fly for the first week and are cared for by both parents for at least 2 weeks (Bent 1953; Pitocchelli et al. 1997). A single brood is probably raised each year in British Columbia, a widespread pattern in warblers (Morse 1989). There are no data for Connecticut Warblers on hatching success, survival of nestlings, or fledging success anywhere in its range (Pitocchelli et al. 1997). The first nest found in British Columbia (spring 2002) contained five eggs on June 19, five well-feathered chicks on July 8 which left the nest by July 10.

Site fidelity

No data but likely return to same areas. There are no data to suggest that populations expand and contract in response to changes in prey availability (Cooper et al. 1997).

Home range/territory size

Data on breeding territory size is limited, however one study in Minnesota found territory sizes to range from 0.24 to 0.48 ha (Niemi and Hanowski 1984). In west-central Alberta, density of territorial males in 30-year-old aspen forest was 4.4/100 ha (Westworth and Telfer 1993). Lance and Phinney (1994) reported 4 pairs in one 32 ha study plot in northeastern British Columbia.

Dispersal and movements

Connecticut Warblers winter further south than most other North American warblers and so have a longer distance to travel during migration. They arrive in Canada later and leave earlier than most other warblers except for Mourning and Canada warblers (Cowan 1939; Salt 1973; Francis and Cooke 1986). Males probably arrive slightly earlier than females, a general pattern in many bird species. Spring migrants enter the province through northern Alberta, beginning in the last few days of May, with most probably arriving in early June (Campbell et al. 2001).

After nesting is completed, adults probably begin to migrate south in mid- to late July and juveniles probably follow in mid-August (Cooper et al. 1997).

Habitat

Structural stage

5: young forest
6: mature forest
7: old forest

Important habitats and habitat features

Nesting

Connecticut Warbler populations in different geographic regions may occupy somewhat different forest types, but all habitat descriptions from the western limit of its range (Saskatchewan, Alberta, and British Columbia) include deciduous, mainly aspen, forest (Johns 1993). In British Columbia, Connecticut Warblers generally breed in deciduous, often in pure trembling aspen (*Populus tremuloides*) stands, although aspen and spruce (*Picea* spp.), and balsam poplar (*Populus balsamifera*) and white spruce (*Picea glauca*) forests are also used.

There is some disagreement as to the preferred forest age in British Columbia. Although recent clearcuts are not used, breeding territories have been documented in forests from pole stage to old forest (>80 years old) (Westworth and Associates Ltd. 1984; Enns and Siddle 1992; Westworth and Telfer 1993; Lance and Phinney 1994). Pole age forests are probably the minimum growth stage suitable for this warbler as it has not been found in recent clearcut slash, sapling, or early pole seral stands (Lance and Phinney 1993, 1994; Westworth and Telfer 1993). It is not known whether pole stage forests are suitable or are possibly population sinks. Since this species nests on the ground or near the ground, structure may not be as important as development of appropriate herbaceous and understorey layers.

The herbaceous and shrub layers are probably the most important habitat features as this warbler forages almost exclusively on, or very near, the ground. Only one nest has been found in British Columbia (Campbell et al. 2001; M. Phinney, pers. comm.), however, the presence of singing males suggests breeding occurs at various localities. The one nest in British Columbia was found in a patch of pole-stage aspen trees within a larger multi-aged aspen mosaic. The nest was on the ground, situated under a dead stick and concealed from above by dead grasses and lush greenery (grasses, rose, peavine, columbine) (M. Phinney, pers. comm.) Some common characteristics of reported Connecticut Warbler nesting habitat in British Columbia include variable-aged forest with plenty of free mid-canopy level space, noticeable gaps in cover between the dense, shrubby understorey and the even, high canopy.

Nest site microhabitat seems to be relatively constant throughout its range (Baicich and Harrison 1997). The ground cover at nest sites can be characterized as richly vegetated and an overstorey of late pole or older stage forest is required. Nests are placed on the ground among herbs and grass or at the base of a sapling, in mossy hummocks, or a few inches off the ground in the base of a shrub (often wild rose), and are usually well concealed by overhanging vegetation (Bent 1953; Baicich and Harrison 1997). In northeastern British Columbia, most breeding territories seem to be on "warm" (south- or west-facing slopes) sites (M. Phinney, pers. comm.).

Associated species include tall bluebell, white geranium, baneberry, rose, northern bedstraw, red-osier dogwood, willow, bluegrass, wildrye, timothy, paintbrush, junegrass, bunchberry, soopolallie, fireweed, American vetch and purple peavine, spruce are often interspersed sporadically throughout the stand (McTaggart-Cowan 1939; Penner 1976; Siddle 1992; Enns and Siddle 1992; Lance and Phinney 1993, 1994).

Habitat patch size seems critical as Connecticut Warblers do not seem to occupy aspen groves <4 ha in size (Johns 1993). In northeastern British Columbia, suitable habitat <5 ha may be used if it is within a larger forested area (Phinney, pers. comm.).

Low intensity spring ground fires may be important in maintaining suitable habitat (i.e., promotes herb layer and reduces shrub layer).

Foraging

Birds probably forage mainly within the nesting habitat, therefore feeding and nesting habitat requirements are the same.

Conservation and Management

Status

The Connecticut Warbler is on the provincial *Red List* in British Columbia. Its status in Canada has not been determined (COSEWIC 2002).

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

BC	AB	Canada	Global
S2B, S2N	S4B	N5B	G4

Trends

Population trends

There are no data on population trends for Connecticut Warbler in British Columbia. Recent studies in northeastern British Columbia have shown conflicting results. Some authors reported Connecticut Warblers to be one of the least common warbler species in the northeast (Siddle 1992; Enns and Siddle 1992), while others suggest it may be more widespread and numerous (but still of local occurrence) than currently documented (Lance and Phinney 1993, 1994; Phinney 1998; Bennett et al. 2000). Data from the Fort Nelson Lowland are few, but Connecticut Warblers may occur there more frequently than is currently known as well (Cooper et al. 1997). Flack (1976) also suspects that, throughout its range, the Connecticut Warbler is more locally common and widely distributed than generally thought.

However, some authors believe all northeastern warblers are in decline (Siddle 1992). Rappole (1995) lists Connecticut Warbler amongst the neotropical migrants with a high probability of population decline in the next decade due to loss of winter habitat. This may be important because low-density breeding populations, particularly those at the edge of a species range, as in British Columbia, are usually the first to decline when overall numbers decline (Wilcove and Terborgh 1984). A comprehensive analysis of Breeding Bird Surveys from eastern North America revealed no significant population trends for the Connecticut Warbler between 1966 to 1988 (Hagan and Johnston 1992).

Considering the widespread population declines of neotropical migrants (Morton and Greenberg 1989; Terborgh 1989; Finch 1991), the overall lack of records for Connecticut Warblers in British Columbia, and the fact that this species relies on habitat in decline, it is probable that populations are stable or decreasing, and improbable that populations are increasing (Cooper et al. 1997).

Habitat trends

Trends in nesting habitat quantity for Connecticut Warblers are directly linked with harvesting of aspen stands (Cooper et al. 1997). An estimated 1800–4000 ha of aspen mixedwood forest is being harvested annually in the northeast (MOF 1994). Forests on flat, rolling topography, which may contain some of the best habitat, are being harvested at the greatest rate because of easy access (Cooper et al. 1997).

Threats

Population threats

The impact of nest parasitism by Brown-head Cowbirds is thought to be severe on neotropical migrant songbirds, especially in fragmented forests (Brittingham and Temple 1983; Askins et al. 1990; Hagan and Johnston 1992; Finch and Stangel 1993). Connecticut Warblers are known to be parasitized by cowbirds; however, the extent of parasitism has not been documented because of lack of nesting records (Pitocchelli et al. 1997). However, it is likely that the rate of parasitism will increase with increasing fragmentation of northeastern forests.

Forest fragmentation also increases edge habitat favoured by predatory species such as jays, crows, and magpies. Although there are no data for predation on Connecticut Warblers, all forest songbirds face greater predation intensity as forests are cleared (Wilcove 1985; Yahner and Scott 1988; Askins et al. 1990).

Migration is typically the period of highest mortality for both adult and juvenile warblers with hazards including natural environmental factors such as inclement weather and human-related factors such as collision with light towers (Pitocchelli et al. 1997).

Habitat threats

The primary threat to the Connecticut Warbler in British Columbia is the harvesting of aspen stands in northeastern British Columbia. Loss or deterioration of forest habitat has been widely blamed for declines in breeding populations of many warbler species (Burgess and Sharpe 1981; Askins and Philbrick

1987; Terborgh 1989; Saunders et al. 1991; Hagan and Johnston 1992; Maurer and Heywood 1993). Research within northeastern British Columbia suggests that this warbler will be eliminated in the short term from clearcut blocks of aspen forest and will not recolonize these areas unless it is allowed to regenerate to the late pole stage (>10 cm dbh and >35–40 years; Cooper et al. 1997).

Timber harvest and shortening of harvest rotation cycles (Peterson et al. 1989) is rapidly reducing the amount of mature aspen and mixedwood forest within this species range. As a result, the age-class distribution of deciduous forests in the northeast is expected to change dramatically. In the Dawson Creek Timber Supply Area (TSA), it is projected that age-class distribution will be primarily <50 years of age in 50 years. In the early 1990s, there were approximately 112 000 ha of deciduous forest >80 years of age. However in 100 years, less than 12 000 ha of deciduous forest is forecast to be >80 years of age. Only aspen stands that are difficult to access, often due to a steep slope location, or reserved for other reasons, are not targeted for harvest (MOF 1994). It is not known if these areas are suitable for Connecticut Warblers.

Fragmentation effects are very important for this species as well. In Saskatchewan, there was a significant negative trend of occurrence with increasing isolation of suitable habitat (Johns 1993). Therefore, as habitat becomes increasingly fragmented, Connecticut Warblers are less able to use isolated suitable patches of habitat.

Silvicultural techniques that alter the shrub component, debris structure, and the eventual plant species distribution in mixedwood stands may also reduce the suitability of habitat for Connecticut Warblers (Cooper et al. 1997). Application of herbicides to eliminate deciduous forest and understoreys would reduce habitat availability (Cooper et al. 1997). Large-scale spraying of insecticides in deciduous forest habitat would inevitably reduce their insect prey base and therefore the quality of habitat available (Freedman et al. 1981).

Fire suppression may also be detrimental to Connecticut Warbler nesting habitat. Occasional fire may play a role in creating the habitat features, specifically the herbaceous and shrub development required by this species. However, regular prescribed burning to create ungulate winter range eliminates forest and potential Connecticut Warbler habitat (M. Phinney, pers. comm.).

In the Dawson Creek TSA, many of the pure stands of large aspen occur on private land adjacent to agricultural fields. Harvesting is currently taking place on private land, with an unknown area being converted to agricultural fields. This area is unlikely to revert to a mixedwood forest in the future (Cooper et al. 1997).

Grazing by domestic animals affects the herbaceous and shrub vegetation layers, which are important habitat features for this species. The precise impacts of grazing are not known but heavy grazing is likely very negative and light grazing may be compatible. Heavy grazing is bound to be detrimental to habitat quality (M. Phinney, pers. comm.).

Habitat is also lost or fragmented by other activities such as clearing for road building, transmission lines, and oil and gas exploration. For example, breeding territories in Minnesota were found to be farther from power lines than control plots with similar characteristics, suggesting that power line rights-of-way created unfavourable edge habitat (Niemi and Hanowski 1984).

Loss of winter habitat is expected to reduce the continental population, which may then be reflected in British Columbia's breeding population (Rappole 1995).

Legal Protection and Habitat Conservation

The Connecticut Warbler, its nests, and its eggs are protected from direct persecution in Canada by the *Migratory Birds Convention Act*. In British Columbia, the same are protected under the provincial *Wildlife Act*.

Like most warblers, this species is widely scattered on the breeding grounds. In British Columbia, small numbers are likely protected in various reserves and parks but data are generally lacking. Siddle (1992) lists Gundy, north of Tupper, and Cecil Lake as areas of consistent occurrence, but densities of birds and status of lands are uncertain. Class A parks such as Taylor Landing (2.4 ha), Kiskatinaw River (154 ha), and Beatton (312 ha) are within the known range and habitat type of this species, although records may be lacking. Belcourt River, Peace Boudreau Protected Area, and other proposed protected areas also have suitable habitat (Cooper et al. 1997).

Most other nesting habitat is on Crown land; therefore, habitat conservation may be partially addressed by the old forest retention targets (old growth management areas) riparian reserves and wildlife tree retention area recommendations as required under the results based code.

In addition, forest structure and species composition, especially the herbaceous and understorey layers, may be addressed by guidelines in the *Range Management Guidebook*. However, typical range management practices for livestock in the Dawson Creek area seem to preclude use of grazed areas by Connecticut Warblers (M. Phinney, pers. comm.). Grazing typically removes or damages the structural integrity of herbaceous and shrub layers. Light grazing may not be detrimental, but grazing in the northeast tends to be heavy where it occurs (M. Phinney, pers. comm.).

Identified Wildlife Provisions

The habitat for Connecticut Warblers is unique among northeastern songbirds at risk; therefore, habitat must be specifically managed for this species.

Sustainable resource management and planning recommendations

- ❖ Maintain suitable nesting habitat (deciduous leading stands). Consider greater mature or old retention in areas where this species is known to occur.
- ❖ Incorporate stands of pure trembling aspen and mixedwood forest within the Boreal Plains Ecoprovince into (1) old growth management areas; (2) areas constrained for other management objectives (e.g., visual quality, recreation, ungulate winter range, terrain concerns); or (3) stand level reserves such as wildlife tree retention areas and riparian management areas.
- ❖ Wildlife tree retention areas (WTR areas) and old growth management areas (OGMAs) may be suitable alternatives to wildlife habitat areas if centred on habitat used by Connecticut Warblers and at least 5–10 ha. Consider wildlife tree and old forest retention objectives for this species in the BWBSmw1, BWBSmw2 in Fort Nelson, and Peace forest districts. Blocks should be assessed to identify potentially suitable WTR areas. The following attributes (Table 1) should be used to design suitable WTR areas or OGMAs for this species.

Table 1. Preferred WTR area characteristics for the Connecticut Warbler

Attributes	Characteristics
Size (ha)	≥5 ha
Location	BWBSmw1, BWBSmw2; flat to gently sloping sites with southerly to westerly aspects
Features	herbaceous and shrub layers
Tree species	aspen; deciduous species
Age/structure	≥40 years; structural stages 5–7

- ❖ Maximize interior forest conditions of reserves, restrict salvage or harvest, maintain over the long term, and avoid insecticide use.
- ❖ Maintain corridors of forest habitat suitable for Connecticut Warbler where possible to reduce the impact of harvesting on this species (Cooper et al. 1997). Habitat corridors that connect patches of forest are proving to be an important factor in retaining bird community diversity in isolated patches (MacClintock et al. 1977), especially for ground-dwelling migratory birds such as Connecticut Warbler.

Wildlife habitat area

Goal

Maintain suitable nesting habitats. Consider size and shape of the WHA to minimize edge habitat.

Feature

Establish WHAs only within highly suitable nesting habitat (i.e., deciduous-leading forests) where concentrations (>3 pairs/10 ha) of Connecticut Warblers occur.

Size

Typically between 20 and 40 ha but will depend on site-specific factors.

Design

WHAs should include aspen or mixedwood stands with lush understoreys of herbs, within a larger undisturbed tract of forest. Consider locating in mesic or riparian sites and close to other protected forest areas or constrained areas (e.g., riparian reserve zones, sites with sensitive slopes, or soils). Minimize edge habitat wherever possible.

General wildlife measure

Goals

1. Ensure WHA is windfirm.
2. Maintain the herbaceous community.
3. Minimize disturbance during the nesting season (1 June to 31 July).
4. Minimize disturbance to nests.

Measures

Access

- Do not construct roads, trails, or other access routes.

Harvesting and silviculture

- Do not harvest.

Pesticides

- Do not use pesticides.

Range

- Plan livestock grazing (i.e., timing and browse utilization) to minimize negative impacts to this species. The "desired plant community," including seral stage mix, species composition (i.e., aspen and deciduous species), and structural characteristics (i.e., understorey vegetation) should be maintained.
- Grazing after the nesting season (after 31 July) is preferable.
- Limit grazing of herb/forb species by livestock to no more than 50% utilization.
- Do not place livestock attractants within WHA.

Additional Management Considerations

Avoid prime Connecticut Warbler habitat when planning seismic explorations, transmission lines, and other access routes.

Information Needs

1. Distribution, population size, and trends.
2. Habitat suitability, especially the minimum suitable "desired plant community," forest age class, and minimum patch size.
3. Effects of timber harvest, silviculture practices, and range management practices on populations and habitat.

Cross References

Black-throated Green Warbler, Bay-breasted Warbler, Cape May Warbler

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Nelson's Sharp-tailed Sparrow

Ammodramus nelsoni

Original prepared by John M. Cooper and Suzanne M. Beauchesne

Species Information

Taxonomy

Nelson's Sharp-tailed Sparrow and Saltmarsh Sharp-tailed Sparrow (*Ammodramus caudacutus*) were considered conspecific, as Sharp-tailed Sparrow, until 1995 (AOU 1995) when Sharp-tailed Sparrow was separated into two species based on morphological and behavioural differences (Greenlaw 1993; Rising and Avise 1993; Greenlaw and Rising 1994; Rising 1996). There are three recognized subspecies of Nelson's Sharp-tailed Sparrow. Of the three subspecies, only *A. nelsoni nelsoni* occurs in British Columbia (AOU 1957; Cannings 1998).

Two other subspecies breed in eastern North America: *A. nelsoni alterus* in saltmarshes along the coast of James Bay and Hudson Bay, and *A. nelsoni subvirgatus* along the coast of the St. Lawrence River estuary, Gaspe Peninsula, New Brunswick, Prince Edward Island, Nova Scotia, and Maine south to the Delmarva Peninsula.

Description

This sparrow has a buffy orange face (broad eyebrow and malar stripe) with grey ear coverts. The crown consists of a grey stripe bordered by dark brown lateral stripes. The upper parts are olive brown with distinct greyish or white streaking on the back and grey on the sides of the neck. The breast is ochre with darker streaks on the sides. The abdomen is white. The tail is brown and tapered. Sexes are similar. Juveniles are similar but facial markings are less distinct and the ear covert is brown, not grey.

Distribution

Global

Ammodramus nelsoni nelsoni, found in north-eastern British Columbia, ranges from southern District of Mackenzie through northern Alberta, central Saskatchewan, and southwestern Manitoba to South Dakota, Minnesota, and rarely Wisconsin. All three subspecies of Nelson's Sharp-tailed Sparrow primarily winter along the southern Atlantic and Gulf of Mexico coasts although small numbers are regularly found in appropriate habitat on the California coast (Greenlaw and Rising 1994).

British Columbia

Nelson's Sharp-tailed Sparrow is an uncommon summer visitor to the Peace Lowlands of British Columbia. Known from only 13 sites, of which five are likely only frequented on unusually wet years, it has one of the most restricted distributions of any passerine occurring in British Columbia. There are only two confirmed nesting records for British Columbia. There is one record of a fall vagrant near Vancouver (Campbell et al. 2001).

Forest regions and districts

Northern Interior: Peace

Ecoprovinces and ecosections

BOP: PEL, KIP

Biogeoclimatic units

BWBS: mw1

Broad ecosystem units

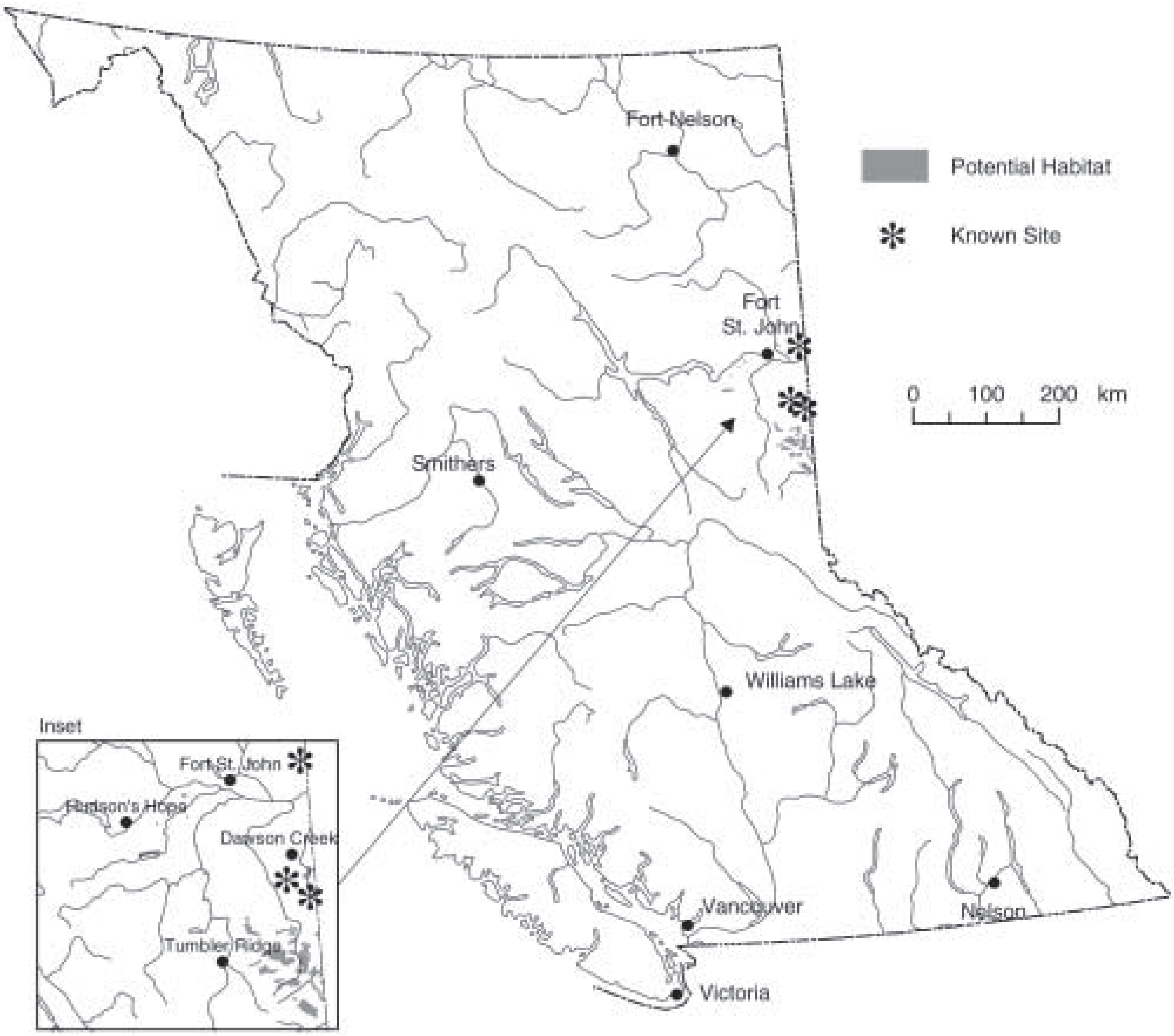
LL, LS, WL

Elevation

690–800 m (Campbell et al. 2001).

Nelson's Sharp-tailed Sparrow

(Ammodramus nelsoni)



Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on several ecosystem classifications (Ecoregion, Biogeoclimatic and Broad Ecosystem Inventory) as well as current knowledge of the species' habitat preferences. This species may or may not occur in all areas indicated.

Life History

Very little is known about the specifics of Nelson's Sharp-tailed Sparrow biology within British Columbia, therefore most of the following information is inferred from studies outside the province.

Diet and foraging behaviour

During the breeding season, adults feed primarily on insects, spiders, amphipods, molluscs, and other invertebrates. This diet may be supplemented with seeds (Greenlaw and Rising 1994).

Reproduction

No pair bonds are formed. A dominant male may breed with more than one female. It is generally believed that the female alone builds the nest, incubates the eggs, and apparently provides all parental care although males have been observed bringing food to the nest (Greenlaw and Rising 1994; M. Phinney, pers. comm.). Clutches contain four or five eggs; eggs are incubated for about 11 days; nestlings fledge after about 10 days and fledglings remain dependent on the female for another 2–3 weeks (Semenchuk 1992; Baicich and Harrison 1997). One brood is probably produced annually; however, restarts after nest failure have been documented (Greenlaw and Rising 1994). In British Columbia, based on two nest records, the calculated occurrence of nests with eggs or young is between 27 June and 17 July (Campbell et al. 2001). Adults and young probably leave nesting grounds and begin migration shortly after young are independent (Greenlaw and Rising 1994; Campbell et al. 2001).

Site fidelity

This species is believed to regularly use seven of the known sites in British Columbia.

Home range

Males are non-territorial, and establish large, overlapping home ranges. Females establish smaller home ranges than males, which may overlap with other females. In good habitat, active nests may be located within metres of one another (Greenlaw and Rising 1994).

Migration and dispersal

Nelson's Sharp-tailed Sparrow is a migratory songbird. Birds apparently move directly to the breeding grounds upon arrival in the province in spring. Although movements in British Columbia are poorly documented, the earliest spring record is 8 June and the latest fall record is 12 September.

Habitat

Structural stage

2: herb

Important habitats and habitat features

Nesting

Grassy areas within wetlands, usually near-dead or living willows (*Salix* spp.) are used. Wetlands with persistent grasses and patches of willows or other emergent vegetation are important nesting habitat (Greenlaw and Rising 1994). In British Columbia, this sparrow has been found in marshes at the edge of woodland lakes, between creeks and wet meadows, and on willow covered islets on lakes. In wet years it may also use smaller wetlands. Only two nests have been found in British Columbia. Both were in clumps of tall, dry grass, one directly over water and the other near a water channel (Campbell et al. 2001). Known breeding sites in British Columbia are larger (>5 ha) W1 class hydrophytic wetlands, but smaller (1–5 ha) wetlands are also likely used, especially in wet years.

It is likely that the availability of suitable wetlands is the most significant limiting factor influencing Nelson's Sharp-tailed Sparrow distribution and abundance.

Foraging

Birds probably feed exclusively within the nesting habitat, therefore feeding and nesting habitat requirements are the same.

Wintering

This species winters in coastal saltmarsh habitat (Greenlaw and Rising 1994).

Migration

Habitat requirements unknown. The use of transitional habitats during migration in British Columbia has not been documented (Campbell et al. 2001).

Conservation and Management

Status

The Nelson's Sharp-tailed Sparrow is on the provincial *Red List* in British Columbia. It is considered *Not at Risk* in Canada (COSEWIC 2002).

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

BC	AB	MT	NWT	WA	Canada	Global
S2B, S2N	S3B	S1B, S2N	S?	S?	N5B	G5

Trends

Population trends

No population trend data are available for British Columbia. To date only 13 sites are known. This sparrow's extremely secretive habits make populations difficult to assess and there are no data for breeding population density for this species (Greenlaw and Rising 1994). In general, population data are also sparse throughout the species range; however, prairie birds apparently occur in local, scattered groups that may consist of only a small number of birds (Semenchuk 1992; Siddle 1992; C. Siddle field notes).

Habitat trends

At least one historic site in British Columbia has been drained making it unsuitable for this species while, outside of the province, the Nelson's Sharp-tailed Sparrow has also been extirpated from parts of its range due to habitat loss (Greenlaw and Rising 1994; Campbell et al. 2001).

Threats

Population threats

This species has an extremely small, localized population in British Columbia which may increase its risk of extirpation. There have been only two breeding records in British Columbia. Based on available information, there are estimated to be fewer than 50 birds known from only 13 sites in British Columbia.

Habitat threats

The primary threat to this species habitat in British Columbia is the loss of wetland nesting habitat. Wetlands are vulnerable to change from any activity that impacts water level, water quality, or the surrounding vegetation. Significant changes in water levels can result from intensive forestry activity. Trampling of marsh vegetation by livestock, or use of machinery along wetland edges could also negatively impact habitat quality by crushing grasses and shrubs. Agriculture practices can also affect both water level and quality through draining, infilling, or pesticide or herbicide spraying. Flooding wetland habitats to enhance habitat for other species can be detrimental to Nelson's Sharp-tailed Sparrows, at least in the short term. Nesting habitat can also be disturbed by domestic animals or human activities such as recreation.

Elsewhere, the species as a whole is vulnerable because it overwinters in localized, concentrated groups in threatened coastal saltmarsh habitat (Greenlaw and Rising 1994).

Legal Protection and Habitat Conservation

The Nelson's Sharp-tailed Sparrow, its nests, and its eggs are protected from direct persecution in Canada by the *Migratory Birds Convention Act*. In British Columbia, the same are protected under the provincial *Wildlife Act*.

Nesting sites are currently conserved in Boundary Lake Ecological Reserve and Nature Trust land (McQueen's Slough). Ducks Unlimited also maintains some wetland habitats. On Crown land conservation of habitat may be partially addressed by the wetlands and lakes management recommendations and the range use guidelines for riparian areas. For small wetlands (class W3), the riparian guidelines may not be sufficient to protect nesting habitat.

Identified Wildlife Provisions

Wildlife habitat area

Goal

Maintain suitable nesting habitat.

Feature

Establish WHAs at known breeding sites or sites with high suitability nesting habitat.

Size

At least 1 ha but will depend on site-specific factors such as size of the wetland and extent of riparian vegetation.

Design

For wetlands <5 ha, the WHA should include the wetland and surrounding emergent and riparian areas. For wetlands >5 ha, the WHA should include 5 ha around the nesting area and include surrounding riparian vegetation.

General wildlife measure

Goals

1. Minimize trampling of marsh vegetation by livestock.
2. Minimize damage to vegetation structure.
3. Maintain important structural components (i.e., willow species, emergent vegetation).
4. Maintain hydrological conditions and water quality.
5. Maintain WHA in a properly functioning condition.

Measures

Access

- Do not construct roads or trails.

Harvesting and silviculture

- Do not harvest.

Pesticides

- Do not use pesticides.

Range

- Control livestock grazing (i.e., timing distribution and level of use). Fencing may be required by the statutory decision maker.
- Maintain shrub community (willow). Limit browse utilization by livestock to no more than 10%.
- Do not place livestock attractants within WHA.

Recreation

- Do not establish recreation sites or trails.

Additional Management Considerations

Within the breeding range of this species (Peace Lowland and Kiskatinaw Plateau ecosections), timber harvest adjacent to W1 wetlands should be within the retention levels suggested for this region in the results based code, but higher retention levels should be considered in RMAs adjacent to known breeding wetlands or WHAs established for this species.

Seismic explorations which cross wetlands suitable for, or known to be used by, Nelson's Sharp-tailed Sparrow, should be planned in such a way that damage to vegetation structure is minimized, and during times that will not disturb the species.

Protect wetlands from drainage.

Maintain hydrological wetland characteristics (i.e., avoid building roads or culverts that could impact water flow into wetland).

Minimize negative impacts on water quality, water levels, or structure of emergent vegetation.

Maintain at least a 10 m reserve zone around small wetlands (<5 ha) with persistent grasses and patches of willows.

Information Needs

1. Inventory of wetlands >1 ha near known nesting wetlands.

Cross References

Sandhill Crane, Short-eared Owl

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"Columbian" Sharp-tailed Grouse

Tympanuchus phasianellus columbianus

Original prepared by R.W. Ritcey and Doug Jury

Species Information

Taxonomy

The Columbian Sharp-tailed Grouse is one of six subspecies of Sharp-tailed Grouse, a species found only in North America. Three subspecies occur in British Columbia: *Tympanuchus phasianellus columbianus*, *T. phasianellus caurus*, and *T. phasianellus jamesi*.

Description

Medium-sized grouse (length 41–48 cm; weight 596–1031 g); both sexes have similar plumage; overall cryptically coloured; white breast with several V-shaped brown markings; head, neck, and back are heavily barred dark brown, black, and buff; wedge-shaped tail; two middle tail feathers extend past other tail features. During display, males can be identified by pink air sacs on either side of neck and by linearly marked central rectrices (Tirhi 1995, Connelly et al. 1998).

Distribution

Global

Sharp-tailed Grouse range from north-central Alaska and the Yukon east to central-western Quebec, south through the western North American interior to eastern Oregon, northern Utah, Colorado, Minnesota, and northern Michigan. The Columbian Sharp-tailed Grouse occurs in parts of the intermountain or Great Basin region of western North America from southcentral British Columbia south to Colorado. In Idaho, Montana, Utah, and Wyoming, it inhabits <10% of its historic range; in Colorado and Washington from 10 to 50% of its original range; in British Columbia the estimate is from approximately 80% (Tirhi 1995).

British Columbia

In British Columbia, the Columbian subspecies is found from near Vanderhoof south to Merritt, east to the Cariboo Mountains, and west to the Coast Ranges.

Forest region and districts

Northern Interior: Vanderhoof

Southern Interior: 100 Mile House, Arrow Boundary, Cascades, Central Cariboo, Chilcotin, Kamloops, Okanagan Shuswap, Quesnel, Rocky Mountain

Ecoprovinces and ecosections

CEI: BUB, CAB, CCR, CHP, FRB, NAU, QUL

SBI: BAU, NEL

SIM: EKT, UCV

SOI: GUU, NIB, NOB, NOH, NTU, OKR, PAR, SHB, SOB, SOH, STU, THB, TRU

Biogeoclimatic units

BG: xh1, xh2, xh3, xw, xw1, xw2

IDF: dk1, dk2, dk3, dk4, dm1, dm2, mw1, mw2, mw2a, un, xh1, xh1a, xh2, xh2a, xh2b, xm, xw, xw2

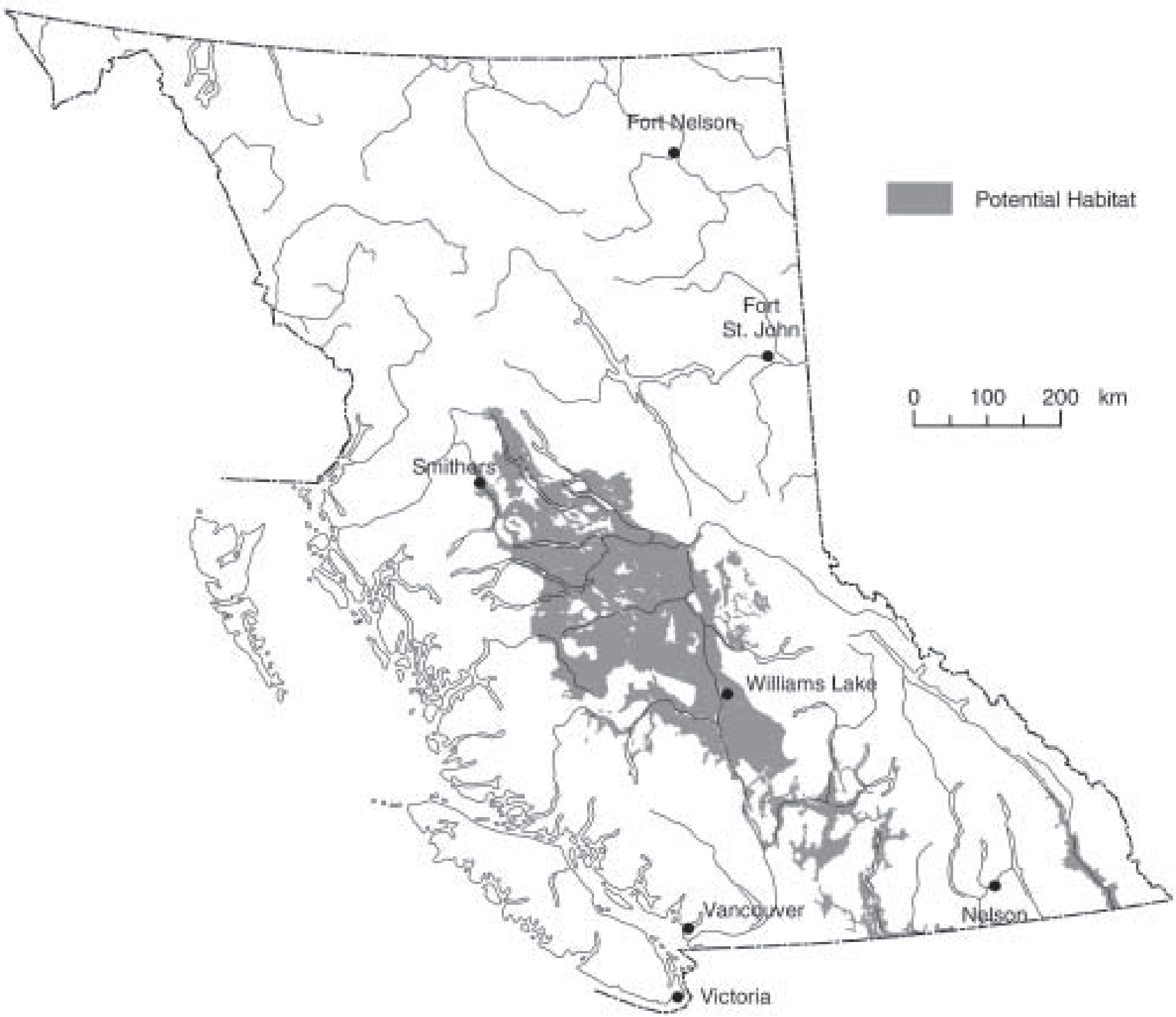
PP: dh1, dh2, xh1, xh1a, xh2, xh2a

SBS: dk, dw2, dw3, mh

SBPS: xc

Sharp-tailed Grouse - subspecies *columbianus*

(*Tympanuchus phasianellus columbianus*)



Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on several ecosystem classifications (Ecoregion, Biogeoclimatic and Broad Ecosystem Inventory) as well as current knowledge of the species' habitat preferences. This species may or may not occur in all areas indicated. More detailed maps are available for this species from the Ministry of Sustainable Resource Management.

Broad ecosystem units

Season									
Breeding		Nesting		Summer		Fall		Winter	
Unit	Structural stage	Unit	Structural stage	Unit	Structural stage	Unit	Structural stage	Unit	Structural stage
BS	all	AC	2,3	AC	2,3	AC	all	BS	all
DF	2,3	BS	all	BS	all	BS	all	CF	all
DL	2,3	CF	all	CF	all	CF	all	CR	all
LP	2,3	DL	2,3	DL	2,3	CR	all	DL	2,3,4
PP	2,3	DP	2,3	DP	2,3	DL	2,3,4	DP	all
		PP	2–7	PP	2,3	LP	2,3,4	FE	all
						PP		ME	all
								MR	all
								PP	all
								SC	all
								SH	all
								SS	all
								SW	all

Elevation (breeding)

275–1190 m

Life History

Diet and foraging behaviour

Sharp-tailed Grouse feed on a variety of plants and insects depending upon the season. The general pattern of food intake appears to be similar between Sharp-tailed Grouse occupying grasslands or clearcuts. In spring, Sharp-tailed Grouse eat forbs, grasses, and insects. Insects are more important in the summer and fall when they are more available. Chicks also feed primarily on insects and other invertebrates.

In early fall, Sharp-tailed Grouse of southern British Columbia eat mainly greens of several leafy plant species with grass leaves making up a lesser part of the diet. As fall progresses, berries become more important although green leaves are available and eaten until freeze up. Insects, chiefly grasshoppers, are a minor food item in fall. Sharp-tailed Grouse begin to eat leaves and twigs of deciduous trees with the approach of winter.

In winter, they feed primarily on buds and catkins of deciduous trees and shrubs. Of lesser importance are fruits and berries. Although Sharp-tailed Grouse are often found in open grassland habitats during winter, grass seeds appear to be a minor component of the diet during that season. Cultivated grains can supply quality winter food but little is grown in the range of Columbian Sharp-tailed Grouse in British Columbia.

For grassland populations, the most important forage species are snowberry (*Symphoricarpus alba*), rose (*Rosa species*), and dandelion (*Taraxacum officinale*). Important browse species include water birch (*Betula occidentalis*), trembling aspen (*Populus tremuloides*), saskatoon (*Amelanchier alnifolia*), and choke cherry (*Prunus virginiana*). Seeds from any source appear to be unimportant in the fall diet of grassland Sharp-tailed Grouse in British Columbia.

For populations utilizing clearcuts, the most important shrub species are kinnikinnick (*Arctostaphyllos uva-ursi*), common juniper (*Juniper communis*), and prickly rose (*Rosa acicularis*). The most commonly eaten browse species is scrub birch (*Betula glandulosa*) and to a lesser extent, water birch and aspen.

Reproduction

Breeding males congregate at specific areas to display and attract females. Nearly all breeding occurs at these sites, known as leks. When a choice is available, females select males positioned near the centre of the lek. Calls from the leks may be heard for a distance of up to 1.5 km (Ritcey 1995).

Females lay a first clutch at 11 months of age and produce annually with a mean clutch size of 12.8. A high percentage of eggs are fertile and nearly all females nest. Re-nesting is common if the nest is destroyed leading to a second or sometimes third nesting attempt. There is one brood per year. Because of their high reproductive rate and variability in survival of young, sharp-tailed grouse populations show pronounced year-to-year fluctuations in fall numbers.

Site fidelity

Leks are traditional and may be used for many years if habitat remains unchanged and disturbance by humans is not too great. Males may tolerate most disturbances but females avoid disturbed leks (Baydack and Hein 1987).

Home range

Despite the ability for long flight, they may have relatively limited home ranges where year-round requirements are met within a small area. For example, in Montana males had a home range of 1.7 km^2 while females were 3.6 km^2 (Cope 1992); in Idaho during the summer both sexes used a 1.87 km^2 range (Marks and Marks 1987) and in British Columbia year round home ranges were 4.9 km^2 (Van Rossum 1992). Nests have been located within 100 m of lek and >3 km from lek sites but most are within 1.6 km of lek (Marks and Marks 1987; Meints 1991; Giesen and Connelly 1993).

Dispersal and movements

Sharp-tailed Grouse are considered non-migratory although they are well adapted to undertake long flights to obtain seasonal foods within their home range. Banded Sharp-tailed Grouse in South Dakota travelled up to 148 km; juveniles travelled farther than adults and females travelled farther than males (Robel et al. 1972).

Habitat

Structural stage

See *Broad ecosystem units* table above.

Important habitats and habitat features

Breeding

Openness is an important requirement of a dancing ground (lek) because it enable the detection of predators and in attracting grouse to the lek by seeing and/or hearing displaying males. Leks are often located on ridge tops or elevated ground but not necessarily the highest ground available. Seclusion is an important attribute of successful leks.

Nesting

Adequate cover to conceal nests is crucial. Extensive areas of nesting habitat are necessary to prevent nest predators concentrating their searches. Residual grass cover with a minimum height of 25 cm is recommended for nesting habitat for grassland populations (Meints et al. 1992). Jury (pers. comm.) found four of five nests of radio-marked Sharp-tailed Grouse in clumps of residual bluebunch wheatgrass (*Pseudoroegneria spicata*) while a fifth was in a dense stand of Kentucky blue grass (*Poa pratensis*). Rough fescue (*Festuca campestris*) is also often dominant at many sites in British Columbia (D. Fraser, pers. comm.) There is conflicting information on characteristics of nesting habitat for "Columbian" Sharp-tailed Grouse in the U.S. Cope (1992) found nests located in native grass cover and only one nest found within 50 m of shrub cover while Tihri (1995) cited several studies in other states where shrub cover was the preferred nesting habitat.

Summer (brood)

Areas with an abundance of ground dwelling insects are vital for chicks. A high percentage of ground cover was a characteristic of brood rearing areas in Montana (Cope 1992). Tihri (1995) cited studies that found shrub habitats to be preferred for raising broods in some areas while grass/forb habitats were used elsewhere. Few data are available on preferred brood habitats in British Columbia.

Fall

Berries are important both for grassland and clearcut populations. Disturbed areas such as roadsides and landings with abundant greens such as clovers, dandelion, and yarrow are heavily used. Lodgepole pine stands with developed or developing canopies have heavier crops of kinnikinnick than new clearcuts, especially in dry situations. Also in the first snowfalls of winter, locating berries and moving about in the understorey of those stands is facilitated by snow interception of the canopy.

Winter

Riparian areas rich in deciduous shrub and tree species provide berries, palatable catkins, and twigs for important winter feeding habitat. Shrub fens and shrub carrs with low growing scrub birch provide wintering habitats for clearcut populations (Ritcey 1990). Snow roosting by Sharp-tailed Grouse is a common strategy to conserve energy in winter (Evans and Moen 1975). Leupin and Murphy (2000a) found Sharp-tailed Grouse to roost in upland rose patches in the absence of snow. Snow roosting areas were all found near deciduous/ riparian and shrub cover. Gratson (1988) found roosting in Wisconsin to be in open sedge-meadows and shrub-marshes where there is little alternate prey to attract predators.

Conservation and Management

Status

The Columbian Sharp-tailed Grouse is on the provincial *Blue List* in British Columbia. Its status in Canada has not been determined (COSEWIC 2002).

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

BC	ID	MT	OR	Canada	Global
S2S3	S3	S1	S1	N2N3	G4T3

Trends

Population trends

Concern over Sharp-tailed Grouse populations was noted as early as 1905. By the mid-20th century, populations had declined to extinction through much of the Columbian subspecies range in the southern part of the province (Munro and McTaggart-Cowan 1947). In 2001, it was estimated that there were approximately 10 000 breeding birds in British Columbia based on extrapolations of male counts at dancing grounds and allowance for annual variability and error. The largest populations occur in the central Interior where the population is estimated to be between 4000 and 8200. In the southern Interior, the population is estimated to be between 600 and 1200.

A review of lek counts in the climax grasslands of the Thompson Okanagan Plateau (WLAP Region 3) from 1986 through 1999 documented a decline in population and number of leks (Leupin and Murphy 2000b). Populations declined by close to 50% from 1990 numbers when populations were at their most recent peak. Of 23 known leks (1986–1988) period, only 43% remained active in 1998. However, it is uncertain whether recently discovered leks in the grasslands are replacements for those abandoned in the past decade.

Lek counts in seral grasslands of Cariboo Basin and Chilcotin Plateau (WLAP Regions 3 and 5) from 1993 through 2000 showed a decline of similar proportions. Counts at seven leks fell from an average of 18 birds/lek in 1993 to 10 birds/lek in 2000 (i.e., 44% decline in numbers). This decline was not unexpected as forest regrowth has invaded open sites even during this relatively short time. However, of eight leks known in 1993 and revisited in 2000, all remained active. New leks are being found each year in clearcuts indicating at least some compensation for the downward trend in numbers observed on leks of the older clearcuts. Overall the limited evidence suggests a decline in numbers of birds in clearcuts since 1993 but it is unlikely that the decline is as severe as that recorded in the climax grasslands.

Habitat trends

Urban and agricultural development and forest encroachment into climax grasslands continue to reduce or degrade the amount of available habitat for the grassland populations. In the northern part of the Columbian Sharp-tailed Grouse range, clearcut logging has increased habitat, although planting and mechanical site preparation techniques may reduce the overall benefit.

Threats

Population threats

Disturbance at leks may cause females to avoid them rendering the leks reproductively inactive (Baydack and Hein 1987). Illegal hunting may threaten isolated populations whose numbers are already depressed by habitat alteration and fragmentation. Predation may keep populations depressed where predator populations are high or birds are predisposed to predation due to poor habitat conditions.

Habitat threats

The main threats include subdivision of ranchlands, heavy livestock grazing, water management, and fire suppression. Some silvicultural and agricultural practices may also act to depress populations.

Subdividing ranches into hobby farms is a growing trend that has already displaced Sharp-tailed Grouse from some of their best grassland habitats. Subdivision means more disturbance by higher numbers of humans and pets. It also brings with it grazing that tends to be heavier than on well-managed rangelands.

Livestock grazing occurs over most of the range of the Columbian Sharp-tailed Grouse. The impact of livestock is most apparent in the grassland habitats where rotational grazing systems often leave little residual grass for nesting Sharp-tailed Grouse on fall and early spring grazed ranges or pastures. Long-term grazing has reduced shrub and tree components of riparian habitats and continues to do so. Those components are vital to the survival of Sharp-tailed Grouse in grassland habitats.

Water storage and diversion may damage riparian vegetation. Damage from fluctuating water levels is most evident at impoundments but storage and diversion of water results in less water downstream for maintaining riparian vegetation. Drainage of wetlands can severely reduce the size of areas supporting scrub birch, water birch, and willow.

Several common silvicultural practices have the potential to reduce populations over the long term:

1. Planting xeric, treeless sites can reduce openness and contributes little to fibre production from the forest.
2. Deep trenching to improve seedling survival may impede movement of chicks, making it difficult for them to forage and increasing their vulnerability to predation in the first few days after leaving the nest.
3. Plantations are often thinned and weeded after establishment removing deciduous species such as willow, aspen, and birch that are winter food sources.
4. Use of insecticides reduces the amount of insects available to chicks during critical early stages of development.

Legal Protection and Habitat Conservation

The Columbian Sharp-tailed Grouse, its nests, and its eggs are protected from direct persecution by the provincial *Wildlife Act*.

This subspecies is hunted over part of its range in British Columbia (Parts of MWLAP Region 5 and management unit 3-31) but season closures are in effect in all grassland habitats of these regions.

Approximately 7000 ha of suitable habitat are within wildlife management areas (WMAs) including Junction, Chilanko Marsh, Dewdrop-Rosseau Creek, and Tranquille WMAs.

A number of protected areas include habitat for Columbian Sharp-tailed Grouse totalling about 32 000 ha. However, some of those overlap WMAs so the total area of habitat protected is probably less than 35 000 ha. Except for their importance as ecological benchmarks, ecological reserves contribute little to the protection of Columbian Sharp-tailed Grouse.

Range use plans under the results based code may address the needs of this species provided management objectives and measures as follows are incorporated into the plans.

Identified Wildlife Provisions

Wildlife habitat area

Goal

Maintain known lek sites in native grassland habitats. The priority for establishing WHAs should be in grassland habitats where populations are most at risk. At this time it is not considered necessary to establish WHAs for populations occurring in clearcuts.

Feature

Establish WHAs at known lek sites in native grasslands.

Size

Typically 700 ha but will vary depending on site-specific factors.

Design

Ideally, the WHA should be at least a 1.5 km radius around the lek but the shape will vary according to site-specific considerations, including nearness of wintering, nesting, and rearing habitats. When present, riparian areas should be included as well as other important habitat features (i.e., deciduous copses, shrub patches and tall grass areas).

General wildlife measure

Goals

1. Minimize disturbance during critical times.
2. Maintain winter food supply.
3. Maintain secure nesting and rearing habitat.
4. Minimize forest encroachment.

Measures

Access

- Permanently deactivate or rehabilitate roads after use. Close roads that pass within 100 m of an active lek during April and May. Consult MWLAP for site-specific times.
- Prohibit access to leks between 1 April and 31 May when females attend the leks for breeding.

Pesticides

- Do not use pesticides.

Range

- Maintain residual grass cover to a minimum height of >25–30 cm in 50% of grass stands. Graze to an average of no greater than 30% use.
- Do not graze during the nesting or early rearing season (i.e., 1 April to 31 May).
- Maintain deciduous shrub and tree components in riparian areas. A maximum removal from livestock grazing of 10% of annual growth of woody vegetation <2 m is recommended.
- Do not hay or mow until after August 15. Maintain residual grass cover to a minimum of 20 cm. Retain shrub cover in meadows surrounding the harvested area.
- Do not place livestock attractants within WHA.
- Do not construct fences or place livestock oilers within 400 m of lek. Fences may be constructed within 400 m if not within line of sight of lek.
- Do not herd large numbers of livestock through the WHA between 15 April to 30 June.

Additional Management Considerations

Water licence applications that would flood, drain, or divert water from known wintering areas for Columbian Sharp-tailed Grouse should not be permitted. Draining of sedge meadow complexes should be prevented.

Protect water supply to water birch and scrub birch stands where Sharp-tailed Grouse winter. Discourage channelling of creeks.

For populations occurring in clearcuts or sedge meadow complexes, consider the following recommendations:

- Maintain natural openings and continued supply of early seral habitat. Consult MWLAP when harvesting near known sites.
- Avoid deep trenching (>20 cm) and other mechanical site preparation that result in deep depressions and loss of deciduous species. Where necessary, patch scarification methods are preferred over disc trenching.
- Retain aspen, birch, and willow when thinning and weeding.
- Maintain deciduous species in riparian areas adjacent to known populations.
- Do not use insecticides in clearcuts used by nesting or rearing Sharp-tailed Grouse.
- Control forest encroachment. Prescribed burning may be used to stimulate shrub production and to prevent forest encroachment.
- Maintain aspen, birch, willow, and deciduous species.
- Minimize haying of scrub birch/sedge meadow complexes.

Information Needs

1. Research on cutblock/sedge meadow complex populations including DNA analysis.
2. Use of prescribed fire in maintaining suitable habitat.
3. Adaptive management to determine which grazing regimes are most appropriate for managing grassland populations of the Columbian Sharp-tailed Grouse.

Cross References

Burrowing Owl, Long-billed Curlew, "Sagebrush" Brewer's Sparrow

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American White Pelican

Pelecanus erythrorhynchos

Original[1] prepared by William L. Harper

Species Information

Taxonomy

The American White Pelican (*Pelecanus erythrorhynchos*) is one of two species from the family Pelecanidae that occurs in British Columbia; the other is the Brown Pelican (*P. occidentalis*). No subspecies of the American White Pelican are recognized (Evans and Knopf 1993; Cannings 1998).

Description

A very large white bird (150–188 cm in length; wingspan of 240–300 cm), with black wingtips and a long, orange-pink pouched bill (Godfrey 1986). The bill has a conspicuous gular pouch that is used to hold captured fish and sieve them from water. During the breeding season, an upright horny plate grows on the top portion of the culmen. Feet and legs are a bright orange; bare skin found around the eyes is orange and eyelids are red. Adult males and females are similar in appearance; females are noticeably smaller. Immatures are similar to adults; however, feathers are typically more greyish and bill and feet duller.

Distribution

Global

American White Pelicans only occur in North America (Evans and Knopf 1993). They breed from central British Columbia, extreme southwestern Northwest Territories, central Saskatchewan, southern Manitoba, and western Ontario, south locally to California, Nevada, Utah, Wyoming, South Dakota, and southeastern Texas (Godfrey 1986; Evans and Knopf 1993). Their winter range includes California, Arizona, and the Gulf States south through Mexico to Guatemala (Cannings 1998).

British Columbia

Pelicans nest at only one location in British Columbia—Stum Lake, 70 km northwest of Williams Lake. Birds from the Stum Lake colony forage in lakes, rivers, and streams over a broad area of the Fraser Plateau, approximately 30 000 km^2 (Harper and Steciw 2000). Little is known about the size or behaviour of non-breeding pelican populations that occur in British Columbia; however, it is thought that many of them forage within the same area as breeding birds. A substantial population of unknown breeding status forage at Nulki and Tachick lakes, 15 km southwest of Vanderhoof. In the Kootenays, pelicans regularly occur within the Creston Valley Wildlife Management Area south of Kootenay Lake (Gowans and Ohanjanian 2000). Pelicans do not typically winter in British Columbia, although individuals occasionally stay during winter months (Campbell et al. 1990).

Forest region and districts

Coast: Chilliwack, South Island, Sunshine Coast

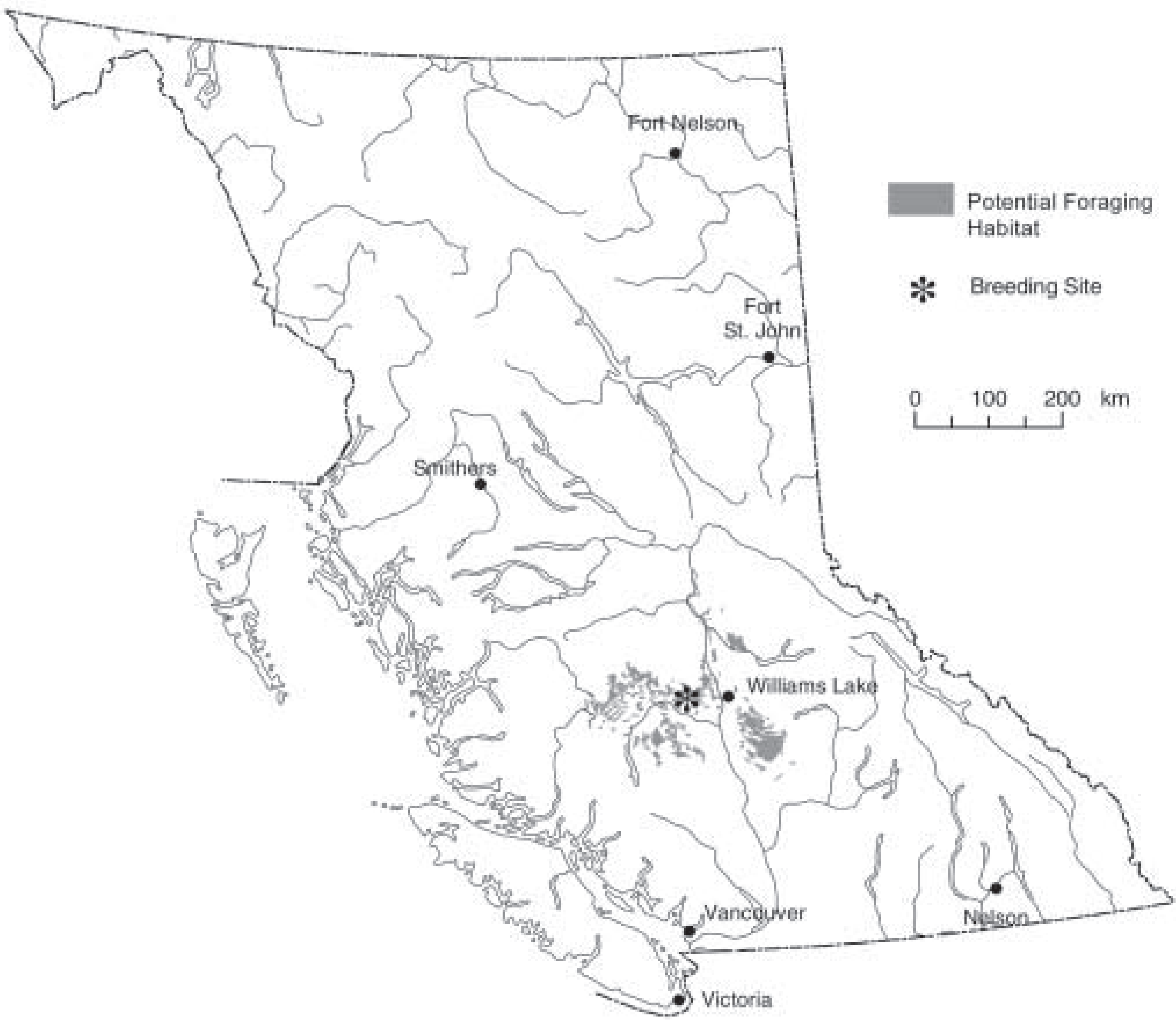
Northern Interior: Fort St. James (substantial population of unknown breeding status), Vanderhoof

Southern Interior: 100 Mile House, Arrow Boundary (non-breeding and migratory), Central Cariboo, Chilcotin (breeding and foraging), Kamloops, Okanagan Shuswap, Quesnel

1 Volume 1 account prepared by R. Dawson.

American White Pelican

(Pelecanus erythrorhychos)



Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on several ecosystem classifications (Ecoregion, Biogeoclimatic and Broad Ecosystem Inventory) as well as current knowledge of the species' habitat preferences. This species may or may not occur in all areas indicated.

Ecoprovinces and ecosections

CEI: BUB, CAB, CHP, FRB, NAU, QUL, WCU
GED: FRL, GEL, NAL, SGI (migratory), SOG
SBI: BAU
SIM: SFH
SOI: NOB, SOB, STU, THB

Biogeoclimatic units

BG, IDF, SBPS, SBS – all subzones (breeding)
ICH (non-breeding and migratory), PP
CDF (migratory), CWH

Broad ecosystem units

FE, GB, LL, LS, ME, OW

Elevation

Sea level to 1220 m (Campbell et al. 1990)

Life History

Diet and foraging behaviour

American White Pelicans are mainly piscivorous (fish-eating), foraging both singly and in co-operative groups (Johnsgard 1993). Group foraging includes flocks of pelicans driving schools of fish toward shallow water by dipping their bills into the water while slowly swimming forward (Anderson 1991). Pelicans appear to be able to shift feeding strategies to optimize foraging efforts in lakes and streams depending on the availability of prey resources (McMahon and Evans 1992).

Analysis of regurgitates from nestlings showed that minnows (Cyprinidae – *Cyprinus, Gila, Pimephales, Richardsonius, Rhinichthys, Ptychocheilus*) and suckers (Catostomidae – *Catostomus*) dominate the nestling diet at many pelican colonies (reviewed in Harper 1999). Other prey species found include stickleback (Gasterosteidae – *Pungitius, Culaea*), sunfish (Centrarchidae – *Archoplites, Pomoxis*), bullhead (Ictaluridae – *Ameiurus*), perch (Percidae – *Perca, Stizostedion, Etheostoma, Micropterus*), salmon and trout (Salmonidae – *Oncorhynchus*), salamanders (Caudata – *Ambystoma, Necturus*), and crayfish (*Orconectes, Astacus*). Bones from seven fish estimated to be 30–40 cm long were discovered at the Stum Lake breeding colony. These were determined to be from six suckers (*Catastomus* spp.) and one northern squawfish (*Ptychocheilus oregonensis*) (Dunbar 1984).

Pelicans are surface feeders, typically foraging in shallow water near shore, but they are also known to forage in the upper metre of the water column over deeper open waters (Findholt and Anderson 1995). Measurements of bill and neck lengths suggest foraging is restricted to the upper 1.25 m of the water column (Anderson 1991). Fish are typically caught with a rapid dip of the bill, with the gular sac held open in the form of a scoop.

Nocturnal foraging is common during the breeding season, but apparently not in winter (Evans and Knopf 1993). In the daytime, prey is probably located visually. At night, bill contact combined with an increased rate of bill dipping is thought to help locate prey. Besides possible advantages in capturing prey at night, nocturnal foraging allows pelicans to travel during the day to take advantage of rising thermals to save energy while soaring (O'Malley and Evans 1984). Recent studies have confirmed the importance of nocturnal foraging to pelicans in British Columbia (Harper and VanSpall 2001).

Reproduction

American White Pelicans are colonial breeders, with nesting generally synchronized across an entire colony (Baicich and Harrison 1997). Pelican colonies are often mixed with nesting Double-crested Cormorants (*Phalacrocorax auritus*), as is the case at Stum Lake with approximately 13 nesting cormorant pairs (Fraser et al. 1999).

Pelican courtship begins shortly after birds arrive at the nesting island. In British Columbia, nest building is typically initiated within 3–4 days after pelicans arrive at the nesting colony (Campbell et al. 1990). Both adults build the nest over 3–5 days (Baicich and Harrison 1997). Most nests are made from mounds of dirt, sticks, reeds, and debris, although occasionally shallow depressions in sand are used (Campbell et al. 1990).

In British Columbia, clutches are laid between early May and late July, peaking during the second and third weeks of May (Dunbar 1984). Clutch size ranges from one to four eggs, with an average clutch size of 1.95 in years with no disturbance, and 1.69 in years with disturbance (Dunbar 1984). Although two eggs may be laid, only 1% of nests are likely to fledge two young, because the second-hatched chick is killed either directly by the elder sibling or indirectly through starvation (Evans 1996).

Incubation period is 29–36 days and is done by both sexes (Baicich and Harrison 1997). Adults brood young for 15–18 days and are fed mostly a liquefied diet of regurgitated fish matter. Most young in British Columbia are hatched by late June and are fledged by late July to early August (Campbell et al. 1990). Mobile young pelicans form overnight creches (close aggregations of juveniles) beginning at about 17 days of age, after which both parents begin leaving the nest at the same time to forage (Evans 1984). Creching is thought to provide both thermo-regulatory (i.e., reduce resting metabolic rate by at least 16% at 10ºC) and antipredator advantages to young juveniles (Evans 1984). Young typically fledge at 7–10 weeks of age (Baicich and Harrison 1997).

Site fidelity

American White Pelicans exhibit a very strong fidelity to breeding sites, returning to the same nesting islands annually (Evans and Knopf 1993). Human or natural disturbance at nesting colonies during the previous year typically does not deter birds from returning the following year. Only catastrophic disturbance (e.g., island flooding, desecration, or destruction) will cause pelicans to abandon a nesting area. However, under such circumstances, pelicans generally establish a new nesting colony close to the original site. It is believed that pelicans breed every year at Stum Lake, although the location of the colony was not identified until 1939 (Munro 1945).

Home range

American White Pelicans have large home ranges. Pelicans are highly mobile (up to 50 km/hr) and efficient flyers allowing them to shift foraging sites to take advantage of temporarily abundant food supplies (Evans and Knopf 1993). Pelicans routinely fly 50–100 km from their nesting islands to feed at outlying foraging lakes (Johnson and Sloan 1978; Evans and Knopf 1993; Derby and Lovvorn 1997).

In British Columbia, aerial surveys have documented pelican foraging lakes as far as 165 km (Abuntlet Lake) from the nesting colony (Wood 1990). Pelicans from Stum Lake forage at 40 different lakes over an area of 30 000 km^2 on the Fraser Plateau (Wood 1990; Harper and Steciw 2000; Harper and VanSpall 2001). A significant population of adult pelicans also occur approximately 200 km north of the nesting colony at Nulki, Tachick, and Stuart lakes, but the breeding status of these birds is unknown at this time (Harper and VanSpall 2001). Large numbers of non-breeding pelicans are also present throughout the summer in the Creston Valley Wildlife Management Area south of Kootenay Lake (Gowans and Ohanjanian 2000).

Movements and dispersal

American White Pelicans are highly migratory. Most pelicans arrive on the Fraser Plateau in mid-April; earliest arrival 10 March (Campbell et al. 1990). Pelicans leave for their wintering grounds in California and Mexico from September to mid-October (Dunbar 1984; Campbell et al. 1990). It is thought that Stum Lake pelicans migrate west of the Rocky Mountains towards the southwestern United States (Campbell et al. 1990). Pelicans banded at Stum Lake have been recovered in Washington, Oregon, Idaho, Utah, California, and Mexico (J. Young, pers. comm.).

Habitat

Structural stage

1a: sparse (nesting and loafing)
2a: forb-dominated herb (nesting and loafing)
2b: graminoid-dominated herb (nesting and loafing)
2c: aquatic herb (loafing)

Important habitats and habitat features

In general, American White Pelicans require undisturbed islands for nesting and isolated lakes with adequate prey fish species for foraging.

Nesting

Nests are built on islands in lakes with little natural or human disturbance (Evans and Knopf 1993). Nesting islands are typically flat, with little vegetation or large ground debris present due to physical disturbance by pelicans and high soil acidity from guano. Prey fish populations are not necessarily present at nesting lakes, but stable water levels are important to maintain productive nesting habitats. Rising water levels can result in flooding of nest sites, and falling water levels can reduce the effectiveness of the water barrier that is used as security from terrestrial predators.

The only breeding colony in British Columbia is located at Stum Lake on the Fraser Plateau, a shallow (mean depth of 2.5 m), slightly alkaline (pH = 8.6), 900 ha lake at 1220 m elevation (Campbell et al. 1990). Nesting occurs at variable levels on four different islands at Stum Lake (Dunbar 1984; Campbell et al. 1990; Harper and Steciw 2000). Three of the four islands are non-forested and very sparsely vegetated, but one contains well-spaced spruce and birch trees. These nesting islands are located 80–600 m from shore, are low in profile (up to 6.7 m in height), and range in size from 90 to 1000 m^2. Nests are generally closely spaced and situated on flat areas, often adjacent to dead trees, logs, and rocks (Dunbar 1984). Most nests are made from mounds of dirt, sticks, reeds, and debris, although occasionally shallow depressions in sand are used (Campbell et al. 1990). The nests are loosely lined with feathers, twigs, fish bones, or small stones.

Foraging

American White Pelicans forage in slow-moving streams and rivers, lakes, permanent or semi-permanent marshes, reservoirs, and, to a limited extent during migration, coastal bays, estuaries, and near-shore marine sites (Johnsgard 1993). Pelicans are opportunistic in their food habits, and prey species vary greatly depending on location and time of year. Foraging waters range from nutrient-rich to nutrient-poor, muddy to clear, with various shorelines of mud, sand, gravel, and rock (Evans and Knopf 1993). There is less site tenacity than for breeding habitats; however, birds return to the same foraging lakes when prey species are present.

In British Columbia, pelicans forage in shallows along the shorelines of lakes, at creek mouths, in shallow open water in the middle of lakes, and in streams (Dunbar 1984; Harper and VanSpall 2001). Stream foraging, which was only observed in the spring, is thought to be associated with the spawning activities of coarse fish such as longnose suckers (*Catostomus catostomus*). Inlets and outlet streams are a significant component of pelican foraging habitat, not only because their deltas are often used as loafing habitat, but also because these streams provide foraging opportunities, particularly when fish are spawning.

In British Columbia, the average elevation of 19 main foraging lakes is 1004 m above sea level (Harper and Steciw 2000). Puntzi Lake is the largest of these foraging lakes with a surface area of 1706 ha. The other foraging lakes are much smaller, and are relatively similar in size, averaging 321 ha in surface area, 4 m in depth, and 15 million m^3 in volume (Harper and Steciw 2000). Most of these lakes are fairly alkaline in nature with 8 of 11 having pH readings from 8.5 to 9.2.

Loafing areas are important as stopovers for flights from foraging lakes to the nesting colony where pelicans rest, preen, and wait for favourable flight conditions. In British Columbia, the most commonly used loafing sites are sandbars and mud flat islands at the deltas of major inlets and floating vegetation along the marshy edges of shallow lakes (Harper and Steciw 2000). Deadfall, partly submerged logs, and shorelines are also used for loafing (Wood 1990).

Conservation and Management

Status

The American White Pelican is on the provincial *Red List* in British Columbia. It is designated as *Not at Risk* in Canada (down-listed from *Threatened* in 1987 (COSEWIC 2002).

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

BC	AB	NWT	WA	ID	MT	Canada	Global
S1B, SZN	S2B	S?	S1B, SZN	S1B, SZN	S2B, SZN	N4B	G3

Trends

Population trends

The global population of American White Pelicans is estimated at approximately 52 000 breeding pairs (Johnsgard 1993). There are 50 breeding colonies in western Canada and 18 in the United States, many of which are threatened by loss of habitat and water level problems (Evans and Knopf 1993). In British Columbia, the one nesting colony at Stum Lake has been censused numerous times beginning in 1953. Counts of nests have ranged from a low of 85 nests in 1968 to a high of 423 nests in 1993 (Dunbar 1984; J. Steciw, pers. comm.). Nest counts at Stum Lake averaged 285 nests between 1997 and 2001 (J. Steciw, pers. comm.). Although population fluctuations are common, the American White Pelican breeding population in British Columbia is considered stable. Non-breeding birds in the Creston Valley Wildlife Management Area in the Kootenays have increased from a few birds in the 1980s to maximum count of 83 in 1999 (Gowans and Ohanjanian 2000). Birds of unknown breeding status at Nulki and Tachick lakes have increased from a few birds in the early 1990s to a maximum count of 77 in 2000 (Harper and VanSpall 2001).

Habitat trends

Habitats in and around the breeding colony are protected within White Pelican Provincial Park. Trends in foraging habitat quality are linked to rates of development and access to foraging lakes. Most foraging lakes are being impacted at various levels by increasing human use, including road development; lakeshore development for recreational use; boating; changes in lake water levels associated with irrigation use; and changes in fish stocks associated with introduction of game fish.

Threats

Population threats

The negative impacts of disturbance at breeding colonies are severe and well known (Dunbar 1984; Evans and Knopf 1993). Human disturbance can cause predation of eggs and chicks, nest abandonment, cooling or overheating and dehydration of eggs and chicks, accidental crushing of eggs by adults, trampling, and undue stress and regurgitation of foods (Hall 1926; Bunnell et al. 1981; Bowman et al. 1994). The timing of these disturbances is critical. Disturbance by coyotes (*Canis latrans*) or humans early in the nesting period can cause sudden and complete desertion of the nesting colony (Bunnell et al. 1981; Evans and Knopf 1993). Low flying aircraft over the Stum Lake breeding colony are known to have caused high levels of disturbance and offspring mortality (Bunnell et al. 1981; Dunbar 1984). Although causes are unknown, complete abandonment of the Stum Lake colony has been documented three times in the past 41 years: in 1960 (Dunbar 1984), 1986 (Campbell et al. 1990), and 2001 (J. Anderson, pers. comm.).

The level of tolerance at foraging sites to human disturbance is less well known. Human activities that are known to cause disturbance to pelicans at foraging areas include recreational boating; angling; water skiing; backcountry use and lakeshore activities, such as hiking and camping; vehicle traffic; and forest harvesting (Hooper and Cooper 1997; Harper and Steciw 2000). Wood (1990) found foraging pelicans responded to disturbance (human presence, motorboats, aircraft) by flying to another area of the lake or leaving the lake entirely. Pelican responses to different levels of human disturbance can vary greatly (Evans and Knopf 1993). In British Columbia, experimental approaches by researchers elicited various reactions by pelicans, with some birds flying away when approached within 300 m, while others only swam away when approached to 50 m (Harper and VanSpall 2001). The greatest potential impact of human disturbance away from the breeding colony may be at loafing and roosting sites.

Habitat threats

The primary threat to American White Pelicans in British Columbia is the potential destruction and alteration of their nesting habitat (Hooper and Cooper 1997; Harper and Steciw 2000). Although the breeding colony is protected in the Class A White Pelican Provincial Park, stabilizing water levels at Stum Lake is still important to maintain the productivity of the nesting islands. If water levels are too high, then nesting islands are inundated and the nests are flooded. If water levels are too low, then nesting islands become connected to the mainland and lose their ability to act as a barrier to mammalian predators.

Alteration of foraging habitats is major potential threat to American White Pelicans (Hooper and Cooper 1997; Harper and Steciw 2000). Legal and illegal alterations of stream courses and damming of streams affect foraging lake water levels and fish abundance. Streams and lakes are often dammed for irrigation or drained to create more agricultural land (Hooper and Cooper 1997). For example, the Chilcotin River inlet to Chilcotin Lake was illegally diverted in 1975 (Harper and Steciw 2000). In the late 1980s, a number of dams constructed in the Rosita–Tautri Lakes chain altered lake levels and potentially served as barriers to the migration and spawning of Longnose Suckers, a principal prey species for pelicans. As with nesting islands, water levels can affect pelican loafing and roosting habitat. Abnormally high water levels can flood mudflat islands and low water levels cause loafing habitats to become connected to the mainland and lose their ability to provide protection from potential predators (Hooper and Cooper 1997; Harper and Steciw 2000).

American White Pelicans in British Columbia could also be affected indirectly by negative impacts to fish prey species in foraging lakes (Hooper and Cooper 1997; Harper and Steciw 2000). Pollution from motorboats, chemical runoff from agricultural lands, and rural sewage could potentially inhibit reproduction or cause mortality fish prey species (Hooper and Cooper 1997). The introduction of game fish in foraging lakes could also potentially reduce fish prey species due to competition for food resources and/or direct predation (Evans and Knopf 1993).

Legal Protection and Habitat Conservation

The American White Pelican, its nests, and eggs are protected from direct persecution in British Columbia by the provincial *Wildlife Act*. It is also designated *Endangered* under the provincial *Wildlife Act*.

Stum Lake and the breeding colony have been protected within White Pelican Provincial Park, a Class A park of 2763 ha, since 1971 (Bunnell et al. 1981; Fraser et al. 1999). To protect nesting pelicans, the park is closed to the boating, angling, landing of floatplanes, and the discharge of firearms from 1 March to 31 August (Dunbar 1984). Transport Canada regulations restrict aircraft over Stum Lake to altitudes above 610 m (Bunnell et al. 1981).

Nazko Lakes Provincial Park (15 548 ha) and Kluskoil Lake Provincial Park (12 419 ha) are both Class A wilderness parks that encompass foraging habitat of American White Pelicans. Established in 1995, these parks effectively protect some foraging habitat values. However, unlike White Pelican Provincial Park, they are not managed exclusively for pelicans, so there is the potential that park status could lead to increased human use and higher levels of disturbance for foraging pelicans.

The Cariboo-Chilcotin Land-Use Plan (CCLUP) (Province of British Columbia 1995) generally addresses the issue of public access to pelican foraging habitats with the direction that, "where required, roads will be planned to limit impacts on environmental values and road closure and deactivation and rehabilitation requirements for existing and future roads will be specified." This plan identifies important foraging lakes and also directs resource managers to "provide buffers of at least 200 m and limit human disturbance around important pelican feeding lakes" (Province of British Columbia 1995).

Under the results based code, conservation of riparian forest edges at foraging lakes and streams may be partially addressed through application of riparian and lakeshore guidelines.

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

The quality of pelican foraging habitats can be greatly affected by the level of public access, through negative impacts caused by human disturbance and introduction of pollutants. Establishing WHAs, riparian reserves, and lakeshore management zones around these habitats may not be entirely adequate for addressing these concerns. Access management must be given particular attention in forest development plans to ensure that the construction and deactivation of roads near pelican habitats is conducted in accordance with strategic planning objectives.

- ❖ Access objectives should be identified for each pelican foraging lake, beginning with provisions in the Cariboo-Chilcotin Land-Use Plan (Province of British Columbia 1995) and other applicable strategic or landscape-level plans. Objectives under the Recreational Opportunity Spectrum (ROS) as laid out in the Ministry of Forests' Recreation Inventory can serve to describe these access management objectives (MOF and MELP 1996a).
- ❖ As much as possible, important foraging lakes should be classified as *wilderness lakes* (having a primitive ROS objective and allowing no roads within 8 km). Other pelican foraging lakes should be classified as *quality lakes* (having a semi-primitive non-motorized ROS objective and allowing no roads within 1 km) (MOF and MELP 1996a, 1996b). Access management must then be planned to meet those objectives, addressing proximity of roads and road quality, road deactivation, trails to lakes, boating restrictions, aircraft restrictions, and recreation sites.

Wildlife habitat area

Goal

Protect foraging, loafing, and roosting habitat from human disturbance and habitat loss or alteration.

Feature

Establish WHAs on foraging, loafing and roosting sites on and adjacent to lakes, stream reaches, and other aquatic habitats used by American White Pelicans during the breeding season. WHAs should not normally be established on aquatic habitats used only during spring and fall migration unless there are compelling conservation reasons, such as the regular and predictable use of critical staging areas.

Size

Typically, 1 km around the entire aquatic area of lakes and stream reaches used for foraging, loafing, or roosting by pelicans.

Design

The WHA should include a core area and a management zone. The core area should be the reserve area designated by the CCLUP, riparian or lakeshore management guidelines under the *Forest and Range Practices Act*.

The WHA should include the lake or stream reach used for foraging, and all aquatic and riparian areas used for loafing and roosting. Maximize the size of the WHA adjacent to known foraging areas, and loafing and roost sites to maintain the quality and isolation of these habitats.

General wildlife measures

Goals

1. Maintain the isolation of foraging lakes and stream reaches, and loafing and roosting sites.
2. Minimize disturbance during the breeding season (1 April to 15 September).
3. Maintain integrity of habitats of prey species.

Measures

Access

- Do not develop any new permanent roads (e.g., forest service or main haul). Ensure temporary roads (e.g., road sections off main roads) are made impassable to vehicles from 1 April to 31 August.

Harvesting and silviculture

- Do not harvest in the core area.
- Within the management zone, do not harvest, including salvage, during breeding season (1 April–15 September).
- Maintain riparian reserves on all lakes and wetlands within WHA using the largest reserve areas as described in the *Riparian Management Area Guidebook*. Maintain riparian reserves on all streams within the WHA according to stream size as described within the *Riparian Management Area Guidebook*.
- Do not use motorized manual or heavy equipment for site preparation or other silvicultural work from 1 April to 31 August.
- Minimize vehicle use during silvicultural and other work from 1 April to 31 August.

Pesticides

- Do not use pesticides.

Recreation

- Do not develop recreation sites.

Additional Management Considerations

Disturbance of pelicans at their feeding sites can have negative consequences for breeding success. Foraging lakes that do not have permanent road access should be maintained that way by routing any new permanent roads well away from foraging habitats used by pelicans. Floatplanes should not land or fly low over pelican foraging lakes. Operations that involve a lot of human activity (e.g., logging camps, landings) should be located as far away from WHAs as possible. Activities that alter the natural condition of feeding lakes or encourage recreational use (e.g., stocking with recreational fish, use that causes fluctuations in water levels during the breeding season, alienation of Crown land along the perimeter of feeding lakes) should be discouraged.

Draft guidelines, available for commercial recreation tenures in British Columbia, provide conservation objectives for the American White Pelican (see MELP 2000).

Information Needs

1. Specific locations of important stream and river reaches that are used at night by foraging pelicans.
2. Specific locations of loafing and roosting sites for some foraging lakes.
3. Impacts of various levels of disturbance at foraging, loafing, and roosting areas.

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Sandhill Crane

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Great Blue Heron

Ardea herodias

Original[1] prepared by Ross G. Vennesland

Species Information

Taxonomy

Three subspecies of the Great Blue Heron are recognized in North America, two of which occur in British Columbia: *A. herodias herodias*, which occurs across most of North America, and *A. herodias fannini*, which occurs only on the Pacific coast from Washington to Alaska (Payne 1979; Hancock and Kushlan 1984; Cannings 1998). The separation of these subspecies is based on differences in plumage, morphology, and migratory behaviour (Hancock and Elliott 1978; Payne 1979).

Description

The Great Blue Heron is the largest wading bird in North America, and measures about 60 cm in height, 97–137 cm in length, and 2.1–2.5 kg in mass (Butler 1992). The wings are long and rounded, the bill is long, and the tail is short (Butler 1992). Great Blue Herons fly with deep, slow wingbeats and with their necks folded in an S-shape. Plumage is mostly a blue-grey colour and adults have a white crown.

Distribution

Global

Great Blue Herons breed in three distinct regions of North America. *Ardea herodias occidentalis* breeds in Florida, *A. herodias fannini* breeds on the Pacific coast from Washington to Alaska, and *A. herodias herodias* breeds from southern Canada south to Central America and the Galapagos (Butler 1992). Populations of *A. herodias fannini* are non-migratory (Butler 1992). Winter ranges for *A. herodias herodias* include the Pacific coast of North America, the continental United States, Central America, and northern South America to Colombia, Venezuela, and the Galapagos (Butler 1992).

British Columbia

In British Columbia, *A. herodias fannini* occurs year-round on the Pacific Coast and occasionally inland to the Bulkley Valley (Campbell et al. 1990; Gebauer and Moul 2001), and *A. herodias herodias* occurs in southern interior regions of the province primarily during breeding and migratory periods (Campbell et al. 1990; Cannings 1998). The highest concentrations of breeding herons occur in the Georgia Depression ecoprovince due to the presence of several large colonies (Campbell et al. 1990; Gebauer and Moul 2001).

Forest regions and districts

The *A. herodias fannini* subspecies occurs in the Coast Forest Region and the *A. herodias herodias* subspecies occurs in the Southern and Northern Interior forest regions.

Coast: Campbell River*,[2] Chilliwack*, North Coast*, North Island, Queen Charlotte Islands*, South Island*, Squamish*, Sunshine Coast*

Northern Interior: Kalum, Nadina, Peace, Prince George, Skeena Stikine, Vanderhoof

Southern Interior: 100 Mile House*, Arrow Boundary*, Cascades*, Central Cariboo*, Chilcotin, Columbia*, Headwaters*, Kamloops*, Kootenay Lake*, Okanagan Shuswap*, Quesnel*, Rocky Mountain*

1 Draft Vol. 1 account prepared by Ken Summers.

2 * = known to breed.

Great Blue Heron
(Ardea herodias)

Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on several ecosystem classifications (Ecoregion, and Biogeoclimatic) as well as current knowledge of the species' habitat preferences. This species may or may not occur in all areas indicated.

Ecoprovinces and ecosections

BOP: PEL, HAP

CEI: BUB, CAB*, CAP*, CHP, FRB, NAU, NEU

COM: CPR, CRU, EPR*, HEL*, KIM, KIR, MEM, NAM, NCF, NIM, NPR, NWC*, NWL, OUF, QCL*, QCT, SBR, SKP*, SPR*, WIM*, WQC*

GED: FRL*, GEL*, LIM*, NAL*, SGI*, SOG*

SBI: BAU, BUB, NEL, NSM, SSM

SIM: BBT, CAM, CCM*, EKT*, EPM, MCR, NPK, SCM*, SFH*, SHH*, SPK*, SPM*, UCV*, UFT

SOI: GUU*, LPR, NIB*, NOB*, NOH*, NTU*, OKR, PAR, SCR, SHB*, SOB*, SOH, STU*, THB, TRU*

Biogeoclimatic units

BG: xh1, xw1

CDF: mm

CWH: dm, ms1, ms2, vh1, vh2, vm1, vm2, wh1, xm

ICH: dw, mk1, mk2, mk3, mw2, mw3, xw

IDF: dk3, dm2, mw1, mw2, un, xh1, xh2

MS: dk

PP: dh2, xh1, xh2

SBS: dk or dh, dw1

Broad ecosystem units

CB, CF, CR, ES, IM, PR, RR, SP, SR, WL, (UR in GED ecoprovince)

Elevation

In British Columbia, most herons occur near sea level on the coast or in the lowlands and valley bottoms of the Interior, though nesting and occurrences have been documented to 1100 m (Campbell et al. 1990).

Life history

Diet and foraging behaviour

Great Blue Herons are prey generalists, although they primarily forage for fish. They stalk prey by walking or standing in shallow water along the shoreline of oceans, marshes, lakes, and rivers and in fields or other vegetated areas (Butler 1992). In upland areas they stalk mostly small mammals such as rodents (Butler 1992). This upland foraging behaviour is more common in winter and for juveniles learning to hunt (Butler 1991). Other prey types include amphibians, reptiles, invertebrates, and birds (Butler 1992). Prey is located by sight and is caught by a rapid thrust of the neck and head (Butler 1992). Herons generally swallow their prey whole (Butler 1992). See Gebauer and Moul (2001) for a more exhaustive review of diet and foraging behaviour.

Reproduction

Great Blue Herons nest throughout the southern Interior and coastal areas of the province, but breeding is concentrated in the Strait of Georgia where several colonies of >100 breeding pairs occur (Eissinger 1996; Butler 1997). It has been estimated that about 84% of the *A. herodias fannini* population and about 65% of all Great Blue Herons in the province breed in this area (Butler 1997; Gebauer and Moul 2001). Large colonies are associated with extensive estuarine mudflats and eelgrass beds around the Fraser River delta (Butler 1993; Eissinger 1996). Colony size has been associated with available foraging area for the Great Blue Heron (Gibbs 1991; Butler 1992; Gibbs and Kinkel 1997).

Breeding is initiated between February and April for *A. herodias fannini* and in late March for *A. herodias herodias* (Butler 1992; Gebauer and Moul 2001). Males arrive at the colony site and establish territories, followed about 1 week later by the females (Butler 1991). Courtship and nest repair and/or building take from several days to about a month (Butler 1991). Monogamous pairs are established for the season (Simpson 1984), and an average of four eggs is laid at about 2-day intervals (Vermeer 1969; Pratt 1970). Clutch size ranges from one to eight, with three to five being typical (Ehrlich et al. 1988; Campbell et al. 1990). Incubation begins soon after the first egg is laid, resulting in asynchronous hatching (Butler 1992). Hatching occurs after about 27 days of incubation (Butler 1992). Young are reared on the nest for about 60 days, fed mostly fish caught near the colony site (Krebs 1974; Simpson 1984). One breeding cycle requires about 100 days, and herons reproduce for about 200 days around the

Strait of Georgia. Thus, herons can potentially breed more than once if their first attempt fails. Breeding duration for the Interior is not known. Heron breeding sites can be relocated rapidly because nests can be built in 3 days (Butler 1997) and eggs can be laid within about 1 week (Butler 1997).

Great Blue Herons first breed after their second winter (Pratt 1973). Estimates of mortality from band recovery data (outside of British Columbia) range from 69% for first year juveniles, 36.3% for second year juveniles, and 21.9%/yr thereafter (Henney 1972, cited by Butler 1992).

Site fidelity

Colonies are dynamic, especially in areas of high disturbance (Butler 1992; Vennesland 2000). Some colonies are used for many years (e.g., Shoal Island, Point Roberts, and Stanley Park, all about 28 years), but most colonies, especially those under 50 nests, are relocated more frequently (Gebauer and Moul 2001). Across British Columbia, it is not clear how frequently the same individuals return to the same nest site. However, at one colony on the Sunshine Coast, Simpson et al. (1987) found that 40% of the breeding herons in 1978 did not return in 1979, and most breeding herons were on different nests and with different mates in 1979. Once a colony has been abandoned for more than 1 year, recolonization occurs infrequently (Gebauer and Moul 2001).

Home range

In British Columbia, breeding colonies range in size from two to about 400 nests with some pairs nesting solitarily (Gebauer and Moul 2001). In south-coastal British Columbia in 1999, Vennesland (2000) reported a mean colony size of 62 nests (SD = 94, $n = 31$), a median of 26 nests, and that the "typical" heron nested in a colony of 199 nests. Large colonies in deciduous trees or small and dispersed colonies can encompass several hectares (R.G. Vennesland, pers. obs.; M. Chutter, pers. comm.). In southern British Columbia, Machmer and Steeger (2002) reported a mean colony size of 19 nests (SE = 6, $n = 7$) and a range of 1–77 nests. During the breeding season, adult herons range within about 30 km of their colonies, although most stay within 10 km (Butler 1991, 1997). During winter, some adults maintain small foraging territories (Butler 1991), but little is known of how frequently alternate sites are used.

Movements and dispersal

Little is known of the initial dispersal of Great Blue Herons from their natal site, but band recoveries suggest that most fledglings disperse from their natal areas (Henney 1972, cited by Butler 1992). Juveniles are believed to disperse widely, often northwards during the summer after fledging. Long distance dispersal of juveniles has been reported. Campbell et al. (1972, cited by Campbell et al. 1990) reported juvenile dispersal from Vancouver to the Fraser Lowlands, Washington State, Oregon State, and Kamloops. On the coast of British Columbia, *A. herodias fannini* is primarily non-migratory, with most birds wintering close to breeding areas (Butler 1997; Gebauer and Moul 2001). In contrast, *A. herodias herodias,* in the interior of the province, is primarily migratory, although the extent of southward movement is unknown. Groups of *A. herodias herodias* are known to overwinter along ice-free watercourses of southern British Columbia (Machmer 2002), but some birds migrate as far south as Mexico and South America (Campbell et al. 1990; Butler 1992).

Habitat

Structural stage (breeding)

5: young forest
6: mature forest
7: old forest

Important habitats and habitat features

Foraging

Great Blue Herons require abundant and accessible prey within 10 km of a breeding location (Butler 1995). Important foraging habitats include aquatic areas such as tidal mudflats, riverbanks, lakeshores, and wetlands (Butler 1992). Shallow water fish species are the most important prey group for herons during breeding and non-breeding seasons (Butler 1992). During winter on the coast, when aquatic prey are less abundant due to a reduced duration of daytime low tides, fallow agricultural fields become important foraging areas for adult and juvenile herons (Butler 1992; Gebauer and Moul 2001). Inland fields are considered an important foraging habitat for both adults and juveniles in the lower Fraser Valley and on southern Vancouver Island (Gebauer and Moul 2001). The number of herons that use non-aquatic foraging habitats is not known, but large numbers of herons reside in south-coastal areas—an estimated 3326 herons (Gebauer and Moul 2001)—so it is likely that these areas are an important foraging habitat for a significant portion of the heron populations in this area. The importance of non-aquatic foraging habitat for herons in the Interior and on other areas of the coast is not known.

Nesting

Colonies occur in relatively contiguous forest, fragmented forest, and solitary trees (Butler 1997). Nests are generally located close together, although highly dispersed colonies have been reported (Vennesland, pers. obs.; M. Chutter, pers. comm.). The most common tree species used for breeding on the coast are red alder (*Alnus rubra*), black cottonwood (*Populus balsamifera*), bigleaf maple (*Acer macrophyllum*), lodgepole pine (*Pinus contorta*), Sitka spruce (*Picea sitchensis*) and Douglas-fir (*Pseudotsuga menziesii*) (Gebauer and Moul 2001). In the southeastern interior, black cottonwood comprises 54% of nest trees with coniferous species —Douglas-fir, western white pine (*Pinus monticola*), hybrid white spruce (*Picea glauca* × *engelmannii*), ponderosa pine (*Pinus ponderosa*), western redcedar (*Thuja plicata*) and western hemlock (*Tsuga heterophylla*)—accounting for the remaining 46% (Machmer and Steeger 2002). Nest in coniferous trees are more difficult to detect, even during aerial surveys. See Gebauer and Moul (2001) for a more exhaustive review of tree species utilized.

The size of Great Blue Heron populations has been correlated with the area of foraging habitat available locally (Butler 1993; Gibbs and Kinkel 1997). It is therefore important, especially in highly urbanized areas such as Vancouver and Kelowna, that sufficient nesting habitat is maintained near important feeding areas (Butler 1997). In addition, since herons frequently relocate colonies, it is also important that alternate forested sites be available. The very large colonies (~200–400 breeding pairs) that occur around the lower Fraser Valley rely on large parcels of primarily deciduous (mostly red alder) forest. Eagle activity is likely increasing at these sites, making the availability of this type of forest important for reducing the potential impact of foraging eagles by giving herons alternate nesting locations if eagle activity becomes too high at traditional sites (Vennesland 2000).

Conservation and Management

Status

Both subspecies of the Great Blue Heron are on the provincial *Blue List* in British Columbia. In Canada, the *fannini* subspecies is considered a species of *Special Concern* (COSEWIC 2002). The status of the *herodias* subspecies has not been assessed.

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

Subspecies	BC	AB	AK	ID	MT	OR	WA	Canada	Global
A. h. fannini	S3B, S5N	–	S4	–	–	–	?	N?	G5T4
A. h. herodias	S3B, S5N	S3B, S1N	–	S5B, S5N	S4B, SZN	S4	S4S5	N5B, NZN	G5T5

Trends

Population trends

Population size has been difficult to estimate for this species because colonies are not stable entities and are difficult to track in a standardized fashion (Butler 1997; Vennesland 2000; Gebauer and Moul 2001). The *fannini* subspecies in British Columbia is currently estimated at 3626 breeding adults, with an estimated 3326 adults breeding in the Strait of Georgia and 300 breeding elsewhere on the coast (Butler 1997; Gebauer and Moul 2001). The size of the *herodias* subspecies in British Columbia is not known, but probably ranges between 300 and 700 individuals (Gebauer and Moul 2001).

Population trends are also difficult to estimate. Few data are available on the coast prior to the past 30 years; however, over this period the population has been reported to be generally stable or declining. Gebauer and Moul (2001) reported that the Great Blue Heron population on the coast had apparently not changed significantly since Butler (1997) estimated the heron population from data collected from 1987 to 1992, although some measures showed declines (Gebauer and Moul 2001). An annual decline rate of 5.7% was reported from Breeding Bird Survey (BBS) data from 1966 to 1994 (Downes and Collins 1996), but Christmas Bird Counts (CBC) showed populations to be generally stable (Gebauer and Moul 2001). An exception is the Sunshine Coast area, where CBC data indicate a decline from 1991 to 1997. In addition, the number of herons observed breeding on the Sunshine Coast dropped from 97 in 1978 (Forbes et al. 1985b) to 11 in 1999 (Vennesland 2000). Campbell et al. (2001) concluded that coastal Great Blue Herons were the most at risk out of 28 species of birds in British Columbia that showed significant declines based on BBS data. It is generally believed that the size of the Great Blue Heron population in the Interior has increased over the past century, but little information is available on the magnitude of this increase (Gebauer and Moul 2001). Seventeen active breeding sites with 259 active heron nests were detected during a 2002 breeding inventory of the Columbia Basin in British Columbia (Machmer and Steeger 2002). This compares to 10 active sites with 266 active nests in a 1982 survey of a smaller portion of the basin (Forbes et al. 1985a); differences in survey methods and survey area size limit conclusions regarding population trends.

Habitat trends

Suitable nesting habitat has undoubtedly declined in British Columbia over the past century due to increases in the size of human populations and industry, especially in south-coastal areas around the Fraser River delta and Vancouver Island (Moore 1990; Butler 1997; Campbell et al. 2001). The availability of suitable forested lands in British Columbia continues to decrease (Butler 1997; Gebauer and Moul 2001). Habitat destruction in south coastal British Columbia has resulted in the abandonment of at least three colonies (Gebauer 1995; Vennesland 2000). Similarly, the construction of dams, flooding or reservoirs, and the development of forest and riparian lands is associated with some heron colony abandonment in the Interior (Machmer and Steeger 2002).

Suitable foraging habitat is also likely declining in British Columbia, and this decline is considered to be as or more important than that of breeding habitat (Gebauer and Moul 2001). The size of Great Blue Heron populations is correlated with the area of foraging habitat available locally, and consequently the largest concentrations of herons occur around the Fraser River delta where extensive mudflats and eelgrass beds provide abundant foraging locations (Butler 1993; Eissinger 1996; Gibbs and Kinkel 1997). Local declines in foraging habitat have likely been greatest in south-coastal British Columbia because most of the province's human population is located in this area (Butler 1997; Gebauer and Moul 2001).

Threats

Population threats

Direct threats to Great Blue Heron populations in British Columbia include disturbance and mortality from predators and humans, food supply limitations, contamination, and weather.

Vennesland (2000) reported that Bald Eagle (*Haliaeetos leucocephalus*) depredation and human disturbance were the most important direct threats to heron populations because of reductions in breeding productivity. During the 1998 and 1999 breeding seasons, eagles were likely involved in 13 of 14 colony abandonments observed, and eagle depredation of eggs and nestlings had a significant negative impact on the breeding productivity of colonies in south coastal British Columbia (Vennesland 2000). Over the same period, human disturbance was likely involved in one colony abandonment (Vennesland 2000). Other authors have also commented on the potential problems associated with eagles and humans (e.g., Parnell et al. 1988; Norman et al. 1989; Butler et al. 1995; Butler and Vennesland 2000; Gebauer and Moul 2001). Human disturbance has been implicated in many historical colony abandonments in British Columbia (Kelsall and Simpson 1979; Forbes et al. 1985a). Additionally, both these sources of disturbance are increasing in British Columbia (Vermeer et al. 1989; Blood and Anweiller 1994), and their impact on breeding herons is also probably increasing (Vennesland 2000). The killing of adult herons who feed on farmed fish stocks is currently prohibited due to the large influence that the removal of breeding adults can have on local heron populations (Butler and Baudin 2000; R.W. Butler, pers. comm.), although the regional manager of Environmental Stewardship, in consultation with the Canadian Wildlife Service, can issue a permit to kill herons at fish farms. Eagles also attack and kill adult herons (Forbes 1987; Sprague et al. 2002). In addition, although herons commonly nest in urban areas (Butler 1997; Vennesland 2000), disturbance from humans can cause herons to temporarily abandon their breeding attempts, allowing predators to take eggs (Moul 1990). High levels of human activity near breeding colonies have also been linked with increased disturbance from eagles (Vennesland 2000). There have been no reports of direct negative effects on breeding or non-breeding herons from cattle or other agricultural animals. Grazing could potentially alter heron foraging success if changes in vegetative cover made it more difficult to catch prey, but no data are available that address this question.

Food supply problems can also threaten Great Blue Heron populations. Pratt (1972) and Blus and Henney (1981) reported significant overwinter mortality of herons on the Pacific coast of the United States due to starvation. In addition, Butler (1995) found that starvation due to a lack of foraging skill was the most important factor affecting juvenile survival during the first winter after fledging. Food supply problems can also affect heron breeding productivity if adult herons cannot obtain enough food to adequately feed their young (Gebauer and Moul 2001). However, food limitations are currently viewed as a less important threat than disturbance from predators and humans (Butler 1997; Vennesland 2000).

Contamination from human industrial activities likely caused the abandonment of one colony near Vancouver Island in the late 1980s (Elliott et al. 1989), but this threat is declining in British Columbia and is currently not seen as a widespread problem (Elliott et al. 2003).

Adverse weather can also impact heron populations. Forbes et al. (1985b) suggested that low rainfall and/or extensive sunshine could increase breeding productivity, implying that high rainfall and limited sunshine might reduce productivity. This effect could be due to hypothermia in nestlings, or reduced prey delivery from attending adults (Gebauer and Moul 2001). Tree or nest blowdown has also been implicated in the death of nestlings (Burkholder and Smith 1991).

Habitat threats

Threats to Great Blue Heron habitat in British Columbia include the loss of breeding and foraging areas to urban development, forestry, hydroelectric power development, and natural processes. Urban development and forestry are the main causes of habitat loss. Heron populations in British Columbia are concentrated around the Georgia Depression ecoprovince and in valley bottoms of the Interior, and these two habitats are also the primary centres of human activity in the province (Moore 1990; Butler 1997; Campbell et al. 2001). Forestry can impact heron habitat through the removal of active or potential nest trees (Bjorkland 1975; Werschkul et al. 1976; Gebauer and Moul 2001). Habitat is also threatened by weather-related problems such as tree or nest blowdown (see previous section). Forest fragmentation may increase access to, or visibility of, breeding colonies for predators, such as Bald Eagles, thereby reducing the amount of suitable breeding habitat available to herons (Vennesland 2000).

Legal Protection and Habitat Conservation

The Great Blue Heron, its nests and eggs are protected year-round from direct persecution by the provincial *Wildlife Act,* as well as the *Migratory Birds Convention Act*. Scare/kill permits were provided up to 1998 to control herons feeding on fish stocks, but these have since been revoked (Butler and Baudin 2000).

Many sites are currently protected within regional or municipal parks, wildlife management areas, or have other protected status directly related to the occupancy of breeding herons (Gebauer and Moul 2001). This includes colonies at Vaseux Lake and Wilmer Wildlife Area in the Kootenay region, as well as the four largest colonies in the lower Fraser Valley (67% of all active nests in the area, n = 1070) and two colonies on Vancouver Island and the Gulf Islands (39% of all active nests in the area, n =459) (Gebauer and Moul 2001). In total, 59% of all active nests in the Georgia Depression are currently protected (n = 1529 active nests). The continuing efforts of the Wild Bird Trust are now directed at mid-sized colonies to secure covenants on private and commercial lands (Butler and Baudin 2000; Gebauer and Moul 2001). The Delta Farmland Trust has recently established grassland set-asides to protect heron foraging habitat, and several projects have been undertaken to restore original habitat in areas that have been altered by causeways and dikes (Gebauer and Moul 2001).

Under the results based code, some critical foraging and nesting habitats could be addressed through establishment of old growth management areas, riparian management areas and wildlife tree retention areas. In addition, the "wildlife habitat feature" designation may also protect known nest sites. Although buffers are not currently enabled under this designation, licensees should voluntarily maintain a buffer to minimize disturbance and maintain the integrity of nesting habitat. However, many breeding colonies are located on private land, and the protection of heron nesting locations on Crown land should be considered a priority because most herons nest on private land where less regulatory control is available.

For colonies on private land, best management practices guidelines have been created by the British Columbia Ministry of Water, Land and Air Protection, Region 1 (Vancouver Island). These voluntary guidelines outline how developers can help to protect breeding herons in existing developed areas (K. Morrison, pers. comm.). In addition, herons on private land can be protected through zoning at the municipal level (M. Henigman, pers. comm.).

Identified Wildlife Provisions

Wildlife habitat area

Goals

Protect heron nesting sites and adjacent foraging areas from human disturbance and habitat loss or alteration.

Feature

Establish WHAs at nesting areas and nesting colonies. Important foraging sites (i.e., concentrations of herons feeding on a regular basis) may be recommended for WHA establishment by the Canada/U.S. Heron Working Group.

Size

Typically 80 ha but will ultimately depend on site-specific factors. Size should depend on the number of individuals using locations for breeding and/or foraging (Butler 1997; Gebauer and Moul 2001) and density of use. Other important factors to be considered include location, topography, proximity of foraging sites (for colonies), relative isolation, and degree of habituation to disturbance.

Design

The design of the WHA should consider the colony size, location, proximity of foraging sites, relative isolation, and degree of habituation to disturbance. The core area should be approximately 12 ha and include known nest sites, potential nesting areas and, where appropriate, foraging areas and flight paths. Ideally, the boundary of the core area should be approximately 200 m radius from the edge of the colony or important habitat feature(s). A 300 m management zone should also be included to minimize disturbance to all components of the WHA (nest site, foraging sites).

In areas where human disturbance is a concern, incorporate boundaries that may act as barriers to humans wherever possible. Carlson and McLean (1996) showed that barriers that completely excluded humans were more effective than management zones that allowed some intrusion, and breeding productivity was higher at sites with stronger barriers (e.g., ditches and fences).

For existing developed sites in areas of high human use, a minimum naturally vegetated strip around all breeding colonies of at least 50 m is recommended by the best management practices guidelines produced by the Ministry of Water, Land and Air Protection in Region 1 (K. Morrison, pers. comm.).

General wildlife measures

Goals

1. Minimize disturbance during the breeding season (15 February to 31 August) and between 1 November and 31 March for colonies that occupy areas year round.
2. Maintain important structural elements for nesting and foraging (i.e., suitable nest trees, non-fragmented forest around nest trees, wetland characteristics for foraging if applicable, roost trees, and ground barriers to exclude mammalian predators).

Measures

Access

- Do not develop roads or trails within the core area. Road and trail construction or blasting in the management zone should not occur between 15 February and 31 August.
- Limit access on existing roads and trails between 15 February and 31 August. Types and levels of use must not exceed levels that customarily occur during the breeding period.

Harvesting and silviculture

- Do not harvest within the core area.
- Do not harvest within the management zone between 15 February and 31 August.
- No silvicultural activities, except restoration or enhancement activities, should occur within the core area. In the management zone, no mechanized activities that exceed noise or disturbance levels (including distance from colony) previously experienced during this period should occur between 15 February and 31 August.
- Within a management zone that has few trees other than the nest trees, restocking and/or silvicultural techniques can be applied to enhance rapid development and protection of the stand.

Pesticides

- Do not use pesticides.

Range

- Maintain WHA in a properly functioning condition.
- Control level of livestock use and plan grazing to ensure that the structural integrity of stands of emergent vegetation are maintained. Fencing could be required by the statutory decision maker to meet goals described above.

Recreation

- Do not develop recreation trails, structures, or facilities.

Additional Management Considerations

Avoid disturbance within 500 m of colonies and adjacent foraging habitats between 15 February and 31 August and between 1 November and 31 March for year-round colonies. Some colonies may have become habituated to some levels of disturbance, in which case it may not be necessary to refrain from activities. In general, motorized, loud, or continuous activities are more disturbing than non-motorized activities. When incorporating barriers to minimize access or disturbance, it is better to use barriers that completely exclude humans than those that allow some intrusion (Carlson and McLean 1996).

Where permanent activities or habitat modifications are planned, vegetative screening should be planted or maintained between the activity and the colony as close to the activity area as possible. Where possible, the trees/shrubs planted should be a mixture of deciduous and coniferous, and half should be of the same species currently used for nesting.

Consider constructing a fence or other barrier between the activity and vegetative screening.

Protect heron foraging resources, especially those within 4 km of colonies and in key wintering areas, from development, degradation, and pollution, particularly aquaculture operations and discharge of toxic effluents. Coastal heron concentrations occur on estuaries and other low gradient intertidal habitats and on adjacent farmlands during the winter. Interior birds feed in marshes and along shallow shorelines of lakes and rivers; during winter they need areas of open (unfrozen) water.

Maintain perch trees adjacent to major summer and winter foraging areas.

Prevent further loss of important coastal and interior riparian mature/old-growth forest nesting habitat to urban/suburban and forest development.

Information Needs

1. Monitoring of key breeding locations is ongoing on the coast and should be continued at the existing, or a more intensive level.
2. Heron surveys on foraging grounds.
3. Current and future impact of Bald Eagle disturbance at coastal and interior heron colonies. Eagle populations are increasing, but it is not known how long they will continue to do so, whether human activities are enhancing their populations, or how this activity may change the location or distribution of breeding herons.

Cross References

Marbled Murrelet, "Queen Charlotte" Goshawk, Spotted Owl, "Vancouver Island" Northern Pygmy-Owl

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Long-billed Curlew

Numenius americanus

Original[1] prepared by I.A. (Penny) Ohanjanian

Species Information

Taxonomy

The Long-billed Curlew (*Numenius americanus*) is the largest member of the sandpiper family, Scolopacidae, to breed in British Columbia. Two subspecies are recognized by some researchers, the lesser Long-billed Curlew (*N. americanus parvus*) which nests in Canada and the northern United States, and the greater Long-billed Curlew (*N. americanus americanus*) which occurs farther south (Allen 1980; Cannings 1998). Genetic work has not yet been carried out to determine if this distinction is valid.

Description

The Long-billed Curlew is a large, long-legged shorebird found primarily in grassland habitats during the breeding season. It has mottled, light brown plumage, a buff-coloured breast, and cinnamon underwing linings. The bill is long and curves downwards, reaching a length of up to 195 mm in females and 140 mm in males (Jenni et al. 1982).

Distribution

Global

In the United States, Long-billed Curlews breed west of the Mississippi River in Washington, Oregon, northeastern California, Idaho, Nevada, central Utah, northern New Mexico, northern Texas, northwestern Oklahoma, Wyoming, Montana, Colorado, North Dakota, South Dakota, Nebraska, and western Kansas (Sauer et al. 2000). Since the early 1900s they have been extirpated from much of their historic range (Allen 1980; De Smet 1992). The major wintering areas for Long-billed Curlews are the coastal lowlands of California, the inland grasslands of the Central Valley, west Texas, eastern New Mexico, and along the Gulf coast in Texas and Louisiana (Sauer et al. 2000). De Smet (1992) has also reported this species wintering in the coastal lagoons of southern Mexico and south to Venezuela.

During the last century in Canada, curlew numbers have declined and the breeding range has shrunk. Formerly a breeder in southern Manitoba, the species is now listed as extirpated (De Smet 1992; Sauer et al. 2000). Long-billed Curlews remain in Saskatchewan (Smith 1996, cited by Hill 1998) but no longer occupy some of their historic range in the southeastern portions of the province (De Smet 1992). In Alberta, Long-billed Curlews breed in the southern half of the province, with the highest densities in the grasslands south of Red Deer (Hill 1998).

British Columbia

Non-breeding birds are widely distributed through the south-central Interior, north to the Nechako Lowland. This shorebird appears sporadically on the south coast during spring and autumn migration, where it is restricted to estuaries, mudflats, airports, or other open grassy areas.

The Long-billed Curlew breeds in the southern Interior. Breeding areas are fairly disjunct and include areas from (1) Lillooet north to Quesnel (Chubb Lake), (2) the Chilcotin west to Alexis Creek, (3) the south Okanagan and lower Similkameen valleys, (4) the North Okanagan, (5) the Thompson-Nicola, and (6) the East Kootenay Trench (Cannings 1999). Small populations breed in agricultural cropland near McBride and in the Creston Valley (Van Damme 1996, cited by Cannings 1999). Records outside the periphery of its breeding range suggest that it may breed over a slightly larger range than currently documented. Breeding does not occur on the coast.

1 Volume 1 account prepared by M. Sarell.

Long-billed Curlew
(Numenius americanus)

Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on several ecosystem classifications (Ecoregion, Biogeoclimatic and Broad Ecosystem Inventory) as well as current knowledge of the species' habitat preferences. This species may or may not occur in all areas indicated. More detailed maps are available for this species from the Ministry of Sustainable Resource Management.

Forest region and districts

Coast:[2] Campbell River, Chilliwack

Northern Interior: Fort St. James (possible), Prince George, Vanderhoof

Southern Interior: 100 Mile House, Arrow Boundary, Cascades, Central Cariboo, Chilcotin, Headwaters, Kamloops, Kootenay Lake, Okanagan Shuswap, Quesnel, Rocky Mountain

Ecoprovinces and ecosections

CEI: CAB, CHP, FRB, QUL

COM: WIM

GED:[2] FRL, NAL

SBI: NEL

SIM: EKT, ELV, SCM, UCV, UFT

SOI: GUU, NIB, NOB, NOH, NTU, OKR, PAR, SHB, SOB, SOH, STU, THB

Biogeoclimatic units

BG: xh1, xh2, xh3, xw, xw1, xw2

CDF: mm

CWH: dm, vh1, vh2, vm1, xm1

ICH: xw

IDF: dk1, dk2, dk3, dk4, dm2, mw1, mw2, mw2a, xh1, xh1a, xh2, xh2a, xm, xw

PP: dh1, dh2, xh1, xh2, xh2a

SBS: dh, dw3, mk1

Broad ecosystem units

AB, BS, CF (in FRL only), DF, ES, ME, SS

Elevation

280–1220 m (Campbell et al. 1990; Fraser et al. 1999)

Life History

Diet and foraging behaviour

On the breeding grounds, adult Long-billed Curlews have been observed eating ground beetles (Allen 1980), and grasshoppers (Redmond and Jenni 1985) as well as earthworms in nearby irrigated hayfields (Ohanjanian 1985). Grasshoppers and beetles are the predominant prey of chicks, and caterpillars and spiders are also eaten (Redmond and Jenni 1985). In wintering habitats, the Long-billed Curlew feeds on mud crabs, fiddler crabs, ghost shrimps, and occasionally small fishes (De Graaf et al. 1991).

Reproduction

Long-billed Curlews first breed at 2–3 years (females) and 3–4 years (males) (Redmond and Jenni 1986). They nest in dry, open grasslands with low profile vegetation. Nests are shallow scrapes on the ground, from 130 to 275 mm in diameter and approximately 20 to 65 mm deep (Allen 1980). Nest cups may be lined with leaves, twigs, sheep or rabbit pellets, small stones, and grass (Allen 1980; Jenni et al. 1982). Four eggs are usually laid over 1 week (Jenni et al. 1982; Redmond 1984; Campbell et al. 1990). Clutches are initiated from mid-April until the first half of May, with most occurring in the third week of April (Redmond 1984; Cannings et al. 1987). More northerly birds may initiate clutches slightly later than those in the south, but it is unlikely that eggs are laid in any location after mid-May. Both adults share incubation (which takes about 28 days) (Allen 1980) and depend on their cryptic plumage to camouflage their presence. When incubating birds are flushed, they may take up to 1 hour to return to the nest (Allen 1980).

Chicks hatch synchronously, and adults and broods remain within 100–300 m of the nest site for the first few days (Jenni et al. 1982), after which time they become highly mobile. Some chicks become capable of flight at 35–40 days (Jenni et al. 1982), although Fitzner (1978) reports 40–45 days to fledging. Females usually depart from the breeding grounds prior to their chicks being fledged, leaving males to tend broods after the first few weeks (Redmond 1984; De Smet 1992). The young of birds that initiate clutches in the third week of April are generally fledged by the end of June. This date may extend into mid-July for later breeders.

Site fidelity

Both male and female Long-billed Curlews show strong site fidelity, returning each year to previous nesting territories (Redmond 1984). There is evidence that male curlews tend to return to their place of birth to set up a territory and attract a mate when they reach sexual maturity. Long-billed

2 Non-breeding.

Curlews are monogamous and have long-term pair-bonds (Redmond 1984).

Home range

Nesting territory is highly variable in size. In the Chilcotin, nesting curlew densities ranged from a low of 0.73 pairs/100 ha of suitable habitat to 3.4 pairs/100 ha (Ohanjanian 1987). Hooper and Pitt (1996) found breeding densities ranged from 0.7 pair/100 ha to 2.1 pair/100 ha between 1987 and 1992. In the East Kootenay, densities at Skookumchuck ranged from 1 pair/20 ha (1985) to 1 pair/30 ha (Ohanjanian 1992). In southwestern Idaho estimates ranged from 1.74 males/100 ha suitable habitat to a maximum of 8.4 males/100 ha (Jenni et al. 1982). In southeastern Washington, breeding densities ranged from 1 pair/172.6 ha to 1 pair/66 ha in the densest area (Allen 1980). Broods require more space than nesting adults, and home ranges of up to 1000 ha are recorded in the literature (Jenni et al. 1982). Jenni et al. (1982) suggest that a curlew brood requires a minimum of 250 ha.

Movements and dispersal

Migrants appear from late March through early April during most years. Females may depart from the nesting areas as early as the latter half of June (Redmond 1984) with some males following soon after. Juveniles of the year remain the longest on the breeding grounds, forming feeding flocks and then departing at the end of July (Allen 1980; Redmond 1984).

Habitat

Structural stage

2: herb

Important habitats and habitat features

Nesting and brood rearing

Long-billed Curlews breed in areas with maximum visibility, largely because of co-operative anti-predator mobbing behaviours. They therefore need large contiguous openings of grassland and prefer areas that are gently sloping (Hooper and Pitt 1996). During pre-laying and incubation, areas with low vegetation (<10 cm tall preferred) and a maximum vertical coverage value of 40% at the height of a curlew's eyes (30 cm) are used preferentially (Allen 1980; Jenni et al. 1982; Ohanjanian 1992). During brood-rearing, higher vegetation (up to 30 cm) may be used, and irregular spacing of taller grass clumps complement chicks' cryptic colouration and provide hiding and shading opportunities for them (Allen 1980; Jenni et al. 1982). Mean width of openings used for nesting at Skookumchuck was 547 m (range 250–900) at the narrowest point (Ohanjanian 1992). A buffer of 300–500 m between nesting territories and non-suitable habitat or human activities has been observed by Bicak et al. (1982) and Jenni et al. (1982).

Use of new crested wheatgrass seedings has been documented in British Columbia, where a high proportion of native plant species were still present and the vegetative profile was low (Ohanjanian 1985). Such seedings will not continue to support the species if left ungrazed; in Idaho, they were avoided because their vertical coverage values were too high (Jenni et al. 1982).

Migration

This shorebird appears sporadically on the south coast during spring and autumn migration, where it is restricted to estuaries, mudflats, airports, or other open grassy areas (Campbell et al. 1990).

Foraging

Insects are obtained primarily on the grasslands. Curlews may be seen soon after their arrival in spring, however, earthworms provide immediate, high quality protein in irrigated hayfields (Ohanjanian 1985).

Conservation and Management

Status

The Long-billed Curlew is on the provincial *Blue List* in British Columbia. It is designated as a species of *Special Concern* in Canada (COSEWIC 2002).

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

BC	AB	ID	MT	OR	WA	Canada	Global
S3B, SZN	S3B	S3B, SZN	S4B, SZN	S3S4	S2B, S2N	N4B	G5

Trends

Population trends

The population of Long-billed Curlews in the North Okanagan Valley declined considerably between 1982 and 1995 (Cannings et al. 1987; Cannings 1999). The south Okanagan birds appear to fluctuate, and may have done so historically as well (Cannings 1999). The East Kootenay population has increased since the 1970s (Ohanjanian 1992), and new reports of birds at Creston (Van Damme 1996, cited by Cannings1999) suggest that they may be expanding their range in this region. There is no hard data on current population trends elsewhere in British Columbia. The overall population appears to be stable, with some areas increasing and other decreasing (Cannings 1999).

Habitat trends

Habitat continues to be lost due to forest encroachment, subdivisions, and conversion of rangelands to agricultural use.

Threats

Population threats

In British Columbia, the Long-billed Curlew has a restricted breeding distribution and small population size. Cannings (1999) estimated a minimum population of about 250 breeding pairs. The Long-billed Curlew is a ground-nesting species and therefore experiences high rates of predation on eggs and young. Predators of nests or chicks include coyotes, weasels, badgers, magpies, ravens, dogs, and snakes (Allen 1980; Redmond 1984). If nests are predated, adults do not usually re-nest (Cannings 1999).

Habitat threats

Major threats to Long-billed Curlew habitat are urbanization, forest encroachment due to fire suppression, noxious weeds, and conversion of native rangelands to agricultural crops such as ginseng and hay (Ohanjanian 1992; Cannings 1999). Hay fields are generally too dense for small chicks to move about in. There are reports of Long-billed Curlews nesting in grain fields (Cannings 1999); their productivity in these habitats, however, has not been ascertained. Cheatgrass (*Bromus tectorum*), an introduced invasive grass, is tolerated and may even be preferred by Long-billed Curlews but other invasive species, particularly knapweed, are thought to be avoided by curlews.

All-terrain vehicles (ATVs) may pose a serious threat in localized areas. Range quality may become degraded as ATV tracks destroy vegetation and facilitate topsoil erosion. ATVs may also cause direct mortality to Long-billed Curlews in several ways: eggs may become overheated leading to heat stress and embryo death while adults are flushed off nests, predators such as ravens may be attracted to chicks by adult alarm calls while they mob human intruders, and nests or chicks may be run over.

Although Long-billed Curlews tolerate and may even benefit from livestock grazing, they may be impacted (e.g., trampling) or disturbed by heavy livestock during critical times during the breeding season.

Pesticides, particularly organochlorines, may also impact curlew breeding success.

Legal Protection and Habitat Conservation

The Long-billed Curlew, its nests, and its eggs are protected under the federal *Migratory Birds Convention Act* and the provincial *Wildlife Act*.

For the most part, very little of known curlew nesting habitat is protected. Cannings (1999) estimates that <10% of curlews nest within lands protected for conservation. In the south Okanagan and Similkameen, only 6% of curlew habitat is considered to be within lands designated for conservation purposes and 47% is within private land (MELP 1998). In the Cariboo/Chilcotin, some protection is available for a few pairs of Long-billed Curlews at the Junction Provincial Park (410 ha) (Ohanjanian 1987; T. Hooper, pers. comm.). There are also a few pairs in the south Okanagan Wildlife Management Area and at White Lake, which is under long-term lease to Nature Trust (Cannings 1999). In the East Kootenay, one or two pairs nest on properties owned by the province at Bummer's Flats and on Wolf Creek Road. Churn Creek and Lac du Bois may also contain nesting curlews.

Under the results based code, range use plans that consider the requirements of this species may be sufficient to meet the needs of the species. However for a species to be specifically addressed within these plans they must be designated as Identified Wildlife. In some cases, current grazing practices may be adequate to maintain habitats for this species and therefore it may not be necessary to establish a WHA. This assessment must be made case by case.

Identified Wildlife Provisions

Wildlife habitat area

Goals

Maintain suitable nesting and brood rearing habitat for multiple pairs.

Feature

Establish WHAs over breeding areas occupied by multiple pairs. Breeding areas include nesting, incubation, and brood rearing habitats.

Size

Typically between 250 and 500 ha but will ultimately depend on the number of pairs and area of suitable habitat. Larger contiguous openings will support more curlews (denser numbers) than smaller areas (Bicak et al. 1982).

Design

The WHA should include flat to moderately rolling terrain and short grass cover (ideally ≤10 cm tall during the pre-laying period and up to 25 cm during brood-rearing) (Jenni et al. 1982). Ideally the WHA should include as large an area of grassland as possible but should include ~250 ha of brood rearing habitat with scattered clumps of grasses 20–30 cm in height (this may include the nesting territory). The WHA should be at least 250 m wide at its narrowest point but should include a 500 m buffer of similar open habitat (Jenni et al. 1982) to protect against disturbance. The buffer should be managed similar to the core so does not need to be distinguished but should be considered when designing WHA boundaries.

General wildlife measures

Goals

1. Provide low profile vegetation (<10 cm) for nesting in April.
2. Provide vegetation that is approximately 25 cm in height for brood rearing in May.
3. Minimize disturbance from humans or livestock during critical times throughout the breeding season (1 April to 15 July).
4. Maintain native bunchgrass in brood-rearing areas.
5. Minimize forest encroachment.

Measures

Access

- Do not construct roads unless there is no other practicable option.
- Limit road use during critical times during the breeding season (1 April to 15 July) when considered necessary by statutory decision maker. Contact MWLAP staff for site-specific times.

Pesticides

- Do not use pesticides.

Range

- Control timing and distribution of livestock grazing to avoid disturbances during the breeding season. Consult MWLAP for site-specific times.
- Plan livestock grazing to maintain grass cover in nesting areas that is on average <10 cm in height when curlews return in spring.
- Avoid concentrating livestock during the breeding season (1 April to 15 July) particularly during the incubation period. Place salt and water troughs in treed areas wherever possible to prevent livestock concentrations in the open where nests may occur. When it is necessary to move livestock through a WHA during the incubation period (generally 15 April to 31 May) and there is no other practicable option, use forest or shrub areas or areas immediately adjacent to trees (<20 m) rather than in the middle of openings. Consult MWLAP for specific times.
- Do not use fire in nesting areas during egg-laying or brood-rearing times.

Recreation

- Do not establish recreational trails.

Additional Management Considerations

Prevent or restrict motorized recreation vehicles such as ATVs and dirt bikes within WHA particularly between 15 March to 15 July.

Where appropriate, and the habitat capability is high, revegetate crested wheatgrass seedings to native grass species.

Control forest encroachment using logging in combination with burning or other suitable methods.

Information Needs

1. Population size and trend.
2. Determine if Long-billed Curlews breed in Churn Creek Protected Area.
3. Research on brood rearing and rearing habitat requirements is needed.

Cross References

Grasshopper Sparrow, Sage Thrasher

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Sandhill Crane

Grus canadensis

Original[1] prepared by Martin Gebauer

Species Information

Taxonomy

Of the 15 crane species in the world (Sibley 1996), two breed within North America: Sandhill Crane (*Grus canadensis*) and Whooping Crane (*Grus americana*) (NGS 1999). Early literature recognized three subspecies of Sandhill Crane (AOU 1957), however, more recent literature recognizes six subspecies: Lesser (*G. canadensis canadensis*), Canadian (*G. canadensis rowani*), Greater (*G. canadensis tabida*), Florida (*G. canadensis pratensis*), Cuban (*G. canadensis nesiotes*), and Mississippi (*G. canadensis pulla*) (Walkinshaw 1973, Tacha et al. 1992) of which the first three subspecies occur in British Columbia (Cannings 1998).

The Lesser Sandhill Crane is a common migrant through British Columbia, as is the Greater Sandhill Crane and possibly the Canadian Sandhill Crane breed. The Greater Sandhill Crane is thought to be the subspecies breeding in the Lower Mainland, the Queen Charlotte Islands, Vancouver Island, the Hecate Lowlands, and interior areas of the province (Campbell et al. 1990). Some authors have questioned the splitting of Greater and Canadian Sandhill Cranes into separate subspecies since a continuum in morphology and random pairing among the supposed subspecies has been demonstrated (Tacha et al. 1992).

Description

These large grey birds are perhaps most often confused with the morphologically similar, but taxonomically different, Great Blue Heron (*Ardea herodias*). Sandhill Cranes can be distinguished by their large size, overall grey colouration (often stained with rusty colouration), with dull red skin on the crown and lores, whitish chin, cheek and upper throat, and black primaries. Young are more brownish and without a bare forehead patch (Godfrey 1986; NGS 1999).

Distribution

Global

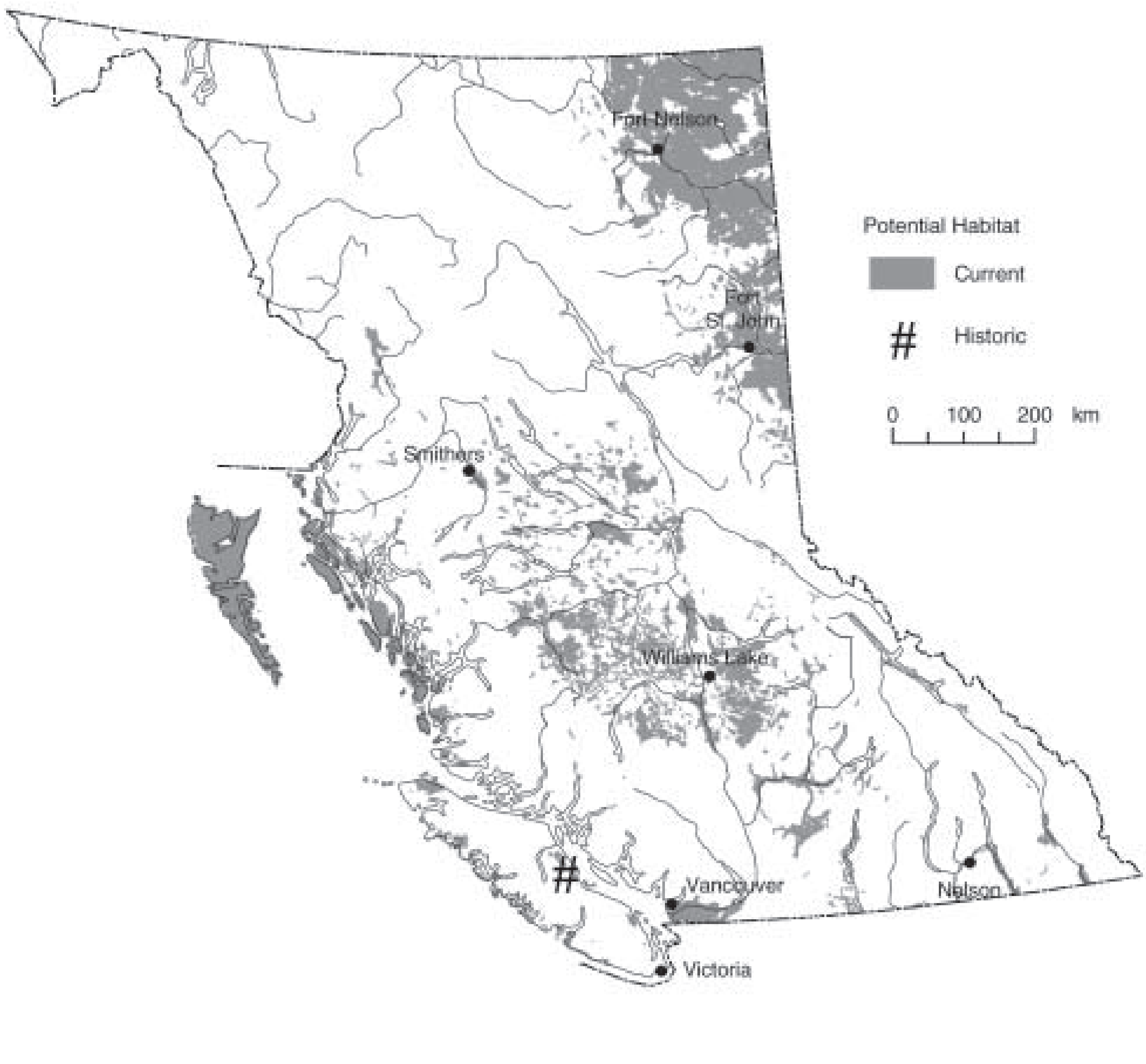
The Sandhill Crane is restricted to North America breeding primarily from the northwestern United States (e.g., northwestern California, Nevada, and Oregon) and the Great Lakes area north to Alaska, and the Northwest Territories including Baffin and Victoria Islands. Resident populations breed in the Mississippi River delta, Florida and southern Georgia, and Cuba (Tacha et al. 1992). Sandhill Cranes winter from central California, southeastern Arizona east to central Texas, in scattered areas of the Gulf Coast and southern Florida, and south to the states of Sinaloa, Jalisco, Chihuahua, Durango, and Veracruz in Mexico (Tacha et al. 1992; Howell and Webb 1995; Drewien et al. 1996).

British Columbia

The Sandhill Crane has a widespread breeding distribution in British Columbia, although the breeding distributions of the three separate subspecies is not well understood. Known breeding areas include much of the central Interior, the Queen Charlotte Islands, the central mainland coast, Mara Meadows near Enderby, East Kootenay, northeastern British Columbia near Fort Nelson, and at Pitt Meadows and Burns Bog in the Lower Mainland (Gebauer 1995; Cooper 1996). The Greater Sandhill Crane is thought to breed throughout most of the Interior, whereas the Canadian Sandhill Crane is thought to breed on the coast (Cooper 1996) but may also breed in the central Interior and northeast (Littlefield and Thompson 1979). Lesser Sandhill

1 Volume 1 account prepared by J. Cooper.

Sandhill Crane
(Grus canadensis)



Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on several ecosystem classifications (Ecoregion, Biogeoclimatic and Broad Ecosystem Inventory) as well as current knowledge of the species' habitat preferences. This species may or may not occur in all areas indicated.

Cranes occur in the province in large numbers primarily during migration, but may also breed in the northeast (Cooper 1996). Stopover points for migrating Sandhill Cranes include White Lake in the south Okanagan, Lac Le Jeune in the Kamloops area, Becher's Prairie near Williams Lake, the Kispiox Valley north of Smithers, Nig Creek northwest of Fort St. John and Liard Hot Springs in north-central British Columbia (Campbell et al. 1990).

Forest region and districts

Coast: Campbell River, Chilliwack, North Coast, North Island, Queen Charlotte Islands, South Island, Squamish

Northern Interior: Fort Nelson, Kalum, Mackenzie, Nadina, Peace, Prince George, Skeena Stikine, Vanderhoof

Southern Interior: 100 Mile House, Arrow Boundary, Cascades, Central Cariboo, Chilcotin, Headwaters, Kootenay Lake, Okanagan Shuswap, Quesnel, Rocky Mountain

Ecoprovinces and ecosections

BOP: CLH, HAP, KIP, PEL

CEI: BUB, CAB, CAP, CHP, FRB, NAU, NEU, QUL, WCR, WCU

COM: CPR, CRU, FRL, HEL, KIM, KIR, NAB, NAM, NIM, NPR, NWL, OUF, QCL, SKP, WIM, WQC

GED: FRL, LIM, NAL

NBM: LIP, TEB, TEP

SBI: BAU, ESM, MAP, MCP, NEL, NHR, PAT, SHR

SIM: BBT, CAM, EKT, QUH, SCM, SFH, SHH, SPM, UCV, UFT

SOI: GUU, NIB, NOB, NTU, OKR, SHB, SOB, STU, TRU, (THB – eastern end only)

TAP: ETP, FNL, MAU, MUP, PEP, TLP

Biogeoclimatic units

BG: all

BWBS: dk1, dk2, mw1, mw2

CDF: mm

CWH: all

ICH: all

IDF: dk1, dk1a, dk1b, dk2, dk3, dk4, mw1, mw2, mw2a

MS: all

PP: all

SBPS: dc, mc, mk, xc

SBS: dk, dw1, dw2, dw3, mc, mc1, mc2, mc3, mh, mk1, mk2, mw

Broad ecosystem units

BB, BG, BS, CB, CF, ES, ME, OW, RE, SS, TF, WL

Elevation

Breeding: sea level to 1220 m

Non-breeding: sea level to 1510 m (Campbell et al. 1990)

Life History

Diet and foraging behaviour

Sandhill Cranes are opportunistic foragers, feeding on both animal (primarily invertebrates) and plant foods (Walkinshaw 1973; Mullins and Bizeau 1978; Ballard and Thompson 2000). In Nebraska, cranes feeding in cornfields ate >99% corn whereas those feeding in native grasslands and alfalfa fields consumed 79–99% invertebrates (Reinecke and Krapu 1986). Invertebrates consumed by cranes in Nebraska included earthworms, beetles, crickets, grasshoppers, cutworms, and snails. In Idaho, plants made up 73% of the total food consumption of summering cranes, and insects and earthworms made up the remaining 27% (Mullins and Bizeau 1978). Large flocks of staging cranes feeding on agricultural grain crops has lead to crop depredation in some areas (Tacha et al. 1985; McIvor and Conover 1994a, 1994b). Other foods taken by Sandhill Cranes include crayfish, voles, mice, frogs, toads, snakes, nestling birds, bird eggs, berries, and carrion (Cooper 1996).

Reproduction

Dates for 20 clutches in British Columbia ranged from 2 May to 25 June with 50% recorded between 9 and 24 May. Clutch size ranged from one to three eggs with 84% having two eggs (Campbell et al. 1990). Dates from two nests in British Columbia suggest an incubation period of 33–34 days (Campbell et al. 1990), more than the 28–32 days reported by Ehrlich et al. (1988). Dates for 47 broods in British Columbia ranged from 15 May to 1 September with 57% recorded between 15 June and 15 July. Sizes of 46 broods ranged from one to two young with 72% of the broods having one young (Campbell et al. 1990). Fledgling period ranges from 65 to 70 days (Ehrlich et al. 1988; Campbell et al. 1990). Replacement clutches may be laid if the first clutch is lost within an interval of about 20 days (Nesbitt 1988).

Site fidelity

Drewien et al. (1999) found that radiomarked Sandhill Cranes of the Rocky Mountain population exhibited strong site fidelity to summer and winter grounds during successive years, and that juveniles apparently learned traditional use patterns from parents. Tacha et al. (1984) found that individuals (particularly established pairs) consistently returned to the same wintering grounds. However, preliminary data in central British Columbia suggest that site fidelity of breeding pairs between years is not strong (Cooper 1996).

Home range

Sandhill Crane territories at Grays Lake, Idaho, with the densest known nesting concentrations, averaged 17 ha (Drewien 1973). At Malheur National Wildlife Reserve (NWR), territories averaged approximately 25 ha (Littlefield and Ryder 1968). Walkinshaw (1973) found average territory sizes ranging from 53 to 85 ha in Michigan. Territory sizes of cranes nesting in British Columbia have not been determined.

Movements and dispersal

Three migration routes are known in British Columbia, each of which is used in spring and autumn: coastal, central Interior, and northeastern Interior. Cranes migrating along the coastal route enter British Columbia over Juan de Fuca Strait and are occasionally seen in the Barkley Sound and Johnstone Strait regions. The main passage of migrants occurs in early April, whereas the autumn movement peaks in October (Campbell et al. 1990). Birds using the coastal route (~3500) are suspected of nesting in the coastal islands of British Columbia and southeast Alaska (Campbell et al. 1990). In the central Interior, the migration route follows the Okanagan Valley to Peachland, then over Chapperon Lake and the Kamloops area, through the central Chilcotin-Cariboo, over the Fraser Plateau following the Bulkley and Kispiox valleys, past Meziadin Lake and into southeastern Alaska. Between 22 000 and 25 000 birds are thought to use this route (Campbell et al. 1990). The main spring movement is at the end of April, with the main passage in the fall from late September to early October. Known stopover points include White Lake in the south Okanagan, Lac Le Jeune, Becher's Prairie west of Williams Lake, and the Kispiox Valley north of Hazelton (Campbell et al. 1990). In northeastern British Columbia, between 150 000 and 200 000 birds move through the Peace River area on their way to Alaskan and Siberian breeding grounds (Kessel 1984; Tacha et al. 1984), generally passing over Nig Creek and Cecil Lake (Campbell et al. 1990). Spring migration occurs from late April to early May, whereas fall migration is generally during the second and third weeks of September (Campbell et al. 1990).

After hatching, young leave the nest and forage with their parents around the perimeter of the natal wetland, primarily in sedge meadows. Once young have fledged, localized congregations occur in pre-migration staging areas (Gebauer 1995). In the fall at Burns Bog, cranes moved from roosting areas within the Bog to agricultural fields for foraging each day, moving distances of 2–4 km (Gebauer 1995). Lewis (1975) found the average distance of flight movements between feeding and roosting areas to range from 2 to 16 km.

Habitat

Structural stage	Roosting	Nesting	Escape	Screen
1: non-vegetated or sparsely vegetated	x	x		
2: herb	x	x		
3a: low shrub	x	x		
3b: tall shrub	x	x	x	x
4: pole/sapling			x	x
5: young forest			x	x
6: mature forest			x	x
7: old forest			x	x

Important habitats and habitat features

Nesting

Typical breeding habitats include isolated bogs, marshes, swamps and meadows, and other secluded shallow freshwater wetlands generally >1 ha in size surrounded by forest cover. Emergent vegetation such as sedges (*Carex* spp.), Cattail (*Typha latifolia*), bulrush (*Scirpus* spp.), Hardhack (*Spiraea douglasii*), willows (*Salix* spp.), and Labrador Tea (*Ledum groenlandicum*) are important for nesting and brood rearing (Robinson and Robinson 1976, Runyan 1978, Littlefield 1995a). Nesting wetlands are usually secluded, free from disturbance, and surrounded by forest. In coastal areas, brackish estuaries are used for rearing broods. Johnsgard (1983) and Walkinshaw (1949) identified sphagnum bogs as important nesting habitats for Greater Sandhill Cranes. Most sightings of cranes in Burns Bog were from wet and dry heathland (i.e., sphagnum) vegetation communities (Gebauer 1995).

Forested buffers around nesting marshes are likely critical for relatively small (1–10 ha) wetlands. Forests are used for escape cover by young and provide a buffer against disturbance. Although the Sandhill Crane has occasionally been reported as nesting in revegetating clearcuts (Campbell et al. 1990), clearcuts are generally not suitable habitat alternatives to wetlands.

Nests consist of large heaps of surrounding dominant vegetation, usually built in emergent vegetation or on raised hummocks over water (Melvin et al. 1990; Campbell et al. 1990). Robinson and Robinson (1976) found the average depth of water at five nests in the Pitt River Valley to be 4.3 cm in May and 13 cm in June. In Michigan, cranes selected nest sites in or near seasonally flooded emergent wetlands and avoided forested uplands (Baker et al. 1995). Nests may adjust (i.e., float) to slight increases in water level (Tacha et al. 1992).

Foraging

One of the most important habitat characteristics for Sandhill Cranes is an unobstructed view of surrounding areas and isolation from disturbance (Lovvorn and Kirkpatrick 1981). Typical foraging habitat includes shallow wetlands, marshes, swamps, fens, bogs, ponds, meadows, estuarine marshes, intertidal areas, and dry upland areas such as grasslands and agricultural fields. In the Interior, flooded meadows and agricultural fields provide good roosting habitat.

Roosting/staging

Observations of numerous roosting sites by Lewis (1975) and Lovvorn and Kirkpatrick (1981) indicated that roosts were characterized by level terrain, shallow water bordered by a shoreline either devoid of vegetation or sparsely vegetated, and an isolated location that reduces potential for disturbance by humans. These features are typical of roosting habitats in Burns Bog (Gebauer 1995) and at White Lake, Okanagan (Cannings et al. 1987). However, Folk and Tacha (1990) noted that open terrain at roost sites was not necessarily a critical element, but that presence of shallow water was critical.

Conservation and Management

Status

Most breeding populations of Sandhill Crane are on the provincial *Blue List* in British Columbia; however, the Georgia Depression population is on the provincial *Red List*. The Greater Sandhill Crane (*G. canadensis tabida*) is considered *Not at Risk* in Canada (COSEWIC 2002). Other subspecies have not been assessed. (See Summary of ABI status in BC and adjacent jurisdictions at bottom of page.)

Trends

Population trends

Breeding Bird Survey results for the period 1966 to 1999 indicate significant increases in Sandhill Crane populations in the United States (4.9%/yr) and in Canada (14.4%/yr) (Sauer et al. 2000). A review and synthesis of existing information supports these trends (Johnsgard 1983; Safina 1993). Drewien and Bizeau (1974) observed that the formerly abundant crane populations in the northern Rocky Mountain States were reduced to an estimated 188–250 pairs by 1944, but since that time, have increased substantially. A low 6.7% recruitment annual rate at Malheur NWR (caused primarily by coyote depredation) was probably responsible for a decline in breeding pairs from 236 in 1975 to 168 in 1989 (Littlefield 1995b). In California, a 52% increase in breeding pairs of Greater Sandhill Crane has occurred between 1971 and 1988, whereas breeding pairs in Oregon remained stable (Littlefield et al. 1994). Lovvorn and Kirkpatrick (1981) reported a rapid increase in the eastern population of the Greater Sandhill Crane during the 1970s.

In British Columbia, population trend data are lacking, but most populations are likely stable (Fraser et al. 1999). The highest breeding densities appear to be in the Chilcotin region where recent aerial surveys found 18 nest sites in 4 days (Cooper 1996). Breeding waterbird surveys by Canadian Wildlife Service in the central Interior of British Columbia since 1987 suggest that crane populations in this area may be increasing (A. Breault, pers. comm.). Increased winter population levels in the Central Valley also suggest that populations of Greater Sandhill Cranes may be increasing in British Columbia (A. Breault, pers. comm.). The Fraser Lowland populations have declined significantly and are endangered (Gebauer 1995, 1999; Cooper 1996). South Okanagan populations have been extirpated (Cannings et al. 1987). An analysis of Breeding Bird Surveys in British Columbia for the period 1966 to 1999 did not reveal a significant trend in Sandhill Crane breeding populations (Sauer et al. 2000), however, sample sizes are likely too small to obtain significant results.

The Central Valley population of Greater Sandhill Crane (i.e., from British Columbia to California) is estimated to number between 6000 to 6800 birds (Pacific Flyway Council 1997). This population estimate is based on surveys of wintering Greater Sandhill Cranes in Oregon and northern California. Approximately half of the wintering population (i.e., between 2600 to 3400 cranes) may be breeding

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

Population	BC	AK	AB	ID	MT	NWT	OR	WA	YK	Canada	Global
Georgia Depression	S1	–	–							N?	G5T1Q
All others	S3S4B, SZN	S5B	S4B	S5B,SZN	S2N, S5B	S?	S3B	S1B,S3N	S?	N5B	G5

in British Columbia. A target population of 7500 Greater Sandhill Cranes has been set by the Pacific Flyway Management Plan (Pacific Flyway Council 1997).

Habitat trends

In most areas of the province, there have been few changes in habitat suitability or availability. Logging activities adjacent to breeding wetlands are likely the most important land use practice reducing habitat suitability in the province. In urbanized areas, such as the Burns Bog and Pitt Polder areas of the Lower Mainland, rapid urbanization and intensive agricultural regimes have reduce availability of isolated, relatively undisturbed habitats suitable for breeding.

Threats

Population threats

At Malheur NWR in Oregon, 58 of 110 nests in one year were lost to depredation (Littlefield and Ryder 1968). At Malheur NWR in 1973 and 1974, coyotes were implicated as significant predators of eggs and chicks when only two young each year were known to fledge from 236 pairs of breeders (Littlefield 1975). Eight years of predator control at Malheur NWR resulted in a rebound in the number of breeding cranes by 1993 (Littlefield 1995a). In more heavily populated areas of the Lower Mainland, road mortality and nest depredation by coyotes may be factors. Dykes and roads have increased accessibility for predators such as coyotes at Burns Bog and Pitt Polder (Gebauer 1995) and cattle trails have improved access at Malheur NWR (Littlefield and Paulin 1990).

Collisions with power lines has been described as a major mortality factor for cranes in Colorado (Brown and Drewien 1995) and North Dakota (Faanes 1987), however, this is likely not a mortality factor in British Columbia. Lead poisoning has been reported as a mortality factor (Windingstad 1988; Franson and Hereford 1994), but again, this is likely not an important mortality factor in British Columbia, especially since the use of lead shot is gradually being phased out. Windingstad (1988) found that avian cholera, avian botulism, and ingestion of mycotoxins (in waste peanuts) were the leading causes of non-hunting mortality in cranes. Hailstorms, lightning, and avian tuberculosis also killed cranes. Pesticides have generally not been implicated in eggshell thinning, reduced reproductive success, or mortality (Tacha et al. 1992).

Cold and wet spring conditions may also impact breeding success of Sandhill Cranes, as nests are susceptible to rising water levels (Littlefield et al. 1994). The Pacific Flyway Management Plan (Pacific Flyway Council 1997) identified poor recruitment as one of the major problems confronting the Central Valley population of Greater Sandhill Cranes.

Habitat threats

In the Georgia Depression, populations have declined as spreading urbanization and intensive agriculture have encroached on wetlands. In other areas of the province, land use practices such as logging up to the edge of wetlands, draining of wetlands for agriculture, and trampling of emergent vegetation by livestock have resulted in loss of habitats (Cooper 1996). Preliminary investigations by Cooper (1996) suggest that wetlands with recent nearby clearcutting in the Chilcotin region are not used for nesting by cranes.

Littlefield and Paulin (1990) found that nesting success of cranes was lower on wetlands grazed by livestock than on ungrazed wetlands. A factor possibly causing this difference included the presence of livestock trails that improved access for mammalian predators.

Most suitable habitats (e.g., bogs and swamps) in the province are of low value for timber and agricultural purposes and are in remote areas with sparse human populations. Habitats in these areas are not currently threatened.

Legal Protection and Habitat Conservation

The Sandhill Crane, its nests, and its eggs are protected in Canada and the United States under the federal *Migratory Birds Convention Act* and the provincial *Wildlife Act*. Sandhill Cranes are hunted in other jurisdictions but are closed to hunting in British Columbia.

Several nesting areas are protected in Wildlife Management Areas (e.g., Pitt Polder, Bummers Flats in the East Kootenay) or in provincial parks (e.g., Naikoon Provincial Park, Queen Charlotte Islands) (Fraser et al. 1997). Some pairs likely nest in other parks such as Stum Lake and Tweedsmuir Provincial Park. A number of new provincial parks have been announced in the south Okanagan through the Okanagan-Shuswap Land and Resource Management Plan process. The White Lake Grasslands Park (3627 ha) protects a known migratory stopover point for Sandhill Cranes.

Under the results based code, the riparian management recommendations may provide adequate protection for some wetlands particularly larger wetlands and wetland complexes.

Identified Wildlife Provisions

Wildlife habitat area

Goals

Maintain wetlands and riparian habitats that provide breeding habitat for one or more pairs of breeding cranes that are not already protected or adequately managed through the riparian management recommendations. Protect traditional roost sites used in spring.

Feature

Priority for WHA establishment is for the Red-listed Georgia Depression population. Establish WHAs at wetlands not addressed under the *Riparian Management Areas Guidebook* and where breeding is known to occur.

Size

The size of the WHA will vary depending on the size and isolation of the wetland but will generally be 20 ha (excluding wetland area). For primary migratory stopover points (e.g., Nig Creek, Kispiox Valley), a WHA should be up to 20 ha depending on particular habitat conditions of the site.

Design

The key habitat requirements for cranes include water, nesting cover and feeding meadows (Littlefield and Ryder 1968). The WHA should include a core area and management zone. The core area should include the entire stand of emergent vegetation around the wetland plus 50 m. The management zone may be between 200–350 m depending on site-specific factors such as potential disturbances, existing tree density within management zone and characteristics of adjacent upland. Design management zone to maintain seclusion of wetland and minimize disturbance. Staging or roosting sites are generally in open areas with standing water and open fields.

General wildlife measure

Goals

1. Maintain the structural integrity of emergent vegetation in and around nesting areas to provide cover and nesting habitat.
2. Maintain vegetated screen around breeding wetlands.
3. Minimize disturbance and access during the breeding season (1 April to 21 September).
4. Minimize human access to important staging areas during the migratory period (April and Sept./Oct.).
5. Restore historical water regimes to wetland areas that have been drained.

Measures

Access

- Do not develop any permanent roads within core area. Avoid road construction during the breeding season unless there is no other practicable option.
- Limit or reduce access during the breeding period and/or migration period by deactivating or gating roads.

Harvesting and silviculture

- Do not harvest during the breeding season (15 April to 15 August). Consult MWLAP for site-specific times.
- Retain at least 40% of the dominant and codominant trees within core area.

- Retain as much of the understorey trees, shrubs, and herbaceous vegetation as is practicable.

Pesticides

- Do not use pesticides.

Range

- Plan grazing to ensure that the structural integrity of stands of emergent vegetation is maintained and nests are protected from trampling. Fencing may be required in some instances.
- Do not hay wet meadows until after 25 August to prevent mortality of young.
- Do not place livestock attractants within core area.

Recreation

- Do not establish recreational facilities or trails.

Additional Management Considerations

Where water control structures are in place, do not draw down water during the breeding season; encourage landowners to keep meadows wet through July.

Do not remove beaver (*Castor canadensis*) dams where dams flood areas being used by breeding cranes.

Avoid unnecessary draining of wetlands, and changes in livestock grazing regimes.

Avoid harvesting within 800 m of breeding wetlands during the breeding season. Limit access within 400 m during the breeding season and restrict recreational activities in and around habitats used for staging and breeding during periods of use by cranes.

Where possible, ensure suitable croplands (i.e., grain) are near habitats used by migratory and staging cranes.

Maintain intact shallow freshwater wetlands, and retain riparian forests adjacent to these wetlands.

Ditching and creation of compartments and impoundments in conjunction with some wetland management practices are detrimental to crane populations. Cooper (1996) recommends that: (1) structural integrity of wetlands is maintained; (2) water use permits are controlled; (3) buffer zones are established around nesting marshes; (4) building of dykes, roads, and other structures that increase flooding risk be avoided; and (5) incentives are provided to farmers and other land users to discourage draining, dyking, or filling of nesting meadows.

Information Needs

1. Investigate the tolerance of Sandhill Cranes to logging adjacent to their wetland breeding habitats. Determination of an effective forested buffer strip is an important research question as is the effectiveness of current guidelines to protect riparian areas (e.g., *Riparian Management Area Guidelines*).
2. Concentrated inventory of potentially core breeding areas in the Chilcotin-Cariboo, Queen Charlotte Islands (e.g., Naikoon Provincial Park), northern Vancouver Island, and northeastern British Columbia using standardized methods are required to estimate breeding population size.
3. Determining the breeding range of the three subspecies in British Columbia would be of particular management interest for the Pacific Flyway Management Plan.

Cross References

Nelson's Sharp-tailed Sparrow, Pacific Water Shrew

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Mammals

Fisher

Martes pennanti

Original prepared by Mike Badry[1]

Species Information

Taxonomy

Fishers (*Martes pennanti*) belong to the family Mustelidae (weasels). Fishers are considered to be a single undifferentiated species throughout their range (Powell 1993). Fishers are closely related to the other six members of the genus *Martes*: Eurasian Martens (*M. martes*), American Martens (*M. americana*), Yellow-throated Martens (*M. flavigula*), Japanese Martens (*M. melampus*), Sables (*M. zibellina*), and Stone Martens (*M. foina*). Fishers are sympatric throughout much of their range with American martens (Hagmeier 1956; Krohn et al. 1995), which are the only other *Martes* species found in North America.

Description

Fishers have long, thin bodies that are characteristic of most mustelids. Fishers have dense, long, luxurious, chocolate-brown coloured fur, with considerable grizzling patterns around the shoulders and back. Their tails are furred and make up about one-third of their total body length. Fishers have pointed faces, rounded ears, and short legs (Douglas and Strickland 1987). In British Columbia, adult females weigh on average 2.6 kg whereas males weigh 4.8 kg (R.D. Weir, unpubl. data). The average body length, excluding the tail, is 51 cm for females and 60 cm for males (Douglas and Strickland 1987). Fishers can be differentiated from American Martens by their larger body size (approximately 2–3 times larger), darker colouring, and shorter ears.

Distribution

Global

In North America, Fishers occur south of 60° N. They are distributed across the boreal forests and in southerly projections of forested habitats in the Appalachian Mountains and Western Cordillera (Douglas and Strickland 1987; Proulx et al. 2003). Fishers occur in most provinces and territories in Canada, except Newfoundland and Labrador, Nunuvut, and Prince Edward Island (Proulx et al. 2003).

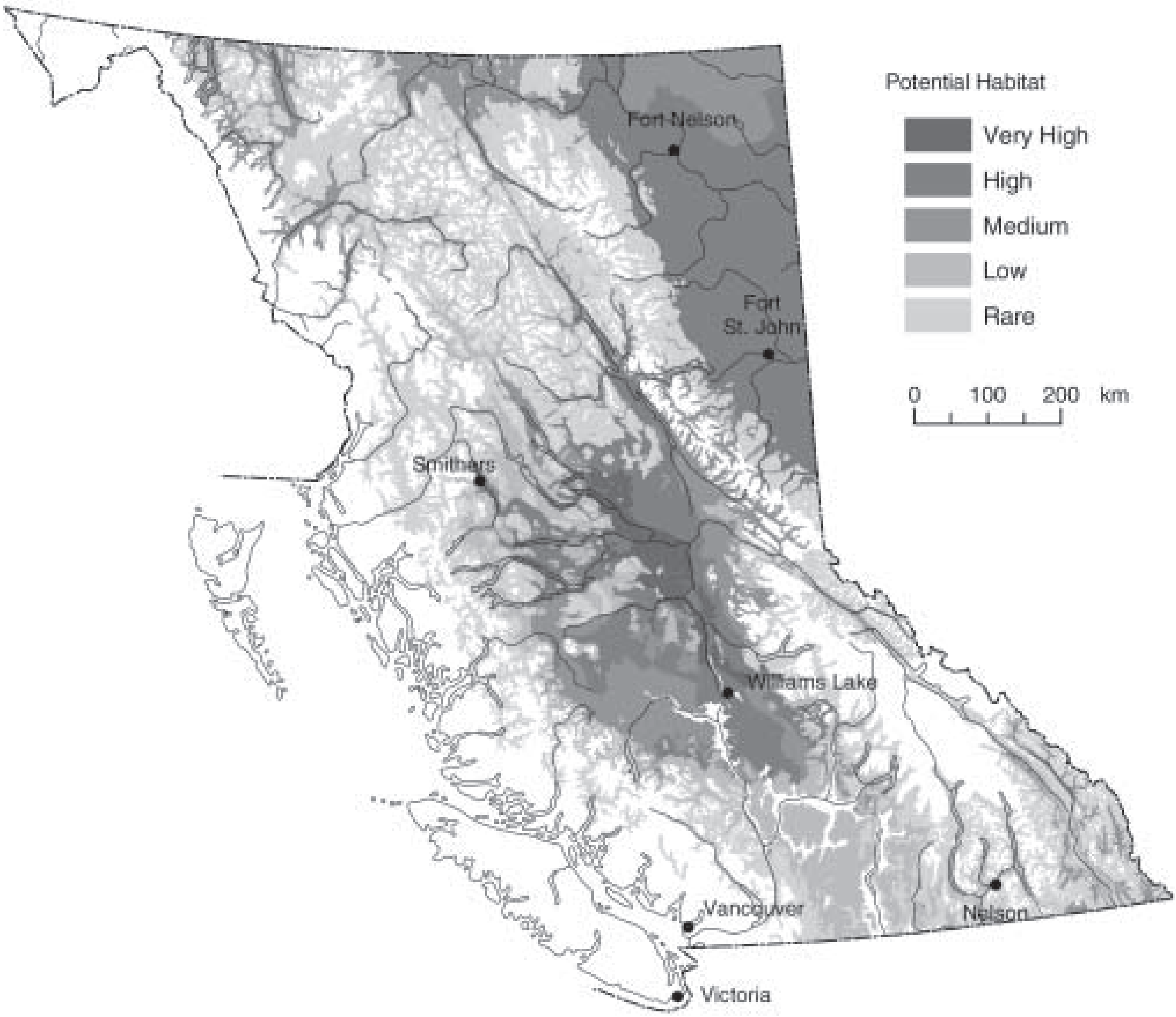
The distribution of fishers in North America has probably been considerably reduced since pre-European contact (ca. 1600; Proulx et al. 2003). The current distribution of fishers has declined primarily in areas south of the Great Lakes region, but has also diminished in some areas of southeastern Ontario and Quebec, the Prairie Provinces, and in the western United States (Gibilisco 1994). The fisher has been extirpated from most of its former range in the western United States (Carroll et al. 1999).

British Columbia

Although fisher occur throughout British Columbia, they are rare in coastal ecosystems. Fishers are currently believed to primarily occur in the Boreal Plains, Sub-Boreal Interior, Central Interior, and Taiga Plains ecoprovinces (Weir 2003). Fisher populations probably have very limited distribution in some portions of the Coast and Mountains, Southern Interior Mountains, Southern Interior, and Northern Boreal Mountains ecoprovinces and have likely disappeared from the Cascade and Okanagan

1 Account largely adapted from Weir 2003.

Fisher
(Martes pennanti)



Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on several ecosystem classifications (Ecoregion, Biogeoclimatic and Broad Ecosystem Inventory) as well as current knowledge of the species' habitat preferences. This species may or may not occur in all areas indicated.

Mountain ranges of the southern interior and in the Columbia and Rocky Mountain ranges south of Kinbasket Reservoir.

A reintroduction program of 61 fishers was conducted in the southern Columbia Mountains west of Cranbrook, which may have restored a small population of fishers in this region (Fontana et al. 1999).

Forest regions and districts

Coast: Campbell River, North Coast, North Island, Squamish, Sunshine Coast

Northern Interior: Fort Nelson, Fort St. James, Kalum, Mackenzie, Nadina, Peace, Prince George, Skeena Stikine, Vanderhoof

Southern Interior: 100 Mile House, Arrow Boundary, Cascades, Central Cariboo, Chilcotin, Columbia, Headwaters, Kamloops, Kootenay Lake, Okanagan Shuswap, Quesnel, Rocky Mountain

Ecoprovinces and ecosections

BOP: all

CEI: all

COM: CPR, CRU, KIM, MEM, NAB, NAM

NBM: CAR, EMR, HYH, KEM, LIP, MUF, NOM, SBP, STP, TEB, TEP, THH, TUR, WMR

SBI: all

SIM: BBT, BOV, CAM, CCM, ELV, EPM, FLV, FRR, MCR, NKM, NPK, QUH, SFH, SHH, SPM, UCV, UFT

SOI: GUU, HOR, LPR, NIB, NOH, NTU, OKR, PAR, SCR, SOH, SHB, TRU

TAP: all

Biogeoclimatic units

BWBS, CWH, ESSF, ICH, MH, MS, SBPS, SBS, SWB (all possible subzones/variants)

IDF: dk3, dk4, dm1, dm2, dw, mw1, mw2, ww, ww2, xm

Broad ecosystem units

Broad ecosystem units of high value are IH, SD, RR, SF (interior locations only), and WR. Those of medium value are BA, BP, DF, DL, ER, HB, IS, and SL.

Elevation

Fishers tend to inhabit low to mid-elevations, up to 2500 m, and are not found at high elevations. Powell and Zielinski (1994) report that the majority of fishers are found below 1000 m and Banci (1989) indicates that fishers occur in middle range elevations. Fishers are likely confined to low elevations during periods of heavy snow (Powell and Zielinski 1994) and changes in elevation between seasons do not occur (Banci 1989).

Life History

Diet and foraging behaviour

Fishers are generalist predators and typically eat any animal they can catch and kill, although they may specialize on porcupines (*Erethizon dorsatum*) and snowshoe hares (*Lepus americanus*) in some areas (Powell 1993). Other reported foods include deer (*Odocoileus* spp., primarily as carrion), squirrels (*Tamiasciurus* and *Glaucomys* spp.), microtines, shrews (*Sorex* species), birds (mostly passerine and galliform), American martens, berries and other vegetation, and even fish and snakes (Coulter 1966; Clem 1977; Kelly 1977; Kuehn 1989; Arthur et al. 1989a; Giuliano et al. 1989; Martin 1994). Most foraging in winter occurs above the snow layer, and as such snow conditions likely influence foraging and distribution patterns. Summer foraging is strongly associated with coarse woody debris (CWD). Primary prey species are associated with abundant CWD and understorey shrub cover.

Diet is affected by several factors including prey availability, abundance, and size. Fishers are able to switch foods when populations of their primary prey fluctuate, permitting them to compensate for changes in prey availability.

Reproduction

Fishers have a reproductive system that results in a low reproductive output relative to their lifespan. Females produce at most one litter per year after they have reached 2 years of age (Douglas and Strickland 1987). Fishers are polygamous breeders, copulating with multiple conspecifics in early April.

Female fishers have an oestrus period lasting 2–8 days approximately 3–9 days following parturition (Hall 1942). A second oestrus cycle may occur within 10 days of the first cycle (Powell 1993).

Female fishers reproduce by delayed implantation (i.e., fertilized eggs lie dormant for approximately 10 months until implantation occurs; Douglas and Strickland 1987). This strategy is fairly common among mustelids (Mead 1994). Active development of the fetuses begins in middle to late February and lasts about 40 days (Frost et al. 1997).

The date of parturition varies throughout the range of fishers, but generally occurs between February and early April (Douglas and Strickland 1987). Reported parturition dates for fishers in British Columbia were between 23 March and 10 April (Hall 1942; Weir 2000). The mean date of parturition of radio-tagged fishers in the Williston region was 6 April (Weir 2000). Captive fishers in the East Kootenay region gave birth to litters between 17 March and 4 April (Fontana et al. 1999).

Fishers typically give birth to between one and three kits in late winter (Powell 1993), with a mean litter size of 2.7 kits (Frost and Krohn 1997). Fontana et al. (1999) recorded the sizes of 10 litters of captive females in British Columbia as ranging between 1 and 4 kits, with a mean of 2.6 kits. Actual reproduction in wild animals may be slightly lower; in Idaho, Jones (1991) estimated the average litter size of four reproductive fishers from placental scars to be 1.5 kits. Estimates from data from fishers harvested in British Columbia in the early 1990s indicated that the mean maximum number of kits per adult female was 2.3 (SE = 0.15; $n = 86$) during this time.

Female fishers typically give birth to their kits in natal dens. Newborn fishers typically weigh between 40 and 50 g and are completely dependent upon their mother for care (Powell and Zielinski 1994). Fisher kits are born with their eyes closed and they remain this way until 7–8 weeks of age. The mother supplies milk to her kits until they reach 8–10 weeks, after which she begins to provide them with solid food (Powell 1993). Fisher kits become mobile at 10–12 weeks, at which time they begin to leave their dens with their mothers (Paragi 1990). Kits travel with their mothers as they mature, presumably learning how to hunt prey and survive on their own. In Maine, kits were found to disperse from their natal home range in their first autumn (Arthur et al. 1993). However, data from the Williston region indicate that dispersal can occur later and successful establishment of home ranges may not occur until fishers are 2 years of age (Weir and Corbould, unpubl. data).

Site fidelity

Fishers are not widely reported to exhibit strong site fidelity, except for females with natal or maternal dens. On average, female fishers in Maine discontinued using maternal dens 71 days following parturition (Paragi et al. 1996). Female fishers may use between 1 and 5 maternal dens following abandonment of the original natal den (Paragi et al. 1996). Observations of natal dens being reused in subsequent years by fishers have been made in both the Williston and East Cariboo regions of British Columbia (Weir 1995, 2000).

Home range

Fishers are solitary and, other than mothers raising their young, they usually only interact with conspecifics during mating and territorial defence (Powell 1993). Fishers are aggressive and conspecific interactions may occasionally be fatal. The asociality of fishers is also exhibited in their spatial organization. Fishers tend to have intrasexually exclusive home ranges that they maintain throughout their lives. This is a common spacing pattern among mustelids (Powell 1979), in which home ranges of members of the same sex may overlap (Kelly 1977), but this is extremely rare among fishers (Arthur et al. 1989b).

Reported home range areas for fishers range from 4 to 32 km^2 for females and 19–79 km^2 for males. Powell (1994b) summarized the reported sizes of home ranges of fishers from across North America and derived a mean home range size of 38 km^2 for males and 15 km^2 for females. Estimates of home range sizes from Idaho and Montana suggest that the home range sizes of fishers are larger in western regions than in eastern and southern areas possibly because of lower densities of prey (Idaho, Jones 1991; Montana, Heinemeyer 1993). However, Badry et al. (1997) found that translocated fishers in Alberta had home ranges of 24.3 km^2 and 14.9 km^2 for males and females, respectively, which were similar to home range sizes of fishers in eastern North America.

Weir et al. (in prep.) described the size and spatial arrangement of annual and seasonal home ranges for 17 radio-tagged resident fishers in two areas of central British Columbia. The annual home ranges of female fishers (= 35.4 km^2, SE = 4.6, n = 11) were significantly smaller than those of males (= 137.1 km^2, SE = 51.0, n = 3). Minor overlap was observed among home ranges of fishers of the same sex, but there was considerable overlap among home ranges of males and females. Home ranges that they observed in central British Columbia were substantially larger than those reported elsewhere in North America, particularly for males. Weir et al. (in prep.) hypothesized that the sizes of home ranges of fishers were relatively large because the density of resources in their study areas may have been lower than elsewhere. They also speculated that home ranges of fishers in their study areas were widely dispersed and occurred at low densities because suitable fisher habitat was not found uniformly across the landscape.

It is unclear what factors affect the size of home ranges in fishers, although it is likely that the abundance and distribution of resources play a critical role in determining home range size. Fluctuating prey densities, varying habitat suitability, and potential mating opportunities are all probably important factors that affect size of the home range. There is likely a lower density at which these resources become limiting which would result in abandonment of the home range (Powell 1994b).

Movements and dispersal

Very little is known about dispersal in fishers because few studies have been able to document this process. In eastern portions of their range, researchers have reported that fishers disperse from their natal home ranges during their first winter and establish home ranges in unoccupied habitats soon afterward (Arthur et al. 1993; Powell 1993). Information from the Williston region suggests that home range establishment may not necessarily occur at this time and may be delayed until fishers reach 2 years of age (R.D. Weir, unpubl. data).

Some evidence suggests that fishers may have poor dispersal capability. Arthur et al. (1993) observed that dispersing juveniles in Maine did not typically establish home ranges more than 11 km from their natal home ranges. A juvenile male fisher in the Williston region moved 20 km from its initial capture location to its eventual home range (Weir 1999). The low degree of relatedness among fisher populations across Canada, and in particular the East Cariboo and Omineca regions of British Columbia, as identified by Kyle et al. (2001), supports this hypothesis of low dispersal capability.

Despite the relatively short distances over which fishers have been documented to successfully disperse, fishers appear to be capable of moving widely through the landscape. A fisher with a radio-collar was photographed using a wildlife overpass in Banff National Park; over 200 km from the nearest radio-telemetry study (T. Clevenger, pers. comm.). A radio-tagged juvenile fisher in the Williston region travelled at least 132 km and covered over 1200 km^2 before it died 77 km from where it was first captured (Weir 1999). Weir and Harestad (1997) noted that translocated fishers in central British Columbia wandered widely throughout the landscape following release and covered areas of more than 700 km^2 while transient. They also observed that major rivers and other topographic features were not barriers to movements throughout the landscape.

The apparent contradiction between short successful dispersal distances and considerable movement potential of fishers may be because effective dispersal is dependent upon many factors in addition to the ability to move through the landscape. Suitable habitat and prey, avoidance of predators and other mortality agents, and the presence of conspecifics can all act in concert to affect successful dispersal.

The process of dispersal is integral to the persistence of fisher populations because fisher populations are inherently unstable (Powell 1994b) and are probably characterized by periods of local extinction and recolonization (Powell 1993). Thus, the ability of individuals to successfully disperse to unoccupied habitats is important for population persistence. Arthur et al. (1993) speculated that the short distances over which fishers dispersed in Maine could limit the ability of the species to recolonize areas where fishers have been extirpated. This relationship between recolonization and dispersal ability may hold true in British Columbia, but information on this is lacking.

Fishers move about their home ranges in their day-to-day activities of acquiring resources. With the exception of females maintaining natal or maternal dens, fishers do not base their activities from any one central point in their home range (Powell 1993). Fishers can typically cross their home range in 16 hours and travel up to 5–6 km/day (Arthur and Krohn 1991), although transient individuals have been observed moving up to 53 km in <3 days (Weir and Harestad 1997). Early snow-tracking studies suggested that fishers follow circuits of up to 96 km as they wander through their home range, although their movements may not necessarily follow such predictable routes (de Vos 1952). Arthur and Krohn (1991) noted that adult male fishers moved more widely during spring than any other season, presumably to locate potential mates.

Fishers typically have two or three periods of activity during the day (Powell 1993). In Maine, fishers were reported to have peaks in activity primarily in the early morning before sunrise and in the evening shortly after sunset (Arthur and Krohn 1991). Approximately half of all radio-locations of fishers in the Williston region indicated that fishers were active, but there was no consistent trend in the timing of activity (R.D. Weir, unpubl. data). Reproductive female fishers with kits were more active than non-reproductive females despite nursing kits each day (Arthur and Krohn 1991; R.D. Weir, unpubl. data). Both cold temperatures and deep snow probably reduce the activity of fishers (Powell 1993; R.D. Weir, unpubl. data).

Deep, soft snow may also inhibit the movements of fishers during winter. Fishers are reported to modify their small-scale movements within stands to avoid areas with less-supportive snow (Leonard 1980; Raine 1983). Weir (1995) suggested that fishers in the East Cariboo region of central British Columbia used patches with large trees because the overstorey closure afforded by these trees may have increased snow interception.

Habitat

Structural stage

Fishers forage within many structural stages. Structural stages 1a (non-vegetated) through 3b (tall shrub) are not used during winter but may be used in other seasons providing sufficient forage and security cover is present. Most habitat use is associated with structural stages 6 (mature forest) and 7 (old forest) where structural characteristics of older forests are most developed. Resting and maternal denning habitat is typically associated with structural stages 6 and 7, and key features are availability of CWD, large wildlife trees, and canopy cover in winter. Fisher will forage in a wider range of structural stages (particularly in summer) and habitat use may be influenced by population cycles of major prey species.

Important habitats and habitat features

In western coniferous-dominated forests, fishers appear to have affinities to specific habitat features, many of them found primarily in late-successional forests (Jones and Garton 1994; Weir 1995). Aspects of forest structure are likely more important determinants of distribution and habitat use than are forest types.

In British Columbia, preferred habitat resembles that found in SBS, SWB, and BWBS biogeoclimatic zones and more specifically riparian and dense wetland forest habitats within those zones. Fishers generally stay in or near forests with ≥30% canopy closure with a productive understorey that supports a variety of small and medium-sized prey species. The presence of suitable resting and maternal den sites is also important as is riparian-riparian and riparian-upland connectivity.

Resting

Fishers use rest sites for a variety of purposes, including refuge from potential predators and thermoregulatory cover (Kilpatrick and Rego 1994). Fishers have been reported to use a wide variety of structures as rest sites, including tree branches, tree cavities, in or under logs (hollow or solid), under root wads, in willow (*Salix* spp.) thickets, in ground burrows, and in rock falls (Raine 1981; Arthur et al. 1989a; Jones 1991; Powell 1993; Kilpatrick and Rego 1994; Gilbert et al. 1997).

Weir et al. (2003) identified four distinct types of structures used for resting by fishers in British Columbia: branch, cavity, CWD, and ground sites. Branch rest structures were arboreal sites that typically involved abnormal growths (i.e., brooms) on spruce trees caused by spruce broom rust (*Chrysomyxa arctostaphyli*) or on subalpine fir trees caused by fir broom rust (*Melampsorella caryophyllacearum*). Occasionally branch rest sites associated with exposed large limbs of black cottonwood (*Populus balsamifera trichocarpa*) and spruce (*Picea* spp.) trees were used. Cavity rest structures were chambers in decayed heartwood of the main bole of black cottonwood, aspen, or Douglas-fir (*Pseudotsuga menziesii*) trees; cavities were accessed through branch-hole entrances into heart-rot (black cottonwood, aspen [*Populus tremuloides*], or Douglas-fir trees) or excavations of primary cavity nesting birds (aspen trees only). Coarse woody debris rest structures were located inside, amongst, or under pieces of CWD. The source of CWD for these sites was natural tree mortality, logging residue, or human-made piling. CWD rest structures were usually comprised of a single large (>35 cm diameter) piece of debris, but occasionally involved several pieces of smaller diameter logging residue. Ground rest structures were those that involved large diameter pieces of loosely arranged colluvium (e.g., rock piles) or pre-excavated burrows into the soil. Weir et al. (2003) recorded fishers using branch rest structures most frequently (57.0%), followed by cavity (19.8%), CWD (18.6%), and ground (4.6%) rest structures.

The selection of rest sites by fishers may be mediated by ambient temperature. Weir et al. (2003) noted fishers used subnivean CWD rest structures when ambient temperatures were significantly colder than when they used branch and cavity structures. The thermal attributes of the four types of rest sites used by fishers in their study likely affected their respective selection and may help explain the patterns that they observed. Taylor and Buskirk (1994) measured and calculated the thermal properties of branch, cavity, and CWD sites in high-elevation forests of southern Wyoming. They found that CWD sites provided the warmest microenvironments during periods of cold temperatures (<–5°C), deep snowpack (>15 cm), and high wind speed. Branch or cavity sites were warmer during all other combinations of ambient temperature, snowpack, and wind (Taylor and Buskirk 1994). Although it is unlikely that fishers in British Columbia encounter temperatures that are near their estimated lower critical temperature for resting, they likely select rest structures that are the most energetically favourable to help maximize their fitness. Fishers in British Columbia exclusively used subnivean CWD structures for the energetic benefits that they confer relative to other structures when temperature were below –15°C (Weir et al. 2003). Fishers probably use branch and cavity structures for resting during most of the year because these sites provide an adequate thermal environment for most combinations of ambient temperature and wind speed.

Reasons for selecting specific rest structures probably change seasonally and thermoregulation is likely not the only factor that affects the selection of rest sites by fishers. Several authors have suggested that fishers rest close to food sources (de Vos 1952; Coulter 1966; Powell 1993). There are more suitable resting sites in trees than on the ground (Martin and Barrett 1991); hence, fishers may select tree sites because of their relative availability. Additionally, Raphael and Jones (1997) speculated that arboreal structures offer greater protection from predators than do ground sites. Because of their elevated position, tree sites may also enhance olfactory or visual discovery of approaching predators. Similarly, elevated sites may improve detection of potential prey, while providing areas for avoiding predators. Thus, in the absence of restrictive thermoregulatory demands, fishers probably select structures based upon these other factors.

Breeding

Female fishers appear to have very specific requirements for structures in which they rear their kits. Natal (i.e., whelping) and maternal (i.e., rearing) dens of fishers are typically found in cavities, primarily in deciduous trees (Powell 1993; Weir 2000). Leonard (1980) hypothesized that dens were situated in tree cavities because they provide thermal benefits and are more defendable. Female fishers use between one and five maternal dens following abandonment of the original natal den (Paragi et al. 1996). In eastern parts of their range, fishers have been documented whelping in a variety of hardwood trees (Maine: median diameter = 45 cm, Paragi et al. 1996; New England: = 66 cm, Powell et al. 1997; Wisconsin: = 60.9 cm, Gilbert et al. 1997). In contrast, recent work by Aubry et al. (2001) has identified fishers in southwestern Oregon using cavities and witches' brooms in coniferous trees (Douglas-fir, incense cedar [*Calocedrus decurrens*], grand fir [*Abies grandis*], western white pine [*Pinus monticola*], and sugar pine [*Pinus lambertiana*]) and logs as natal and maternal dens.

In British Columbia, fishers have been recorded whelping in trees that are atypically large and uncommon across the landscape. Researchers have identified 11 natal and eight maternal dens of radio-tagged fishers, all of which were located in large diameter (= 105.4 cm), declining black cottonwood or balsam poplar (*Populus balsamifera balsamifera*) trees (R.D. Weir, unpubl. data). Den cavities in these large trees were, on average, 15 m above ground (R.D. Weir, unpubl. data).

Elements with these traits may be rare across the landscape, as indicated by observation of natal dens being reused by fishers in the both the Williston and East Cariboo regions (Weir 1995, 2000). Weir (1995) found that 98% of random points in his study area in the East Cariboo had either no cottonwood trees or ones that were smaller than the minimum diameter of any natal or maternal den trees. Thus, suitable cottonwood trees may be an important component in the selection of a home range by female fishers (Weir 1995). The reasons that fishers select this type of tree for whelping is likely related to the decay characteristics of deciduous trees, which produce heart rot and cavities much earlier and at smaller diameters than coniferous trees. The cottonwood trees that fishers in British Columbia use may be atypically large because they grow faster than eastern deciduous trees and rot earlier.

All of the natal and maternal dens identified in British Columbia consisted of holes through the hard outer sapwood into cavities in the inner heartwood (R.D. Weir, unpubl. data). Black cottonwood trees are prone to decay of the heartwood at an early age (Maini 1968), but data from British Columbia suggest that cottonwood trees may be suitable for use by fishers for rearing kits when the bole at the cavity height is >54 cm diameter (R.D. Weir, unpubl. data). Although the relationship between dbh and dbh of the den is unclear, it appears that cottonwood trees need to be >88 cm dbh; for the cavity to be used by fishers, cavity entrances may need to be >5 m above ground (R.D. Weir, unpubl. data). Thus, for fishers to use black cottonwood trees for natal or maternal dens, the trees may need to have heart rot and a bole diameter >54 cm at 5 m above ground.

Foraging

Fishers require the presence of "available" prey and adequate security cover to use habitats for foraging. Availability of prey is affected by not only the abundance of the prey, but also its vulnerability to predation (Buskirk and Powell 1994). Vulnerability is affected by the presence of escape cover for the prey, which can include such features as snow cover and highly complex vegetative structure. Fishers rarely use open areas for foraging (Raine 1981), and when crossing them, they usually run (Powell 1981). Sufficient overhead cover in a foraging habitat can be provided by tree or shrub cover (Weir 1995).

Suitable combinations of available prey and adequate security cover likely occur in a variety of habitat types, and thus, fishers have been reported to use a wide array of habitats for foraging. Researchers have documented fishers using deciduous forests for hunting porcupines (Powell 1994a), riparian zones for small mammals (Kelly 1977), and densely regenerating coniferous habitats for hunting snowshoe hares (R.D. Weir, pers. comm.).

Regardless of prey species, foraging by fishers is believed to involve two components: locating patches of habitat with prey and searching for prey items within these patches (Powell 1993). Fishers appear to have a cognitive map of where suitable patches of prey may be within their home range and visit these areas to hunt for food (Powell 1994a). The characteristics of these patches are likely related to the type of prey that use them; Powell (1994b) noted that fishers hunted for snowshoe hares in patches of dense lowland conifers and for porcupine dens in open upland habitats. Fishers use several very different strategies when searching for prey within patches, depending on the prey being pursued. When searching for high-density prey in complex structure, fishers hunt using frequent changes in direction, presumably to increase chance encounters with prey (Powell 1993). When using habitats with relatively low densities of prey, fishers travel in more-or-less straight lines but will deviate from these routes to opportunistically capture prey (Powell 1993). Unlike the American Marten, fishers are somewhat limited to foraging on the snow surface during winter and are relatively ineffective at catching prey beneath the snow (de Vos 1952; Powell 1993). It is unclear whether the foraging strategies that fishers use for different prey are dependent upon the prey species' respective vulnerability, abundance, or both.

Conservation and Management

Status

Fishers are on the provincial *Red List* in British Columbia. Its status in Canada has not been evaluated (COSEWIC 2002). (See Summary of ABI status in BC and adjacent jurisdictions at bottom of page.)

Trends

Population trends

The range reduction in the eastern part of the fishers range observed in the early 1900s has been attributed to wide-scale habitat alterations and overtrapping (Douglas and Strickland 1987). Fisher populations are believed to be stable or expanding in the central and eastern portions of its range (Proulx et al. 2003), likely because of reforestation of abandoned agricultural lands, trapping restrictions, and several reintroduction programs.

Very little is known about population trends of fishers in British Columbia and what little is known has been derived from harvest statistics. The harvest of fishers in the province has fluctuated widely since 1919. Generally, the annual harvest of fishers decreased during the 1970s and 1980s. In 1973–1974, 1747 fishers were harvested, while in 1990–1991 only 93 fishers were harvested. The mean annual harvest of fishers in British Columbia over the past eight trapping seasons was 276 fishers (SE = 17, range: 206–348). However, harvest information can be biased and dependent upon many other factors in

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

AB	AK	BC	ID	MT	NWT	OR	YK	WA	Canada	Global
S4	S?	S2	S1	S2	S?	S2	S?	SH	N5	G5

addition to population size, such as trapper effort (which is affected by fur prices, economic alternatives, and access) and vulnerability to trapping (Banci 1989; Strickland 1994).

The Ministry of Environment collected 329 fisher carcasses from British Columbia between 1988 and 1993 to assess the harvest rate and population trends of fishers. Age, sex composition, and date of the harvest were determined from these carcasses. The harvest ratio during this survey was 1.34 juveniles per adult and 1.36 females per male. The low juvenile to adult female ratio in the harvest, in combination with a relatively low fecundity rate, suggests that the fisher population in British Columbia may have been declining in the early 1990s, despite a province-wide closure of the trapping season. Notwithstanding this possible decline, harvests of fishers since 1994 have remained relatively stable (about 275 fishers/yr). This may be due to the natural recovery of fisher populations following years of decline (Powell 1994b). Insufficient population inventory restricts our ability to assess the rate of decline or growth during the past 10 years.

A population estimate based on empirical data for fishers in British Columbia is lacking. However, a density estimate of one fisher per 146 km² from the Williston region can be extrapolated to other areas based upon habitat capability. The density estimate from the Williston region was derived for an area with 75% "moderately high" (SBSmk) and 25% "moderate" (SBSwk) habitat capability. These ranks are defined as areas that have densities between 51 and 75% (moderately high) and between 26 and 50% (moderate) of the benchmark density (RIC 1999). The benchmark is the highest capability habitat for the species in the province, against which all other habitats for that species are rated. It is used to calibrate the capability ratings by providing "the standard" for comparing and rating each habitat or ecosystem unit. Thus, using the Williston density of one adult fisher per 146 km², the provincial benchmark density for fishers would range between one fisher per 100 km² if the Williston estimate was 75% of the benchmark, and one fisher per 65 km² if the Williston estimate was 51% of the benchmark. Using the area of each habitat capability rank within the extent of occurrence of fishers in British Columbia, the late-winter population estimate for the province extrapolates to between 1113 and 2759 fishers.

Habitat trends

Habitat for fishers in British Columbia has undergone considerable anthropogenic change during the past 100 years. Habitat alterations, primarily through forest harvesting activities, hydroelectric developments, and land clearing, have changed the composition of many landscapes in which fishers occur. Because fishers rely on many of the habitats that are directly affected by these activities, these changes have likely had considerable effect on fisher populations in the province.

Hydroelectric developments have eliminated fisher habitat in several areas of the province. Flooding typically inundates, and thus removes, substantial portions of the riparian habitat that is found within a watershed. In the Williston region for example, the most productive habitats for fishers appear to be the late-successional riparian habitats that occur alongside meandering rivers (Weir and Corbould, unpubl. data). Much of this habitat in the region was removed with the flooding of 1773 km² of the Rocky Mountain Trench during 1968–1970 to create the Williston Reservoir. Almost 700 km² of "moderately high" capability habitat was flooded during the creation of the Ootsa Reservoir on the Nechako River. Similarly, flooding of ~700 km² of valley bottom habitats of the Columbia River likely removed much of the capable habitat for fishers in many areas of the Kootenay region (B. Warkentin, pers. comm.). The removal of these habitats from the land base has probably had highly localized negative effects on fisher populations in these areas.

Other human developments have diminished the quantity of fisher habitat in many areas of the province. Urban and semi-rural development associated with cities and towns in central British Columbia has probably reduced the quantity of habitat for fishers in some small portions of their range. Development of valley bottoms for agricultural operations has occurred extensively along the

Nechako, Bulkley, and Fraser rivers. Clearing of land over the past 100 years for these activities has probably been detrimental to fisher populations because it removed most of the structures that fishers need for overhead cover, resting, whelping, and foraging. Development of valley bottom habitats in the Skeena region was thought to have effectively removed much of the suitable habitat for fishers (G. Schultze, pers. comm.).

Forest harvesting has probably had the greatest single effect on habitat quality for fishers throughout the province. During the last 15 years, over 213 000 km^2 of forested land has been harvested in the four forest regions that support fisher populations in the province. Of this 213 000 km^2, over 90% was logged using clearcut harvesting systems. Although a substantial portion of this area was probably outside of areas occupied by fishers, modification of late-successional forests into early structural stages through this type of forest harvesting has likely had detrimental effects on the ability of fishers to acquire sufficient resources to survive and reproduce.

Additionally, forests in considerable portions of the Fisher's range in British Columbia are currently experiencing substantial tree mortality caused by outbreaks of the mountain pine beetle (*Dendroctonus ponderosae*) and other insects. In the Prince George Forest Region alone, over 25 000 km^2 of forests are currently under attack from insects (MOF 2002), an area that is more than the total area that has been logged in the Cariboo, Kamloops, Prince George, and Prince Rupert forest regions combined over the past 15 years. Reduction in overhead cover in these areas may be detrimental to Fishers. However, wide-scale harvesting of these forests as part of salvage operations would likely contribute to a substantial decrease in the availability and suitability of Fisher habitat in the both the short and long term (G. Schultze, R. Wright, pers. comm.).

Threats

Population threats

Trapping has the potential to affect populations of Fishers by changing mortality rates and the reproductive potential of the population. Trapping of adults could exacerbate difficulties in Fishers successfully finding mates, which could potentially reduce the reproductive rates within the population. Trapping mortality may be compensatory for the juvenile cohort at moderate harvest intensities (Krohn et al. 1994), but the rate of harvest at which this mortality becomes additive is unknown. Trapping mortality within the adult cohort is probably additive to natural rates (Strickland 1994). Because Fishers typically do not breed until 2 years of age, maintaining this cohort is very important for population health.

Banci and Proulx (1999) identified Fisher populations as having low to intermediate resiliency to trapping pressure, which means that Fisher populations generally have a moderate capability to recover from a reduction in numbers. However, this assessment was primarily based on information from eastern parts of their range. Information specific to British Columbia suggests that fishers in this province have more limited range or distribution, lower reproductive rates, and larger home ranges than Fishers in other areas. These factors suggest that Fisher populations in British Columbia may have a lower resiliency to trapping than populations elsewhere.

Habitat threats

In an extensive review of the worldwide distribution of *Martes* species, Proulx et al. (2003) identified loss of forested habitat from human development as the main long-term threat to fisher populations throughout its range. For a species like fishers with large spatial requirements, the long-term maintenance of extensive forestlands will be the major conservation challenge (Proulx et al. 2003.) This risk is probably even greater in British Columbia, where the home ranges of fishers are larger and the density lower than in other portions of their range.

Forestry activities can affect the quality of fisher habitat in many respects. First, timber harvesting typically removes many of the features of late-successional forests that fishers rely upon, such as large spruce trees, and replaces them with stands that have fewer structural components and are of lower suitability (Weir 1995). Second, forest harvesting may negatively affect the distribution of the remaining habitat so that fishers have to search more widely to sequester sufficient resources. Third, the concomitant increase in access that occurs with forest harvesting in previously inaccessible areas may increase trapping mortality, possibly diminishing "source" populations.

Prior to logging, many forests likely provided habitat structures that fishers require for resting and reproduction (e.g., large cottonwood trees, CWD, large spruce trees). Forest harvesting, which is targeted primarily at late-successional forests, has likely altered the availability of these resources across spatial scales. The reduced availability of these habitat features has probably resulted in previously occupied landscapes becoming unsuitable for fishers.

The quality of regenerating clearcuts to fishers varies tremendously depending upon the silvicultural systems that are implemented. Fishers use many features of late-successional forests to fulfil several life requisites. Thus, the supply of these features is probably critical to the survival and reproduction of fishers. Forest harvesting activities tend to remove many of these features and the resulting silvicultural management of the regenerating forests suppresses the development and recruitment of these structures in managed areas.

Many attributes that are the result of natural processes of growth, disease, and decay of forested stands appear to be important for providing habitat for fishers. Thus, management of forested land that emphasizes tree growth and suppresses disease, death, and decay of trees may negatively affect the quality of fisher habitat. Monotypic stands that are low in structural and plant diversity probably fulfil few life requisites for fishers because many habitat elements that fishers and their prey are dependent upon are missing in these habitats. Thus, maintaining structurally diverse and productive fisher habitat in logged areas is not only a function of the method and extent of timber harvesting, but also the type of site preparation and subsequent stand tending.

The effects of alterations in habitat quantity and quality on fisher populations probably depend upon the scale and intensity at which the changes have occurred. Because the stand is the dominant scale at which an individual fisher operates within a home range, loss of habitats at this scale or larger will likely preclude use of that area by fishers. Habitat loss at smaller spatial scales likely affects the energetics of individual animals because they have to travel more widely to find food and other resources.

The quality of harvested areas is likely substantially diminished for fishers under typical clearcut and intensive forest management practices. With rotational forestry, many of the features of late-successional forests will be lost and not have the opportunity to regenerate. For example, large coniferous trees that are used by fishers for resting may vanish with short rotations (e.g., <100 yr). The retention of CWD within harvested sites may also be insufficient to supply cold-weather resting sites. Interspersion of deciduous trees for potential resting and den sites may disappear as they are removed during stand tending. Sufficient conifer cover may be present at the later stages of the rotation under intensive forest management.

Reductions in the quality and quantity of habitat for fishers will likely continue to occur in the future in British Columbia. Continued harvesting of late-successional forests using conventional clearcut harvesting at the 15-year average rate of 1422 km^2/yr will likely pose a substantial threat to fisher populations in the central interior of British Columbia.

Legal Protection and Habitat Conservation

Fishers are designated as wildlife in British Columbia under the *Wildlife Act* and cannot be hunted, trapped, or killed unless under license or permit. Fishers are also classified as "furbearers" and as such may be legally trapped under license during open seasons. Currently trapping seasons are open in the Thompson, Cariboo, Skeena, and Omineca/ Peace regions between 1 November to 15 February. There is no open season in the Lower Mainland, Okanagan, and Kootenay regions. Furbearing species in British Columbia can only be harvested by qualified personnel on private land or registered traplines (where one individual or group has the exclusive right to harvest furbearers in a specified area). There is no quota on the harvest of fishers in British Columbia.

Fishers in British Columbia occur primarily on Crown land administered by the Ministry of Forests. Within the extent of occurrence of fishers in the province, ~7% lies within 385 protected areas. Many of these are too small to encompass the home range of a fisher; 65 are large enough to encompass the mean home range size of a female fisher (i.e., 35 km^2) and, of these, only 35 are large enough to encompass the mean home range size of a male fisher (i.e., 137 km^2).

Protected areas are generally comprised of low quality habitat for fishers. There is significantly more "nil," "very low," and "low" capability habitat and significantly less "moderate," "moderately high," and "high" capability habitat inside protected areas compared to outside these areas (R.D. Weir, unpubl. data).

Results based code provisions, such as wildlife tree retention areas, coarse woody debris recommendations, old forest retention, landscape level planning, and riparian management, have the potential to address fisher habitat requirements through the retention of large trees, dense canopy closure, and abundant levels of CWD (see following section).

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

The following recommendations should be considered in areas of high management priority for fishers, such as the biogeoclimatic subzones of natural disturbance type (NDT) 3. Fisher populations in NDT3 are the highest in British Columbia because of the abundance of prey, favourable climate, and structurally complex forests with continuous overhead cover. Although the following recommendations have been developed for NDT3 (except for CWH, ICHdw, MSdk, MSdm, and SBSmc subzones) they may also be considered in other areas determined to be of high value to fishers such as the drier interior subzones of NDT2 and more northerly subzones of NDT4. These recommendations are based on the best technical information on the species at this time and some or all of them should be considered for application in localized portions of a planning area where the planning table intends to propose a conservation objective for the species.

- ❖ Fishers select resources at several spatial scales; thus it is important to consider management recommendations at all spatial scales including landscape, stand, patch, and feature. Consider the following recommendations:
- ❖ Maintain sufficient suitable habitat to support healthy populations of fishers. Areas managed for fisher should contain 30–45% mature and old forest, depending on the diversity of habitat available and prey abundance, and be suitable for fishers. Suitable habitat is characterized by shrub cover, coniferous canopy cover, sub-hygric or wetter moisture regime, patches of large, declining trees (particularly black cottonwood), and greater than average amounts of CWD for the zone.
- ❖ Maximize landscape connectivity through the use of corridors of mature and old seral forests. Ideally, connectivity should be centred on stream systems and can be achieved by maintaining large (e.g., 100 m where ecologically appropriate) riparian buffers on either side of streams (S1–S6), focusing on riparian areas that contain suitable habitat features to support fishers.
- ❖ The distribution of cutblock sizes should focus on the small and large sizes of the patch size recommendations described in the *Guide to Landscape Unit Planning*. Fishers will use small cutblocks but also require larger habitat areas. Over the long term, larger cutblocks will develop into these larger habitat areas.

- ❖ Maintain important structural attributes and natural structural complexity of forests.
- ❖ Maintain stands that provide sufficient snow interception, security, foraging, and resting cover. Silvicultural prescriptions should avoid producing stands in the herb structural stage with no CWD and strive to conserve stands with greater than average CWD and >30% closure of the coniferous canopy.
- ❖ Retain patches with a high degree of structure. Fishers use patches within otherwise unsuitable stands that provide sufficient habitat for security cover, foraging, snow interception, resting, and whelping. If it is not possible to conserve stands with the features listed above, conservation of patches within these stands should be maintained. Proposed structural variables within these retention areas include relatively high volume of CWD, large diameter (>20 cm) and elevated CWD, increased canopy and high shrub closure, and increased stocking of trees (including large diameter (>40 cm dbh) and trees containing rust brooms). If the stand that is created or otherwise altered has structural features that are less than any of the desired levels, patches with more structure should be retained.
- ❖ Retain important habitat features across the landscape.
- ❖ When using wildlife tree or old forest retention to provide denning opportunities for fishers, use Table 1 to select suitable sites.
- ❖ It is recommended that salvage does not occur in WTR areas and OGMAs established to provide habitat for this species. In addition these areas should be designed to include as many suitable wildlife trees as possible and that they should be maintained over the long-term (>80 yr).
- ❖ Ensure recruitment of suitable den sites. The availability of suitable maternal and resting den sites may be limiting factors for fisher populations.
- ❖ Maintain natural levels, decay and size characteristics as well as dispersion of CWD.

Wildlife habitat area

Goal

Maintain resting and maternal den sites.

Feature

Establish WHAs at suitable resting or maternal den sites where riparian and riparian-associated habitats contain an abundance of the specific habitat attributes described above (e.g., large declining cottonwoods), and are not included within riparian reserve zones.

Table 1. Preferred wildlife tree retention area and old growth management area (OGMA) characteristics for fishers

Attribute	Characteristics
Size (ha)	≥2 ha
WTR location	Riparian and riparian-associated habitats
Tree features	Presence of cavities, particularly those created from broken branches and primary excavators. Large cottonwoods with cavities (>75 cm), trees with broom rust or witches broom (>40 cm dbh), and trees with heart rot and a bole diameter >54 cm at 5 m above ground.
Tree species	Cottonwood, fir, spruce, or balsam poplar
Tree size (dbh*)	>75 cm cottonwood or fir, >40 cm spruce (minimum 25 cm). Without trees with the preferred dbh, retain the largest available in the stand for recruitment.
Decay class	2 or 3 preferred, 2–6 acceptable
Structural features	Presence of large diameter (>65 cm dbh) , elevated pieces of CWD; CWD in decay classes 2–6; declining cottonwoods (>87 cm dbh)

Size

Generally between 2 and 60 ha but will ultimately be based on the extent of appropriate habitats.

Design

When selecting WHA boundaries, maximize the inclusion of important habitat features such as large cottonwoods and riparian habitats. Ensure suitable den sites are sufficiently buffered.

General wildlife measures

Goals

1. Maintain mature and old cottonwood and large diameter fir and spruce along riparian and riparian-associated habitats.
2. Maintain connectivity between riparian and upland habitats.
3. Maintain important structural attributes for fishers and prey species (i.e., CWD, wildlife trees, cottonwood, and large fir and spruce).

Measures

Access

- Do not develop roads. Where there is no alternative to road development, close road during critical times and rehabilitate.

Harvesting and silviculture

- Do not harvest or salvage.

Pesticides

- Do not use pesticides.

Additional Management Considerations

Reduce incidental harvest of fishers in marten traps (i.e., specially designed traps that exclude fishers, changes to trapping timing).

Refuges have been suggested as an option for population management of fishers (Strickland 1994). Refuges are untrapped areas within fisher populations that act as source populations for trapped areas, and also as insurance against population reductions (Banci 1989). For example, persistence of fisher populations in the Omineca region has been largely attributed to untrapped traplines providing dispersing individuals into actively trapped areas (G. Watts, pers. comm.). Explicitly establishing refuges across the range of fishers in British Columbia would involve considerable co-operation among registered trapline owners and regulatory agencies (MWLAP, MOF).

Information Needs

1. Information on reproduction and trends including conception rates, litter sizes, survival to dispersal, and net recruitment to be able to better predict the ability of fishers in British Columbia to respond to changes in harvest and habitat change.
2. Threshold densities at which fishers can no long acquire sufficient resources at different spatial scales.
3. Reasons for the reuse of structures for whelping and resting remain unclear. Future effort should be directed towards continuing to assess reuse of natal dens and to determining if the availability of suitable den sites is limited across the landscape.

Cross References

Wolverine

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Grizzly Bear

Ursus arctos

Original prepared by Les Gyug, Tony Hamilton, and Matt Austin

Species Information

Taxonomy

The Grizzly Bear, *Ursus arctos*, is one of eight species of the bear family, Ursidae. There are currently two recognized North American subspecies: *U. arctos horribilis*, the common subspecies, and *U. arctos middendorffi*, the Kodiak bear, found on a few Alaskan coastal islands.

Description

Bears are different from other carnivores by their greatly enlarged molar teeth with surfaces that have lost their shearing function and are adapted to crushing, in keeping with their omnivorous diets. The forelimbs are strongly built and the feet are plantigrade and have five toes. Forefeet have long, non-retractile claws. The ears are small and the tail is extremely short.

The Grizzly Bear is the second largest member of the bear family next only to the polar bear (*U. maritimus*). Grizzlies are large, heavy-bodied bears that can attain weights of up to 500 kg (average range 270–360 kg). Exceptionally large bears have been recorded at 680 kg. Adult grizzlies reach nose-to-tail lengths of 1.8 m on average but have been recorded as long as 2.7 m. The long, outer guard hairs of the Grizzly Bear are often tipped with white, silver, or cream giving the bear a grizzled appearance. Coat colour is quite variable, usually brown but ranging from black to almost white. Coat colour is not a good characteristic for distinguishing between Grizzly Bears and Black Bears (*Ursus americanus*). Grizzly Bear facial profiles are usually "dished-in" and a hump of muscle is normally present on the shoulders. The front claws on a Grizzly Bear are longer than on Black Bears, being as long as 10 cm. The long front claws and hump of muscle on the shoulders are adaptations for digging.

Distribution

Global

The Grizzly Bear has a circumpolar distribution once covering most of North America, Europe, and the northern part of Asia. In many of these areas it has been exterminated or its numbers have been greatly reduced. Most of the world's Grizzly Bears now occur in northwestern North America and Russia.

In North America, Grizzly Bears once ranged over most of the west, from Alaska south to Mexico, and from the Pacific coast east to Manitoba, and the Missouri River (Banci 1991). In the wake of westward development and settlement, especially in the plains, the range of the grizzly shrank to its present distribution of Alaska, the Yukon Territory, and British Columbia, with small populations in Alberta, the Northwest Territories, Montana, Idaho, and Wyoming.

British Columbia

Grizzly Bears historically occurred throughout British Columbia, with the exception of some coastal islands (e.g., Vancouver Island, Queen Charlotte Islands, and others). Populations are considered extirpated from much of south and southcentral British Columbia (e.g., lower elevations of the Okanagan, the Lower Mainland, and parts of the Cariboo). However, Grizzly Bear are occasionally sighted in the southern interior plateaus and other areas from which their populations are considered effectively extirpated.

Forest regions and districts

Grizzly Bears occur in all forest regions and almost all forest districts **except** South Island, and Queen Charlotte Islands, and only in the mainland portions of the Campbell River and North Island forest districts.

Ecoprovinces and ecosections

Grizzly Bears occur in most ecoprovinces and ecosections in mainland British Columbia but are absent from Vancouver Island and Queen Charlotte Islands. The following are mainland ecosections within which Grizzly Bear populations are considered **extirpated:**

BOP: PEL, and parts of CLH, HAP, KIP

CEI: CAB, FRB, and parts of CAP, CHP, NAU, QUL

COM: NWC, and parts of EPR, SPR

GED: GEL, FRL

SOI: SOB, SOH, NOB, THB and parts of NOH, NTU, OKR, PAR, STU

Biogeoclimatic units

Grizzly Bears occur in all biogeoclimatic units except BG and CDF.

Broad ecosystem units

Grizzly Bears are wide ranging, and can occur in most broad ecosystem units.

Elevation

All elevations from sea level estuaries to high alpine meadows and talus slopes.

Life History

Diet and foraging behaviour

In British Columbia, Grizzly Bears are efficient predators and scavengers but rely more on a vegetative diet. Grizzly Bears consume a wide variety of foods, including roots and green vegetation, small and large mammals, fish, and insects. A huge variety of plant, animal, fish, and insect food sources are regionally important. Grizzly Bears are omnivorous and opportunistic in their feeding habitats. Habitat selection is governed by forage availability during the growing season. Grizzly Bear diet also changes with the seasons to make use of the most digestible foods. For example, Grizzly Bears will take advantage of palatable early spring forage. Feeding on ungulates is important during early spring, and for many bears, salmon comprises a significant fall diet item.

In general, the largest differences in the feeding patterns are between coastal and interior Grizzly Bears. On the coast (MacHutchon et al. 1993; Hamilton 1987), beginning in the spring, Grizzly Bears feed on early green vegetation such as skunk cabbage (*Lysichiton americanus*) and sedges located in the estuaries and seepage sites that become snow-free first. As the season advances, the bears follow the receding snow up the avalanche chutes feeding on emerging vegetation and roots. Ripe berries attract the grizzlies down onto the floodplain and lower slopes where they eat devil's-club (*Oplopanax horridus*), salmonberry (*Rubus spectabilis*), raspberry (*Rubus* spp.), black twinberry (*Lonicera involucrata*), elderberry (*Sambucus* spp.), and a variety of blueberries (*Vaccinium* spp.). They begin to feed on salmon (*Oncorhynchus* spp.) as they become available in the spawning channels and continue to do so until late fall, feeding on live and eventually dead salmon. Once salmon supplies dwindle, grizzlies return to feeding on skunk cabbage and other vegetation. Grizzlies will feed on insects and grubs when the opportunity arises, as well as molluscs and other animals of the intertidal zone.

In the interior (Simpson 1987; McLellan and Hovey 1995; Ciarniello et al. 2001) beginning in the spring, grizzlies feed mainly on the roots of *Hedysarum* spp., spring beauty (*Claytonia lacneolata*), and/or avalanche lily (*Erythronium grandiflorum*) depending on local abundance, and on carrion. They may also opportunistically prey on winter-weakened ungulates. As the green vegetation emerges the bears begin to graze on grasses, horsetails, rushes, and sedges. During this time, they also prey on ungulates on their calving grounds. In summer, bears follow the green-up to obtain nutritious young spring growth including locally important food sources such as cow-parsnip (*Heracleum* spp.). They also obtain early ripening fruits beginning in mid-July mainly in riparian forests and productive low elevation seral forests, such as pine-soopolallie terraces. In late-summer and fall (August–October) high elevation berries become the major food source, mainly soopolallie (*Shepherdia canadensis*), blueberries, and huckleberries. Late fall feeding focuses mainly on harder berries such as mountain ash (*Sorbus* spp.) or kinnickinnick (*Arctostaphylos uva-ursi*) that persist past the *Vaccinium* fruiting season, and on the roots of *Hedysarum* in areas where it occurs. Throughout the active season, interior grizzlies will prey on small mammals, especially ground squirrels (*Spermophilus* spp.) Fish, roots, pine nuts, or bulbs, and insects are important whenever they are available and sufficiently abundant. Army cutworm moths (Noctuidae) in high elevation alpine talus slopes and boulder fields may be locally important (White et al. 1998a).

Reproduction

Breeding occurs between the end of April and end of June. Cubs are born in the den between January and March. The average age of first reproduction for females in southeastern British Columbia is 6 years, the time period between litters is 2.7 years, and the mean number of cubs per litter is 2.3 (McLellan 1989a). In southern grizzly populations, cubs tend to stay with the mother for approximately 2.5 years. Females remain in estrus throughout the breeding season until mating occurs and do not ovulate again for at least 2 (usually 3 or 4) years after giving birth. Two offspring are generally born per litter, and young are born blind and without fur. They are weaned at 5 months of age but remain with the mother until at least their second spring (and usually until the third or fourth).

Site fidelity

Many telemetry studies have shown that Grizzly Bears are creatures of habit and will usually return to the same seasonal food sources and areas throughout their lifetimes. Foraging strategies are somewhat flexible; individuals adapt to annual variation in food supply and can learn to exploit newly available food sources. However, many of a Grizzly Bear's movements, habitat selection, and foraging patterns are learned as a cub and are reinforced throughout their lives (20–30 yr). Home range fidelity may be strong as a result, especially for females.

Home range

Home range sizes are proportionate to food quality, quantity, and distribution. Generally Grizzly Bear home ranges in productive coastal habitats near salmon stream are smaller than ranges in interior mountains, which are again smaller than ranges in interior plateau habitats. For coastal British Columbia, average minimum single year home range size was 137 km^2 for males, and 52 km^2 for females (Khutzeymateen: MacHutchon et al. 1993). For wet interior mountains, average home range size was 187 km^2 for males and 103 km^2 for females (Parsnip: Ciarniello et al. 2001; Revelstoke: Simpson 1987). For drier interior mountains or plateau areas, average home range size was 804 km^2 for males and 222 km^2 for females (Parsnip: Ciarniello et al. 2001; Flathead: McLellan 1981; Jasper: Russell et al. 1979; Kananaskis: Wielgus 1986).

Grizzly Bears, except females with cubs, and sibling groups, are solitary for most of the year except during the mating season. Mothers, daughters, and even granddaughters tend to have overlapping home ranges, while male home ranges are large and overlap with several adult females (Bunnell and McCann 1993). Habitat use and food habits studies have shown that the areas occupied by male grizzlies (200-300 km^2) are much larger than what would be required simply to obtain food. The smaller range sizes of females with young (100 km^2), which have greater energy needs than males, may provide the best estimate of the minimum feeding habitat requirements of individual bears. The large range sizes of male Grizzly Bears are probably related more to breeding than to food availability, while females may use small ranges where they can improve security of the young while still obtaining adequate food. Social intolerance and security needs of young bears probably act to distribute grizzlies widely over the available range. In many areas, adult females may inhabit marginal ranges or disturbed areas, such as road margins, where human activities exclude most larger males (McLellan and Shackleton 1988). The size of individual home ranges varies annually in response to variation in quality and abundance of food (Picton et al. 1985). Grizzly Bear habitat use is strongly influenced by intraspecific social interactions (e.g., male predation on cubs) and the presence and activities of people.

Movements and dispersal

Grizzly Bears have low dispersal capabilities relative to other carnivores (Weaver et al. 1996). This is especially true for subadult female Grizzly Bears, which usually establish their home range within or adjacent to the maternal range (e.g., McLellan and Hovey 2001). On average, male Grizzly Bears only dispersed 30 km from the ranges used as cubs with their mothers, and female Grizzly Bears only 10 km (McLellan and Hovey 2001). This inherent fidelity, particularly of female Grizzly Bears, to their maternal home ranges may reduce the rate of recolonization of areas where breeding populations have been depleted.

Habitat

Structural stage

In general terms, Grizzly Bear forage tends to be more abundant in non-forested sites, or sites with partial forest, or sites with many tree gaps in older forest. However, security habitat and day bedding areas (for heat relief, rain interception, or warmth) tend to be closed forest sites near higher quality foraging sites. Some types of forage (e.g., salmon in streams, ants in logs, ungulates) can be found within many structural stages and the forage is not necessarily tied to any particular structural stage. (Refer to Table 1 on following page.)

Important habitats and habitat elements

Denning

Denning sites are generally used from November through March and usually to mid-April in the northern areas of British Columbia. Hibernating habitats tend be high elevation areas that are sloped, and have dry, stable soil conditions that remain frozen during the winter (Bunnell and McCann 1993). Dens are usually on steep north-facing slopes, with soils suitable for digging and where vegetation will stabilize the roof of the den and snow will accumulate for insulation (Vroom et al. 1977). Wet or seepage areas and areas with shallow soils or many boulders are avoided. Bears seldom reuse an excavated den but will often come back to the same vicinity to dig their new den (Ciarniello et al. 2001).

On the coast, dens are often dug under large old trees. The tree's root mass creates a stable roof for the den. Coastal grizzlies may also use very large tree cavities much like coastal Black Bears.

Foraging

Grizzly Bears in British Columbia have such an enormous range of learned behavioural adaptations to diverse regional ecosystems that generalization about habitat requirements is difficult. Even within a region, individual bears may have vastly different approaches to meeting their requirements. Some bears, particularly males, adopt a highly mobile, seasonally "transient" strategy, whereas other bears are more "resident." Some bears rely more heavily on predation than others, and some use higher elevation annual home ranges as opposed to migrating to lower elevations on a seasonal basis.

Although meeting nutritional requirements is the primary factor in habitat choice, selection is also based on thermal cover (e.g., dens/bedding sites), security (e.g., females protecting cubs), or access to potential mates during the breeding season. Habitat selection is also strongly influenced by intra-specific (social) interactions and the presence and activities of people.

Grizzly Bear habitat requirements must be viewed at several spatial scales. Transients deliberately travel to specific landscapes in a sub-region on a seasonal basis. Both residents and transients select specific patches of habitat or complexes of habitats within landscapes. Within patches, they may only require specific food-producing microsites. Habitat requirements must also be viewed at various temporal scales; continually shifting seasonal food supplies, annual food variance (e.g., berry crop failure), and

Table 1. Forage values by structural stage

Stage	Value
1a	Forage value for army cutworm moths in alpine rockfields or intertidal marine molluscs in estuaries. Otherwise generally nil forage value except in the presence of human foods or garbage. Seasonal use of small mammals (marmots and ground squirrels).
1b	Forage value for army cutworm moths in alpine rockfields. Forage value for intertidal marine molluscs in estuaries. Otherwise generally nil forage value except in the presence of human foods or garbage.
2	Forage value can be very high on bulbs, corms, grasses, horsetails, and other herbs. These values can be found variously in wet meadows, marshes, avalanche slopes, or alpine/subalpine meadows.
3a	Forage value can be very high, particularly in recovering burned or clearcut sites where *Vaccinium* berries are abundant.
3b	Forage value can be very high, particularly in recovering burned or clearcut sites where *Vaccinium* berries are abundant. Forage value can be high in skunk cabbage swamps, which are usually a mixture of structural stages because the typical skunk cabbage swamp is often partially treed, and contains tall alder or willow shrubs as well. Similarly typical avalanche slopes are mixtures of herb, low shrub, and tall shrub stages, all of which can provide high forage values for Grizzly Bears.
4	Typical value of densely forested sites, which preclude most herb or shrub forage values, are as day bedding sites for security and heat relief in areas near other types of foraging sites. Forests that are not as densely forested may continue to support berry patches (soopolallie or *Vaccinium*) in forests beyond the open shrub stage.
5	Typical value of densely forested sites, which preclude most herb or shrub forage values, are as day bedding sites for security and heat relief in areas near other types of foraging sites. Forests that are not as densely forested may continue to support berry patches (soopolallie or *Vaccinium*) in forests beyond the open shrub stage.
6	Typical value of densely forested sites, which preclude most herb or shrub forage values, are as day bedding sites for security and heat relief in areas near other types of foraging sites. Forests that are not as densely forested may continue to support berry patches (soopolallie or *Vaccinium*) in forests beyond the open shrub stage.
7	Value of forest (beyond security and heat relief) will depend on amount of openings in forest. Forests that remain dense in stage 7 will have little value beyond that found in stages 4, 5, and 6. Forests that become patchy with numerous gaps or dying canopies may support various amounts of berries or herbs for foraging in the canopy gaps.

long-term influences on habitat quality such as fire suppression must all be considered. Concurrent attention must be given to meeting the spatial requirements of individuals within and across landscapes and examining population level habitat supply.

Conservation and Management

Status

Grizzly Bears are on the provincial *Blue List* in British Columbia. In Canada, Grizzly Bears are considered of *Special Concern* in British Columbia and *Extirpated* in part of Alberta, Saskatchewan, and Manitoba (COSEWIC 2002). (See Summary of ABI status in BC and adjacent jurisdictions at bottom of page.)

Trends

Population trends

The provincial population estimate from the B.C. Ministry of Water, Land and Air Protection for Grizzly Bears is estimated at a minimum of 13 800, which is ~50% of the Canadian Grizzly Bear population. Overall, the population in British Columbia currently appears stable, but local population declines have occurred in the past in many areas of the province. Grizzly Bears are considered threatened in 8% of their historic range in British Columbia and effectively extirpated in ~10% (Figure 1). Grizzly bear populations are believed to be increasing in some areas of the province.

Habitat trends

Habitat effectiveness for Grizzly Bears has decreased in British Columbia and can be expected to continue to decrease in British Columbia (MELP 1995b). Habitat effectiveness considers the habitat suitability of the area and further accounts for impacts such as habitat displacement and fragmentation that reduce the ability or willingness of Grizzly Bears to use the habitat. While some of this is due to direct loss to agriculture and settlement, increasing road access is now more important. Road access leads to direct mortality through increased human–bear conflicts, hunting, and poaching, and an avoidance of habitats near roads and areas heavily used by people for recreation, resource extraction, or other reasons.

Threats

Population threats

Historic reductions in Grizzly Bear populations were a result of extensive agricultural land conversion, extermination campaigns often related to livestock protection, and unrestricted killing (IGBC 1987). Today, the primary limiting factors for Grizzly Bears in the Canadian portion of their range appear to be human-caused mortality from a variety of factors, and habitat loss, alienation, and fragmentation (McLellan et al. 2000; Kansas 2002).

Currently, throughout the Grizzly Bear's range in North America, sources of area-concentrated mortality include hunting, poaching, and control kills associated with inadequate garbage management or other types of human-bear encounters including protection of livestock or perceived threats to human safety (IGBC 1987). In southern British Columbia,

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

AB	AK	BC	ID	MT	YK	NWT	WA	Canada	Global
S3	S?	S3	S1	S1S2	S?	S?	S1	N3	G4T3T4

Figure 1. Status of Grizzly Bear Population Units (MWLAP). Population conservation status is based on the percentage the current population estimate represents of the capability of the habitat to support Grizzly Bears. The conservation status categories are: Viable ≥50%; Threatened <50%.

and adjacent areas of the interior mountains, people killed 77–85% of 99 radio-collared bears known or suspected to have died during 13 radio-collaring studies in a 22-year period (McLellan et al. 2000). In British Columbia where Grizzly Bear hunting was permitted, legal harvest accounted for 39–44% of the mortality. The next leading cause of grizzly mortality was killing by people in self-defence or in defence of property or livestock. Similar extensive data to estimate mortality rates is not available for northern British Columbia where fewer radio-collaring studies have been undertaken.

Increased direct Grizzly Bear mortalities are often associated with increased road access (McLellan 1990). Roads result in Grizzly Bear mortalities both directly and indirectly (as well as habitat loss; see “Habitat threats”). The mechanisms in which mortality is increased include direct mortality both through collisions on major roads, and through hunting and poaching; habituation of bears to people when they come in close contact, and the eventual loss of some of these bears involved in human-bear conflicts; and social disruption of bears with other bears when bears start avoiding habitat near newly created roads (McLellan 1990). Most of the new road building in British Columbia stems from forestry, mining, and oil and gas development. Direct human-caused mortality represents a particularly significant threat when adult females are killed in small and localized populations that may have low immigration rates.

Isolation is a significant factor in long-term (100+ yr) viability of small isolated Grizzly Bear populations such as in the Yellowstone area in the northwestern United States (Mattson and Reid 1991). The low population numbers in some areas of British Columbia are so low as to make natural recovery almost impossible given that these areas can be fairly isolated from the other Grizzly Bear population and natural immigration is likely very low. The low population numbers and isolation of localized populations such as in the North Cascades (e.g., estimate of <20; Gyug 1998) may also be creating local inbreeding that may limit any population recovery in these areas in the absence of increased Grizzly Bear immigration.

By comparison to human-caused mortality, natural mortality factors seem to be relatively minor in Grizzly Bear populations (McLellan et al. 2000). There are no known diseases or parasites that appear to have impacts on natural populations of Grizzly Bears (IGBC 1987). Predation/cannibalism, particularly of young bears by older dominant male bears, appears to play a role in population regulation, but its extent is not well known. Malnutrition is a factor in cub mortality, often within the first 1–4 weeks of emergence from the den, indicating that the nutritional state of the pregnant female entering the den is important (IGBC 1987).

Habitat threats

Habitat loss, alienation (the displacement from otherwise suitable habitat), and fragmentation (the separation of previously continuous habitat into one or more disconnected pieces) occur on a broad scale as a result of expanding human settlement, increased access for forestry and other extraction industries, and forestry and fire suppression.

Human settlement

Urban and agricultural developments are concentrated in valley bottoms formerly used as spring habitats and as movement corridors between mountain ranges. These developments cause direct habitat loss as well as habitat fragmentation by isolating major protected areas, sometimes making them inadequate to maintain viable populations. The settlement patterns along major roads or highways also tend to cause habitat fragmentation. The increasing settlement patterns along the Highway 3 corridor through the Rocky Mountains in southern British Columbia is seen as one of the major population fragmentation causes preventing extensive Grizzly Bear population recovery in the northern Rocky Mountains of the United States.

Because Grizzly Bear populations are naturally found at low densities, large areas of occupied and connected habitat are required to ensure their long term viability. To sustain habitat supply for populations, individuals must be able to move freely among valued habitats, without being restricted by human-caused blockages or being attracted to mortality sinks around human settlements. Because individuals tend to disperse very little from established populations (10–30 km; McLellan and Hovey 2001), it is necessary to maintain corridors of habitat between major protected areas that are also good habitat themselves and corridors must be "wide enough for male Grizzly Bears to live in with little risk of being killed" (McLellan and Hovey 2001).

Hydroelectric impoundments behind dams can significantly affect Grizzly Bears when lowland feeding areas, particularly important in spring, are flooded. The effect of dams, particularly on the Columbia River system, has been to stop anadromous salmon runs, which has probably significantly affected Grizzly Bear feeding opportunities over a very wide area as well.

Forest management

Before the advent of widespread fire suppression (about 1945), the primary forest disturbance regime was fire through most of the province. Currently, logging has replaced fire as the primary agent of forest succession, which can be expected to have an impact on Grizzly Bear habitat independent of any effects of increased access (Zager et al. 1983). Many post-fire habitats typically remain high productivity foraging sites (particularly for berries) for 35–70 years, and Grizzly Bears learn to rely heavily on these sites. Under current timber management and silvicultural regimes, extensive site preparation and soil disturbance by heavy machinery reduce berry productivity in clearcuts, and conifer stands are planted, managed, and tended so they close in and lose any berry foraging values within much shorter time frames than they might have had under natural wildfire regimes.

Grizzly Bears typically used forested habitats adjacent to open foraging habitats such as avalanche chutes, wet meadows, marshes and swamps, and subalpine meadows as security habitat and daytime bedding sites to avoid heat stress. Clearcutting the forests adjacent to these sites can significantly affect the suitability in these high value open sites.

Roads

Roads result in Grizzly Bear habitat alienation, (i.e., displacement from preferred habitats), as well as increased direct mortality from hunters, poachers, and management kills for bears that are not displaced (McLellan 1990; Mace et al. 1999). Vehicles on roads may harass bears, and roads tend to displace them from quality habitats (McLellan 1990). Roads also tend to result in increased human activity in areas, which increases chances for bear–human interactions that result in displacement from these habitats (as well as increases in direct mortality) (McLellan 1990).

The displacement of bears from linear habitats (i.e., roads) can also cause habitat fragmentation. In Banff National Park, the Trans-Canada Highway acts as a complete barrier to adult females, and secondary highways are only regularly crossed by female Grizzly Bears that are relatively habituated to people (Gibeau and Herrero 1998). In British Columbia, the Highway 3 corridor near Nelson/Castlegar/Trail/Salmo has been found to be a genetic barrier between southern Selkirk and central Selkirk mountain Grizzly Bear populations (Proctor 2001). Where there are still extant populations of Grizzly Bears in the northern United States, highways also cause habitat fragmentation (Servheen et al. 1998).

While the construction of access roads is not limited to forestry activities, most new roads constructed in British Columbia are to support forestry activities. The increased access allowed on even infrequently travelled roads has been shown to significantly affect habitat use by Grizzly Bears (e.g., Mace et al. 1996; Archibald et al. 1987; McLellan and Shackleton 1988). Even increases in non-motorized and non-hunting-related recreation allowed by increased access to areas can significantly affect Grizzly Bear habitat use (e.g., for mountain climbing) (White et al. 1998b). While road closures or access limitations can be implemented to reduce the effects of forest access roads on Grizzly Bears, road closures implemented in wildlife management areas on national forests in Idaho, Wyoming, Washington, and Montana were found to be relatively ineffective

(27%) at keeping all vehicles off closed roads (Havlick 1998).

Historically, conflict with ranchers and livestock grazing operations have been a major cause of Grizzly Bear population decline or local extirpation in the United States (Storer and Trevis 1978), and this impact is thought to have reduced British Columbia populations as well. Potential impacts include mortalities if ranchers shoot bears to protect livestock, competition for forage, displacement from or alteration of preferred habitats from grazing and trampling. Preferred habitats which may be impacted by grazing or trampling include wetland areas and fruit-producing areas (IGBC 1987). More information on grazing impacts on grizzly bears is provided in the IGBC (1987).

Legal Protection and Habitat Conservation

The Grizzly Bear is protected under the provincial *Wildlife Act* from unrestricted hunting. All hunting seasons on Grizzly Bears are managed through Limited Entry Hunts (LEH) open by lottery to resident hunters or by quotas granted to licensed guides. There are no LEH seasons on Grizzly Bears in any threatened Grizzly Bear Population Unit.

Within the occupied range of Grizzly Bears in British Columbia, >106 000 km^2 or 13.4% is protected. Some parks that are important for the conservation of Grizzly Bears include Khutzeymateen, Spatsizi, North and South Tweedsmuir provincial parks and Tatshenshini-Alsek National Park.

The Grizzly Bear Conservation Strategy (MELP 1995a) identified habitat as one of the key conservation needs for Grizzly Bears in British Columbia and established a framework for establishing Grizzly Bear management areas throughout the province. Habitat management would largely be achieved through strategic land use plans that would establish goals and objectives, and would set the means to attain those on publicly owned land in local areas throughout the province.

Strategic land use planning on publicly owned lands, either land use plans (LUP) or land and resource management plans (LRMP), have been completed or approved in 73% of the province by area as of January 2002. LRMP processes are underway in an additional 12% of the area or the province.

Most of the strategic land use plans that have been completed or approved to date address Grizzly Bear habitat issues (Table 2), some in more detail and length than others. In particular, LRMPs such as the Okanagan-Shuswap and Kalum have addressed Grizzly Bear habitat issues at great length and in detail, while others, such as the Kootenay-Boundary LUP, appear to have treated Grizzly Bear habitat issues only in part, and the Kamloops LRMP is silent on the issue of Grizzly Bear habitat management.

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

Given that Grizzly Bears have large home ranges, both the landscape and stand level requirements of Grizzly Bears should be considered during strategic or landscape level planning. Wildlife habitat areas may be established under strategic level plans to address stand level requirements, provided a timber supply budget is negotiated by the strategic level plan or under the IWMS provincial timber supply limit (see "Wildlife habitat area" below) when within a Threatened Grizzly Bear Population Unit or Grizzly Bear Management Area.

The following strategic level recommendations may be considered for translation into specific legal objectives, strategies, and general guidelines by the strategic level plan and must be clearly defined geographically at an appropriate map scale. The intent is to apply these recommendations to ensure that:

- ❖ adequate amounts of well-distributed, seasonally important habitats are available across the landscape and through time;
- ❖ these habitats can be effectively used by Grizzly Bears (i.e., areas are not unduly impacted by habitat fragmentation or displacement resulting from human activities); and
- ❖ human-caused mortality risks are minimized.

Table 2. Current approaches to Grizzly Bear habitat management within strategic land use plans in British Columbia. LRMPs are underway in the North Coast, Central Coast, Lillooet, and Sea to Sky. No LRMPs or LUPs are underway in Atlin-Taku, Dease Liard, Nass, Morice, Sunshine Coast, Merritt, or Chilliwack.

Strategic land use plan	Type of resource management zone (RMZ)	Approach to Grizzly Bear habitat management *General or specific objectives or area-based direction for Grizzly Bear habitat management*
Fort Nelson	37 area-specific RMZs	Objectives included recommendations to manage and minimize new access, to ensure industrial exploration and timber management activities are undertaken with sensitivity to Grizzly Bear habitat, and to identify and map important habitat elements incorporated into several RMZs.
Cassiar Iskut- Stikine	15 area-specific RMZs	Objectives include maintenance of large areas of high value Grizzly Bear habitat (which have been mapped) by maintaining areas of well-distributed, seasonally important habitats for Grizzly Bear across the landscape and through time. Strategies are spelled out and include managing all access to and activities in these areas, and maintaining mixes of seral stages for forage and other critical habitat features including connectivity of habitats. In addition, access management is to take into account high value Grizzly Bear habitats.
Mackenzie	72 area-apecific RMZs and RM subzones	Under general directions the objectives are to identify and manage to conserve Grizzly Bear habitat to assist in sustaining viable populations; improve the management of interactions between Grizzly Bears and humans; and manage access to maintain healthy Grizzly Bear populations. Strategies to achieve these objectives are included (i.e., developing guidelines for silviculture, timing and activities in high or spring Grizzly habitats, establishment of WHAs).
Fort St. John	24 area-specific RMZs	Objectives and strategies are given for each RMZ, and include Grizzly Bear habitat management in some RMZs where Grizzly Bear management was a priority. For example, in one RMZ, an objective to "Maintain medium and high quality Grizzly Bear habitat" has strategies specified to identify and map the habitat; incorporate habitat protection criteria into landscape and stand level plans; plan and develop access to avoid habitats; incorporate habitats and connectivity corridors into landscape level plans; use WHAs, develop interagency plans where there is the potential for activities to negatively affect habitat; encourage the use of silvicultural systems that minimize negative impacts on habitat; and minimize impacts by ensuring that critical habitat areas are linked by connectivity corridors.
Dawson Creek	12 area-specific RMZs	Specific directions have been left to lower level planning initiatives. Several RMZs contain the following objective: "Manage medium and/or high capability Grizzly Bear habitat to assist in sustaining viable, healthy Grizzly Bear populations" using the strategy of identifying and mapping medium and high capability Grizzly Bear habitat, and incorporating into landscape unit level and operational planning."

Strategic land use plan	Type of resource management zone (RMZ)	Approach to Grizzly Bear habitat management *General or specific objectives or area-based direction for Grizzly Bear habitat management*
Fort St. James	36 area-specific RMZs	Two objectives in general directions are to maintain or enhance Grizzly Bear habitat and populations, and to minimize conflicts in human–bear interactions. The strategies to achieve the first objective include completing Grizzly Bear habitat mapping in areas of concern; managing for a mosaic of habitat types and characteristics to ensure adequate seasonal foraging sites with adjacent cover; reducing habitat fragmentation by providing FENs or movement corridors; and in high Grizzly Bear habitat suitability areas, undertaking access management planning, establishing management zones around important and valuable habitats, timing development to minimize conflicts, minimizing Grizzly Bear displacement from preferred habitats, creating irregular edges and leaving cover within cutblocks and between cutblocks and roads, and locating roads to avoid valuable Grizzly Bear habitat.
Kispiox	18 area-specific RMZs (not including Protected Areas)	Extensive Grizzly Bear habitat management strategies are included in the general management directions, rather than in area-specific RMZs. Listed strategies include identifying and mapping high value habitat at the landscape planning level that will be protected through management strategies such as buffering with reserves, modifying silvicultural systems, and minimizing clearcut sizes; selection harvesting a minimum of 5% of the forested portion of high value Grizzly Bear habitat outside RMAs or WHAs; using established strategies for management of Grizzly Bear habitat in the development and review of landscape and operational plans, designation of Grizzly Bear management areas, co-ordinated access management plans and modified road construction; and restricting Grizzly Bear hunting in portions of the planning area as part of the provincial conservation strategy.
Kalum	Generic land use class RMZs	Grizzly Bear habitat importance, and objectives and strategies for management are extensively laid out at more length and with more specifics than in any other LRMP. Intent of these objectives and strategies was to maintain or restore Grizzly Bear habitats through access management and forage supply for identified watersheds; conserve, mitigate, or restore critical patch habitats at the stand level no matter where they occur; maintain current Grizzly Bear population density, distribution, and genetic diversity in each GBPU to ensure viability; and recover local Grizzly Bear population where appropriate. The Special RMZ class was divided into 9 types, one of which is "Grizzly Bear benchmark and linkages." Three Special Grizzly Bear RMZs were created as benchmark or linkage habitats where no hunting is allowed, in addition to the general management directions.
Bulkley	Generic land use RMZs, with	12 Planning Units overlaid on RMZs Specific directions for Grizzly Bear management are given in each of 12 Planning Units (or for subunits). Directions are relatively generic, e.g., "Maintain goat and Grizzly Bear habitat. Prescriptions will focus on the importance of maintaining Grizzly Bear habitat, especially that required for travel and denning," or "Complete Grizzly Bear interpreted ecosystem mapping and incorporate into management prescriptions as directed by the Babine Local Resource Use Plan (LRUP). Actual management of habitats defaults to lower level plans (LRUP or IWMS).

Strategic land use plan	Type of resource management zone (RMZ)	Approach to Grizzly Bear habitat management ***General or specific objectives or area-based direction for Grizzly Bear habitat management***
Lakes	Established generic land use RMZs	General management direction objectives are to "maintain the diversity and a suitable abundance of wide ranging carnivore populations and the ecosystems upon which they depend." Strategies to implement this for Grizzly Bears include upgrading capability/suitability mapping, establishing Grizzly Bear management plans and management areas in accordance with the provincial Grizzly Bear conservation strategy, and implementing Grizzly Bear management guidelines in areas of important habitat capability and known occurrence of Grizzly Bear.
Vanderhoof	20 area-specific RMZs	Under general management directions, the objective is to maintain or enhance Grizzly Bear populations and habitat by identifying and mapping of high suitability and capability Grizzly Bear habitat, by deactivating non-essential secondary roads and minimizing the amount and duration of new road access in high value habitats, and by managing for a mosaic of habitat types and characteristics.Further strategies for Grizzly Bear habitat management are made in some RMZs but are fairly generic, referring to inventory of habitats, maintenance of habitats, and "establishment of appropriate management plans."
Prince George	54 area-specific RMZs	Addressed in each area-specific RMZ. For example, within RMZ#1, the Parsnip High Elevation RMZ in the Special Resource Management Category-Natural Habitat, the objective is to "manage Grizzly Bear habitat to provide opportunity for population levels to increase" by identifying areas of high suitability and critical habitat where there will be access management planning with the intent of deactivating non-essential roads and minimizing the amount and duration of new roaded access, where the use of sheep in vegetation management will be avoided, where a mosaic of habitat types and characteristics and stand attributes that mimic habitat most suitable for Grizzly Bears, and where disturbance will be avoided to known Grizzly Bear denning sites.
Robson Valley	23 area-specific RMZs	General objective is to "maintain or enhance habitat and/or increase numbers, genetic variability, and distribution" through 9 strategies including identifying, conserving, and managing critical habitat in medium and historically high density bear zones, encouraging land use practices that promote the long-term viability of important forage species, managing road access, establishing Grizzly Bear management areas or other land use designations that benefit Grizzly Bear populations, ensuring the continued existence of adequate seasonal foraging sites with adjacent cover, minimizing bear displacement from preferred habitat by preventing habitat fragmentation, locating roads to avoid avalanche paths, leaving forest reserves of 100 m on each side of important avalanche paths, and timing human activities to avoid conflicts with concentrated seasonal bear use areas. Within individual RMZs, the above objective is repeated for wildlife with area-specific strategies on access and on reducing conflicts between Grizzly Bears and commercial recreation use, mining development, and range use.

Strategic land use plan	Type of resource management zone (RMZ)	Approach to Grizzly Bear habitat management *General or specific objectives or area-based direction for Grizzly Bear habitat management*
Kamloops	6 land use classes with smaller RMZs	Not addressed.
Okanagan-Shuswap	Resource-Use Specific RMZs which overlap with other RMZs	RMZs established for Grizzly Bear habitat management, which overlap with RMZs for other species or other land uses. The Grizzly Bear RMZ establishes (in much more detail than most other LRMPs) the locations of areas managed as Grizzly Bear habitat; and provisions for maintaining screening, security, and thermal cover adjacent to critical habitats. It also establishes how to maintain or enhance forage availability, cover, and connectivity; how to minimize negative interactions associated with access; and how to minimize negative interactions associated with commercial tourism and recreation developments.
Kootenay-Boundary LUP	RMZs are equivalent to forest districts	Addresses land use classes within RMZs by mapping Biodiversity Emphasis Zones, Connectivity Corridors, Enhanced RD Zones (Timber), Caribou Habitat Areas, and Areas managed for mature. The KBLUP-Implementation Strategy has only one objective relating to Grizzly Bear habitat: "To maintain Grizzly Bear habitat, retain adequate amounts of mature, and/or old forests, as determined through Objective 2, adjacent to important avalanche tracks."
Cariboo-Chilcotin LUP	3 resource development zones (RDZ)	Each RDZ is subdivided into areas for which the following clause, or a very close approximation, is included as resource targets: "To manage for Grizzly Bear, moose, furbearer, species at risk, and other sensitive habitats within the areas identified as riparian buffers, recreation areas, caribou habitat, and lakeshore management zones and throughout the polygon under the biodiversity conservation strategy."

Access

Where planning tables propose a conservation objective for Grizzly Bears, they should consider application of a variety of access management measures designed to ensure habitat security, prevent population fragmentation, minimize displacement from preferred habitat, and minimize mortality risk. Access management regimes should be applied over areas roughly equivalent to an average adult female home range, and the practices directed at ensuring adult female security and survival. Access management may include complete closure of roads, seasonal closure of roads, limiting access to commercial or industrial users only, or other access regimes designed to prevent displacement of Grizzly Bears from areas near roads.

Objectives should include provisions that maximize the net amount, quality, and seasonal representation of Grizzly Bear habitat that is >500 m from an open road (i.e., roads that receive any motorized use from 1 April to 31 October). Larger roadless areas (e.g., >1000 ha) are preferred. Wherever possible, retain these areas for at least 10 years. Similarly, objectives should include minimizing the amount of areas with >0.6 km/km^2 of open road (i.e., a road without restriction on motorized vehicle use) where these are in Grizzly Bear habitat. Consider also the following provisions:

- ❖ Promote one-side development (i.e., road construction and harvesting on one side of a valley at a time).
- ❖ Remove ballast from roads across avalanche chutes. Close permanent roads by removing bridges. Remove bridges when permanently deactivating roads. Revegetate temporary access (e.g., excavated or bladed trails), roads, and landings with non-forage species to minimize mortality risk of attracted bears.
- ❖ Minimize the impact of open roads on Grizzly Bears.
- ❖ Schedule forestry activities to avoid displacing bears from preferred habitat during periods of seasonal use.
- ❖ Provide windfirm visual screening along roads to provide security (i.e., do not conduct vegetation management or stand tending adjacent to roads).

Seral stage distribution

- ❖ Maintain or restore Grizzly Bear foraging opportunities and habitat effectiveness across the landscape and over time.
- ❖ Determine current and future forage values and habitat effectiveness of planning area. Landscapes with extensive areas of mid-seral forest characterized by closed canopies, conifer dominance, and high stocking levels have little Grizzly Bear habitat value. Similarly, suitable foraging habitat may not be effective (i.e., useable) because of the proximity to human settlement, transportation routes, agriculture, or other human activities or development. Current forage values and habitat effectiveness at the landscape level can be determined through interpretations of ecosystem maps (e.g., TEM, PEM, BEI) or other surrogate maps using the 6-class wildlife habitat mapping system (RIC 1999). Interpretations should assess habitat effectiveness that may be reduced in areas near human settlement or developments, agricultural areas, and roads. In addition, the type of disturbance that has created early seral habitats, and likely outcome of the type of disturbance should be assessed. For instance, logging and wildfire both produce early seral habitats that may be mapped similarly by ecosystem mapping, but can be very different in the amount of foraging potential for Grizzly Bears, and in the length of time this foraging potential will be available to Grizzly Bears.
- ❖ Where developments reduce the effectiveness of habitat within a landscape, where forest succession is reducing foraging values, or where restoration is an objective, consider management of early seral stages to recover effectiveness lost to development or to forest succession. Foraging habitat can be created by creating early seral habitats, but only if managed effectively for Grizzly Bear forage, and remain useable by Grizzly Bears.
- ❖ Manage landscapes for steady levels of early seral habitat to avoid “booming” and “busting” forage supply.

Silviculture

- ❖ Lower conifer stocking levels to provide Grizzly Bear forage.

- ❖ In NDTs 1–3, retain 50% of the largest pieces (top 20% diameter and length) of coarse woody debris in decay classes 1–2 for summer foraging on ants.
- ❖ Do not use broadcast vegetation management methods in capable watersheds, except where stand establishment or re-establishment is the objective and broadcast methods are required. Vegetation management methods, listed in increasing order of impact on Grizzly Bear forage are manual, chemical, cover crops, and sheep grazing.
- ❖ Do not use sheep, domestic goats, or cattle for vegetation management in occupied Grizzly Bear habitat to reduce direct and indirect conflicts with bears.

Range

- ❖ Consider establishing zones where range permits will be gradually removed and no new permits issued to reduce direct and indirect conflicts with Grizzly Bears. Use the effectiveness classes (based on BEI or finer-scale mapping interpreted for Grizzly Bear seasonal habitats with the application of habitat effectiveness from roads and human settlement) to decide where to limit grazing.

Restoration

- ❖ Conduct controlled burning to improve berry production (e.g., in ESSF).
- ❖ Plan for extended rotations to recover mature and old-growth characteristics such as more open canopies, greater amounts of understorey forage, and/or large trees (e.g., for rain interception in bedding habitat on coastal floodplains).
- ❖ Implement thinning and/or pruning to maintain open stands.
- ❖ Commercially thin to reopen closed canopies and recover productive shrub understories. Consider uneven spacing to maximize forage benefit.

Preventing human–bear conflict

- ❖ Maintain "attractant"-free main and fly-in camps (e.g., camps for tree planters, cruisers, engineers). Ensure adequate food storage and garbage management.

Wildlife habitat area

Goals

Protect known areas of concentrated seasonal use by Grizzly Bears.

Maintain the ecological integrity of important seasonal habitats.

Ensure the security of the bears using these habitats.

Feature

Establish WHAs for provincially significant areas, or for seasonally important habitats used by Grizzly Bears on a more local basis. Areas that are of provincial significance are those areas of known, consistently high, seasonal congregations of Grizzly Bears. Areas of seasonally important habitats may include salmon spawning areas where Grizzly Bears feed, herb-dominated avalanche tracks and run-out zones on southerly and westerly aspects, and known denning areas. On the coast, important seasonal habitats may also include estuaries, skunk cabbage swamps, and non-forested fen/marsh complexes. In the interior, seasonally important units may include herbaceous riparian meadow/wetland complexes, post-fire stands dominated by *Vaccinium* spp., subalpine parkland meadows, and *Hedysarum* and glacier lily complexes. Seasonally important habitats will be evaluated by Grizzly Bear Population Unit or subpopulation unit. In general, the subpopulation units are equivalent in size to landscape units.

In the absence of higher level plan direction, WHAs established within the provincial IWMS timber supply impact limit will only be established within threatened Grizzly Bear Population Units and Grizzly Bear Management Areas designated under the *Wildlife Act*, except for sites where there is no timber supply impact or the site is considered provincially significant (i.e., areas of known, consistently high, seasonal congregations) and recommended by the Director of the Biodiversity Branch, B.C. Ministry of Water, Land and Air Protection.

Size

WHAs will range from 1 to 500 ha but will ultimately depend on area of use, extent of seasonal habitat, and buffer size required to meet goals and objectives.

Design

When the main objective is to minimize disturbance around seasonal concentrations, consider the use of the area by Grizzly Bears and ensure the WHA includes a sufficient management zone to prevent disturbance. When the main objective of the WHA is to maintain seasonally important habitats, the WHA will be based on the extent of the seasonal habitat plus ~50 m but may vary with patch characteristics and objectives.

Use 6-class seasonal Grizzly Bear habitat capability and suitability mapping, where available, to identify seasonally important habitats (see RIC 1999). This assessment should be based on applying the Grizzly Bear densities associated with each capability class at the landscape scale (see Table 3). The result will be an estimate of the number of Grizzly Bears the area could potentially support in each season based on habitat suitability and capability. The season or seasons that would potentially support the lowest number of Grizzly Bears may be limiting or restricting the ability of the area to support Grizzly Bears. The highest suitability habitats within this limiting season(s) should then be considered priorities for protection through the establishment of WHAs depending on how restrictive the habitat "bottleneck" (i.e., limiting) may be and the habitat effectiveness of sites. Consideration should also be given to seasonal habitat effectiveness (e.g., an area may not be limited by the availability of suitable spring habitat; however, human activities disproportionately impact these habitats the area may be limited by the availability of effective spring habitat).

Otherwise use air photos, forest cover mapping, and any other appropriate sources of information combined with expert knowledge of Grizzly Bear habitat values and human impacts to qualitatively approximate the process described above.

General wildlife measures

Goals

1. Maintain ecological integrity of WHA.
2. Ensure security of Grizzly Bears within WHA by minimizing disturbance to bears within WHA.
3. Maintain Grizzly Bear forage values within WHA.
4. Minimize human-bear interactions.
5. Maintain windfirmness.

Table 3. Habitat capability and suitability classes and associated densities for Grizzly Bears*

Habitat capability or suitability class	Habitat capability or suitability range as % of provincial benchmark density	Grizzly Bear population density	
		Minimum bears/ 1000 km^2	Maximum bears/ 1000 km^2
1 – Very High	76–100	76	100
2 – High	51–75	51	75
3 – Medium	26–50	26	50
4 – Low	6–25	6	25
5 – Very Low	1–5	1	5
6 – Nil	0	0	1

* These densities are suitable to use with 1:250,000+ scale mapping; relative densities should be applied to more detailed mapping.

Measures

Access

- Do not construct roads, trails, or landings.

Harvesting and silviculture

- No forestry practices should be carried out with the exception of treatments approved by the statutory decision maker to restore or enhance degraded habitat or to ensure windfirmness.

Pesticides

- Do not use pesticides.

Range

- Plan livestock grazing to maintain forage value for Grizzly Bears and minimize the potential for conflicts.
- Do not place livestock attractants within WHA.
- Incorporate management strategies in the range use plan to reduce contact and competition between livestock and Grizzly Bears. Consider salt placement, alternate water development, drift fencing, or altering periods of livestock use.

Additional Management Considerations

Ensure that Grizzly Bears do not have access to unnatural food sources (garbage) because of the consequent mortality risk.

Development around security and foraging WHAs should be managed to prevent disruption of natural influences of above- and below-surface drainage, shade, wind, and snow movement within the WHA.

Maintain livestock health.

Do not turn livestock out onto WHAs for Grizzly Bears during calving or lambing times.

Information Needs

1. Further development and application of techniques to monitor Grizzly Bear population and habitat trends.
2. Additional research on effects of human activities on Grizzly Bear habitat use (i.e., temporal response to access management).
3. Further development of techniques for assessing the impacts of proposed developments and land uses and for setting strategic objectives for Grizzly Bear habitat conditions.

Cross References

Bull Trout, Marbled Murrelet

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Wolverine

Gulo gulo

Original[1] prepared by R.D. Weir

Species Information

Taxonomy

Wolverines (*Gulo gulo*) are members of the family Mustelidae (subfamily Mustelinae) in order Carnivora. Wolverines are currently considered one species throughout their circumpolar range (Kurten and Rausch 1959), although two subspecies are recognized: *G. gulo luscus* (North America), and *G. gulo gulo* (Eurasia). Banci (1982) determined that there were insufficient differences in cranial morphology to consider the Vancouver Island wolverine as a subspecies distinct from mainland wolverines in British Columbia. Although they are the sole members of their genus, wolverines are most closely related to members of the genus *Martes* (e.g., American Marten, Fisher; Dragoo and Honeycutt 1997).

Description

Wolverines are the largest terrestrial members of the weasel family. Wolverines are sexually dimorphic, with the body mass of males ranging from 12 to 18 kg and females ranging from 8 to 12 kg (Hash 1987). Wolverines have stout bodies ranging from 65 to 105 cm in length with moderately bushy tails 17–26 cm in length (Hash 1987). Wolverines are most easily identified by their pelage that is dark chocolate brown over most of the body with lighter-coloured hair around the forehead and along a lateral stripe extending from the ears or shoulder to the sacral region.

Distribution

Global

Wolverines are holarctic in their distribution, generally occurring between 45° and 70° latitude in North America and 50° and 70° latitude in Eurasia (Wilson 1982). Wolverines occur in the tundra, taiga plains, and boreal forests of North America, Europe, and Russia, and in many of the montane habitats of the western Cordillera of North America.

British Columbia

Wolverines are widely distributed, albeit at low densities, throughout much of British Columbia. Wolverine populations do not occur on the Queen Charlotte Islands and may be extirpated from Vancouver Island, the lower Fraser Valley, the Okanagan Basin, and the Thompson Basin.

Forest region and districts

Wolverines likely occur in portions of each forest region, except for the Queen Charlotte Islands, South Island forest districts, and possibly other districts on Vancouver Island (e.g., North Island and Campbell River).

Ecoprovinces and ecosections

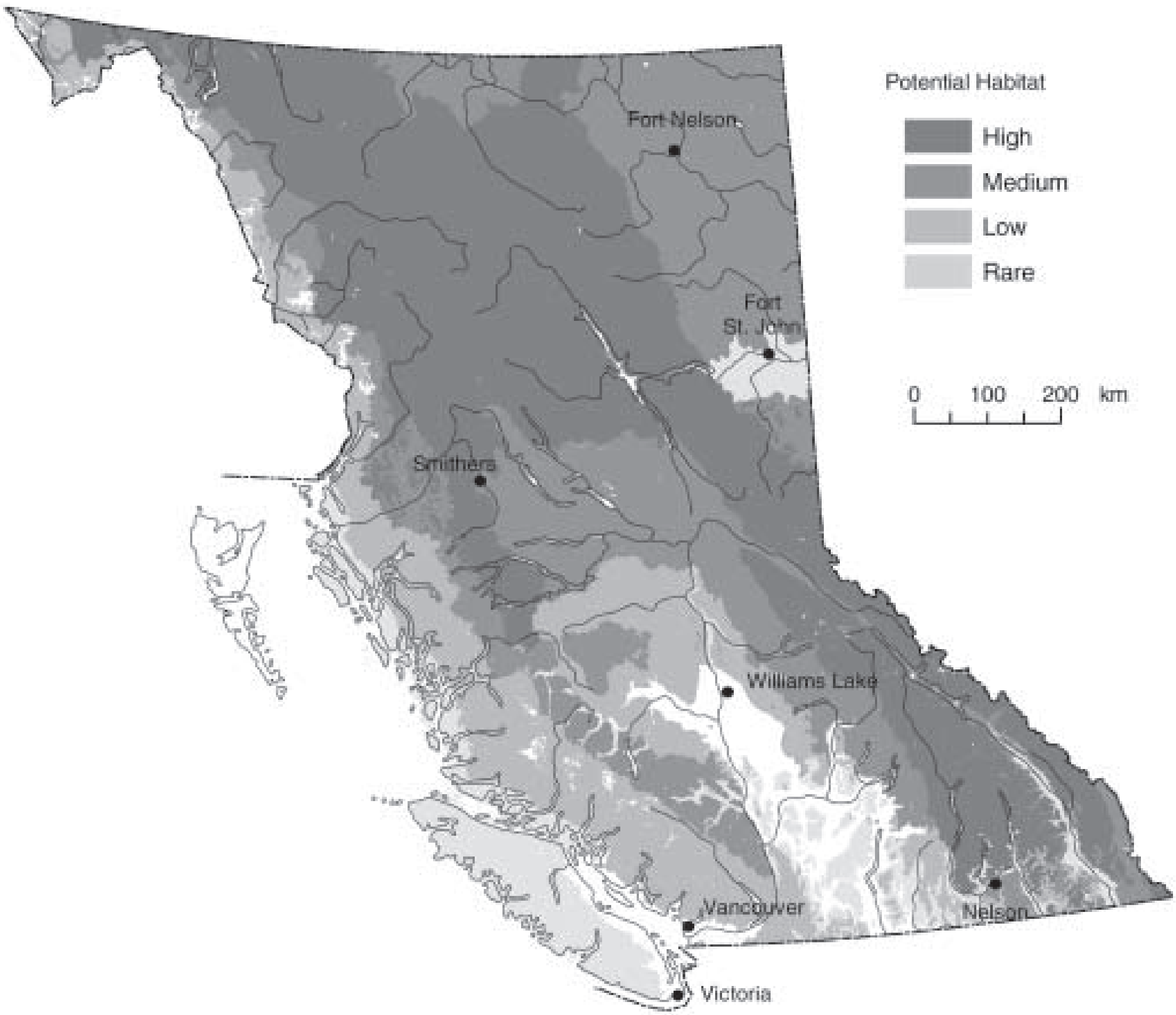
Wolverines occur in all terrestrial ecoprovinces, except for the Georgia Depression Ecoprovince.

Biogeoclimatic units

Wolverines can occur in all biogeoclimatic zones, except for BGxh, BGxw, CDFmm, CWHwh, IDFxh, IDFxm, IDFxw (and all grassland phases in the IDF), PPdh, and PPxh subzones.

1 Draft account for Volume 1 prepared by E. Lofroth.

Wolverine
(Gulo gulo)



Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on several ecosystem classifications (Ecoregion, Biogeoclimatic and Broad Ecosystem Inventory) as well as current knowledge of the species' habitat preferences. This species may or may not occur in all areas indicated.

Biogeoclimatic zones and subzones with the capability to support wolverines

AT: p
BWBS: dk, mw, unr, vk, wk
CWH: dm, ds, mm, ms, unc, vh, vm, wm, ws, xm
ESSF: dc, dcp, dk, dkp, dv, dvp, mc, mk, mm, mv, mw,,mwp, ung, vc, vcp, wc, wcp, wk, wm, wv, xc, xcp, xv
ICH: dk, dw, mc, mk, mm, mw, vc, vk, wc, wk, xw
IDF: dk, dm, dw, mw, unk, unn, unv, ww
MH: mm, unr, wh
MS: dc, dk, dm, dv, unk, unv, xk, xv
PP: dh
SBPS: dc, mc, mk, xc
SBS: dh, dk, dw, mc, mh, mk, mm, mw, unk, unr, vk, wk
SWB: dk, mk, unr, vk

Note that wolverines may not currently occur in each of the subzones listed.

Broad ecosystem units

Wolverines likely use a wide variety of broad ecosystem units (BEUs). The following BEUs may be used by wolverines; however, the intensity and frequency of use is likely highly variable and linked to the ability of the habitat to support specific food sources (e.g., moose, caribou, hoary marmots). Each unit has been assigned a rank to denote its relative importance to wolverine ecology (1 = high, 2 = medium, 3 = low, 4 = very low) (Lofroth 2001, J.A. Krebs, pers. comm.). There is very limited data for the coastal habitats.

Elevation

Wolverines range from valley bottoms to alpine meadows. The upper limit of their elevational range is likely limited by the distribution of prey at higher altitudes (J.A. Krebs, pers. comm.). In areas with mountainous terrain, there appears to be some segregation in use of different elevations among sex and age classes (Whitman et al. 1986, Lofroth 2001); adult females typically occur at higher elevations than other sex and age classes, followed by subadult females, then adult males (Lofroth 2001). Subadult males typically occur at the lowest elevations.

Unit	Likely Importance	Unit	Likely Importance
AD	4	LP	2?
AG	1	ME	4
AH	1	MF	3
AM	1	MR	4
AN	3	MS	3
AS	2	PB	4
AT	1	PR	1
AV	1	RB	3
BA	2	RD	3
BB	4	RR	1
BG	4	RS	3
BK	2	SA	2
BL	3	SB	3
BP	3	SC	3
CG	3	SD	3
CH	3	SF	2
CP	4	SG	2
CR	1	SH	3
CS	2	SK	2
CW	3	SL	3
DF	4	SM	1
DL	4	SR	2
EF	2?	SU	2
ER	1	SW	2
ES	3	TA	1
EW	2?	TB	2?
FB	3	TF	4?
FE	4	WB	2
FP	1	WG	4
FR	3	WL	3
HB	3	WM	3
HL	4	WP	2
HP	2	WR	1
HS	3	YB	4
IG	2	YM	3
IH	2	YS	4?
IS	2?		

Life History

Diet and foraging behaviour

Wolverines consume a variety of food items, but large ungulates (e.g., moose [*Alces alces*], elk [*Cervus elaphus*], caribou [*Rangifer tarandus*], deer [*Odocoileus* spp.], and mountain goats [*Oreamnos americanus*]), primarily obtained as carrion, form a large component of their diet (Hash 1987). Wolverines are also reported to eat snowshoe hares (*Lepus americanus*), porcupines (*Erethizon dorsatum*), sciurids (including marmots), mice and voles, birds, fish, and vegetation (Banci 1994).

Composition of the diet appears to vary seasonally and with the sex of the individual. In the Omineca region, moose are consumed throughout the year by all age and sex classes (Lofroth 2001). However, during summer, adult females with kits included hoary marmots (*Marmota caligata*) as a substantial portion of their diet. Banci (1987) speculated that small mammals become more important as a prey item as the availability of large ungulate carrion diminishes.

The reliance upon particular species for food likely varies regionally with availability of the species. In the Omineca region, wolverines consume moose throughout the year (Lofroth 2001). In the north Columbia Mountains, wolverines consume caribou, mountain goats, and moose most frequently (J.A. Krebs, pers. comm.). In areas with anadromous salmon runs, fish may be an important supply of food for wolverines (Banci 1987).

Female wolverines are faced with an energy bottleneck while using natal and maternal dens. Their dens appear to have specific structural requirements (see "Habitat," below), but they must also be relatively close to a reliable source of food. In both the Omineca region and northern Columbia Mountains, female wolverines situate their natal and maternal dens in areas bordering the ESSF/ESSFp ecotone in early April. The timing of this process concurs with the movement of caribou to high-elevation areas in late winter. The prevalence of caribou remains in scats collected at natal dens suggests that female wolverines rely heavily upon caribou as a predictable food source during this period (Lofroth 2001). Krebs and Lewis (2000) speculated that kit production and survival might be strongly linked to carrion supply.

Researchers have long assumed that wolverines primarily scavenge for food. Wolverines are well-known for their ability to detect animal remains buried under several feet of snow and are also reported to cache food that they have scavenged and revisit these sites later in the year (Hash 1987). It is speculated that wolverines obtain about 60% of their food intake through carrion (E. Lofroth, pers. comm.). However, in the Omineca region and Columbia Mountains, researchers have observed wolverines attacking and killing caribou (Lofroth 2001). In the rugged and snowy northern Columbia Mountains, wolverines appear to rely heavily upon avalanche-killed ungulates (e.g., caribou, mountain goats, moose) during winter and may be less reliant on wolf predation as a source of carrion than in other areas (J.A. Krebs, pers. comm.). Wolverines appear to actively hunt smaller prey during non-winter periods and rely less upon carrion (E. Lofroth, J.A. Krebs, pers. comm.).

Wolverines search widely for food. Daily movements for wolverines can be up to 65 km (Wilson 1982). Female wolverines regularly move 20 km a day even while maintaining a natal den (E. Lofroth, pers. comm.). It is unknown if they use any specific habitats preferentially for foraging, although the activity rates of wolverines within late successional and riparian forest indicate that this may be a heavily used habitat while foraging or searching for prey or carrion (Lofroth 2001).

Reproduction

Wolverines breed between late April and early September but embryos do not implant until January. Sometime between late February and mid-April, females give birth to between one and five cubs. They nurse for 8–9 weeks after which they leave the den but stay with mother for their first winter learning to hunt. Young disperse in spring. Natal dens are often underground.

Site fidelity

Wolverines are not widely reported to exhibit strong site fidelity, except for females with natal or maternal dens. While rearing kits, females will use a natal den for approximately 20–60 days and between one and four maternal dens for 5–20 days each (Magoun and Copeland 1998; Lofroth 2001). These dens are not likely reused between years.

Home range

Only adult wolverines maintain distinct home ranges. Wolverines have mildly intrasexually exclusive home ranges, where males will overlap with one or more females and other males, but females will not overlap their home ranges with other females (Krebs and Lewis 2000). Male home ranges are typically three times the size of those of females (Omineca, males: 1366 km^2, females: 405 km^2 [Lofroth 2001]; northern Columbia Mountains, males: 1005 km^2, females: 311 km^2 [Krebs and Lewis 2000]). Home ranges are maintained between years.

Movements and dispersal

Daily movements of wolverines are likely mediated most strongly by the availability and distribution of food throughout the year, although wolverines do spend substantial time moving through mature and old forest structural stages (E. Lofroth, pers. comm.). Wolverines in the northern Columbia Mountains seem to prefer moving about the landscape by following watercourses and using low elevation passes between valleys (J.A. Krebs, pers. comm.).

However, human-caused features can have a substantial effect on the ability of wolverines to move successfully throughout the landscape. Human activity (e.g., log hauling, logging, mining) may displace or alter movement paths of wolverines in highly modified landscapes (Lofroth 2001) and wolverines will often avoid entering young (<25 years) cutblocks while travelling (J.A. Krebs, pers. comm.). Transportation corridors can interrupt or alter daily movements (Austin et al. 2000) and can be a source of mortality within the population (Krebs and Lewis 2000). Man-made reservoirs may alter the dispersal routes of wolverines in the landscape (E. Lofroth, J.A. Krebs, pers. comm.). Kyle and Strobeck (2001) speculated that habitat loss, overharvest, major transportation corridors, and other anthropogenic factors limit successful dispersal among metapopulations. The viability of populations of wolverines in southern portions of the range may depend upon large areas of undisturbed habitat with corridors connecting them.

Subadult female wolverines typically disperse short distances away from their natal home ranges and males disperse 30–100 km (Magoun 1985), although dispersals of up to 378 km have been documented (Gardner et al. 1986). Subadult wolverines are slightly nomadic and travel widely prior to establishment of a permanent home range. Movements by subadults are characterized by periods of concentrated use of a relatively small area, interspersed by large-scale movements (Lofroth 2001). Subadults typically establish a home range by the time they reach 24 months. Habitat composition likely plays a relatively small role in dispersal; however, extensively clearcut watersheds would likely be avoided while transient (J.A. Krebs, pers. comm.).

Habitat

Structural stage

Wolverines, being dependent upon a variety of different food items throughout the year, use a wide assortment of structural stages in their day-to-day life, although mature and old forest structural stages are used predominately. In the Omineca region of north-central British Columbia, Lofroth (2001) reported that at least 50% of the locations of radio-tagged wolverines were in late successional stands (structural stages 6 and 7) and wolverines had relatively little use of mid-successional stands (stages 3 and 4). He also noted that the use of structural stages by wolverines varied among sexes and seasons; females tended to use both early-successional (stages 1 and 2) and late-successional stands (stages 6 and 7), while males used mostly late-successional stands. Most of the use of early-successional stands by females occurs in the use of high elevation habitats during the rearing season, when they are provisioning for young. In the northern Columbia

Mountains, wolverines tend to use late-successional stands (stages 6 and 7) most frequently when they are not using alpine habitats. Wolverines in this area may use late-successional forests because they confer some thermal and security cover benefits (J.A. Krebs, pers. comm.). To date, neither of these studies has completed their respective habitat selectivity analyses, so these results are preliminary estimates of use, not selectivity.

At a landscape spatial scale, wolverines tend to have some broad patterns of use. In mountainous areas of British Columbia, females tend to use ESSF biogeoclimatic zones during winter and AT zones during the summer. Males, on the other hand, tend to use lower elevation zones during winter and switch to ESSF zones during the summer (Krebs and Lewis 2000, Lofroth 2001). Wolverine populations tend to occur in areas where a diversity of abundant seasonal food is available within home ranges, which is often related to elevational diversity.

Important habitats and habitat features

"Habitat" for wolverines is not easily delineated as a set of vegetative parameters, such as those that are typically used to identify and classify terrestrial ecosystems, but is likely defined by the distribution and abundance of food, including carrion as well as suitable habitat/structures for denning and rendezvous points (i.e., sheltered places where kits are left during foraging periods). Most studies of wolverine habitat use show little, if any, selection for habitat at the stand scale (e.g., Whitman et al. 1986; Banci and Harestad 1990). This is likely because wolverines are not small-scale habitat specialists but rather require a suite of habitat variables that occur at larger spatial scales (e.g., landscapes, regions).

Thus, wolverines do not have easily defined habitats or small-scale habitat features for which they select. For lactating females and their young, an arrangement of habitats that provide a suitable supply of large ungulate carrion during the late winter in close juxtaposition to an area that supplies adequate food during summer (e.g., marmots) and suitable shelter is important (Krebs and Lewis 2000).

Natal and maternal dens are probably the only small-scale structures for which wolverines exhibit selection. Female wolverines typically situate dens in snow tunnels leading to masses of fallen trees (accumulations of classes 1–3 coarse woody debris [CWD]) or rocky colluvium (Magoun and Copeland 1998; Krebs and Lewis 2000; Lofroth 2001). The CWD associated with natal and maternal dens is likely formed through a variety of processes, such as windfall, avalanches, and insect-induced mortality. Natal and maternal dens are generally associated with small-scale forest openings (e.g., <100 m across) at high-elevations (i.e., ESSF/ESSFp ecotone; Krebs and Lewis 2000; Lofroth 2001). The composition and placement of dens within the landscape is important because these structures provide security for kits (i.e., snow cover) with proximity to food resources (i.e., late-winter carrion or prey).

Conservation and Management

Status

The Vancouver Island Wolverine is on the provincial *Red List* in British Columbia; whereas the mainland subspecies is on the provincial *Blue List*. The eastern Canadian population in the Ungava Peninsula and Labrador is designated *Endangered* (COSEWIC 2002). The western Canadian (YT, NT, NU, BC, AB, SK, MB, ON) population of wolverines is considered to be of *Special Concern* (COSEWIC 2002). Wolverine populations in Eurasia are believed to be at a low density, but stable (Hash 1987).

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

Population	BC	ID	MT	Canada	Global
Vancouver Island	S1	–	–	N1	G4T1Q
Mainland BC	S3	S2	S2	N4	G4T4

Trends

Population trends

Very little is known about the size of the population of wolverines in British Columbia and no current estimate of the population size exists for the province. However, a specific density estimate was produced for 1996 and 1997 in the northern Columbia Mountains, where researchers estimated the density of wolverines at approximately 25 wolverines in the 4000 km^2 study area, or 1 wolverine/160 km^2 (Krebs and Lewis 2000). This estimate is not substantially different than the estimate produced for the south-western Yukon of 1 wolverine/177 km^2 (Banci and Harestad 1990). It is not known how applicable these estimates are to other areas in the province.

The relative ability of a population to remain stable or increase is largely dependent upon the survivorship of individuals within it. In a review of population vital rates of wolverines in western North America from 11 research studies, Krebs et al. (2000) determined that survivorship rates of wolverines varied depending upon whether the population was from tundra, boreal, or temperate regions and if the population was exposed to trapping. The highest survivorship rates were among the tundra-untrapped populations, while the lowest were among the temperate-trapped populations. They also concluded that human-caused mortality (e.g., trapping) is additive, not compensatory. Using this as a framework, wolverine populations are probably healthiest in the northern, inaccessible mountain regions of the province. Populations in the southern half of the province that are exposed to human development and trapping pressure likely have poorer survivorship and are thus more tenuous. Kyle and Strobeck (2001) speculated that the high degree of genetic isolation among the wolverines in the northern Columbia Mountains was due to a lack of connectivity between subpopulations and indicated an isolated population that may be more susceptible to stochastic events.

Habitat trends

The suitability of habitat in much of the range of the wolverine has declined over the past 30 years. Conversion of large, contiguous tracts of mature and old forests have likely affected the diversity and abundance of prey and carrion available to wolverines and likely affected the permeability of the landscape for dispersal. Development of previously inaccessible watersheds has introduced trapping mortality and transport-related (i.e., roads, rail) mortality into previously unharvested populations. Logging of high elevation forests may also influence the availability or success of natal and maternal dens.

Threats

Population threats

As noted by Banci and Proulx (1999), wolverine populations have low resiliency to population perturbation (e.g., fur trapping) because of their low densities, large home range sizes, and relatively low reproductive rate. Wolverine populations are believed to sustain a harvest rate of 6% of the population per year (Krebs et al. 2000). Recent analysis of wolverine survivorship has suggested that trapping mortality is additive, not compensatory (Krebs et al. 2000). Historic overharvest of wolverines has certainly contributed to their North American decline. A changing prey base, mediated by habitat and population manipulations by humans, may have also been a source of population decrease over the past 100 years. The primary population threat is the additive mortality resulting from fur harvesting. The increased access provided by forest development greatly enhances the ability of trappers to harvest wolverines in previously inaccessible areas.

Wolverines may also be very sensitive to disturbance particularly disturbance from roads and recreational activities (e.g., heli-skiing, snowmobiling).

Habitat threats

As stated by Banci (1994), the cumulative impacts of trapping, habitat alterations, forest harvesting, and forest access on wolverine populations are not well understood. Although wolverines are not widely reported to be a habitat specialist, habitat loss and alienation are commonly thought to be a major contributing factor to population declines (Banci 1994). The major habitat threat is the large-scale conversion of mature and old forest structural stages into early structural stage habitats. Logging of high elevation forests may also affect rearing success.

Legal Protection and Habitat Conservation

Under the provincial *Wildlife Act,* wolverines are protected from killing, wounding, and taking, and legal harvest for their pelts is regulated. Intentional harvest of wolverines is not permitted in regions 1, 2, and 8. Open trapping seasons on wolverines occur in regions 3, 4, 5, 6, and 7. There is no quota for harvests of wolverines in these regions but trappers must report the capture of wolverines within 15 days following the end of the trapping season. As recorded in the Fur Harvest Database, an average of 168 wolverines were harvested annually over the past decade (Lofroth 2001). Unreported harvests and discrepancies in the harvest reporting system suggest that the actual harvest of wolverines in British Columbia may be different (I. Adams, pers. comm.). Wolverines are also considered "small game" and may be hunted in regions 4, 6, and 7. The annual bag limit for these regions is one wolverine.

Areas protected from timber harvest and trapping are likely an important component of conservation of wolverines in British Columbia (Hatler 1989). Because of large space requirements, low density, and low resiliency to trapping, these refugia are likely critical to the persistence of wolverines in many landscape units. Several parks likely include suitable habitat for wolverines (e.g., Glacier National Park); however, wolverines have very large home ranges and most parks in British Columbia are not large enough to encompass the home range of a wolverine.

Several provisions of the results based code should maintain small-scale habitats for wolverines including recommendations for landscape unit planning and riparian management. Wildlife habitat features may also be used to manage den sites. However, because wolverines occur at low densities and cover large areas, maintaining wolverine habitat will also need to be implemented through higher level plans.

Identified Wildlife Provisions

Effective management of wolverine habitat needs to occur at the landscape spatial scale. Maintaining refugia (i.e., areas with limited resource and recreational activities and trapping), seasonal foraging areas, secure denning sites, adequate movement corridors, and limiting mortality within populations need to be implemented for successful conservation of the species. These issues can best be addressed by incorporating the connectivity of habitats, creation of refugia, and the arrangement and timing of forest development in strategic level plans.

Sustainable resource management and planning recommendations

- ❖ Refugia are probably the single most important landscape planning mechanism for the conservation of wolverine populations in British Columbia. Refugia should be designed using suitable portions of watersheds in juxtaposition with protected areas and no trapping areas that are determined in consulation with the Fish, Wildlife and Allocation Branch of the Ministry of Water, Land and Air Protection, and as part of a recovery planning process.
- ❖ Plan forest development to occur on one side of a watershed at a time where practicable. Limiting concurrent development will concentrate the activity at any one time and allow wolverines to avoid operational areas as much as possible during their daily movements. This will reduce the mortality risk (e.g., road kill, trapping) and displacement associated with forest development and will help facilitate normal movement throughout the landscape.
- ❖ Minimize road access (i.e., number of km and length of time active). The increase in access associated with forest development into previously pristine areas (especially large drainages) exposes resident wolverines to a much higher mortality risk from hunting, poaching, and road traffic. Careful road planning and deactivation should be considered.

- ❖ Maintain seasonal foraging areas. Seasonal foraging areas can be maintained through the appropriate juxtaposition of structural stages throughout a watershed. Adequate foraging habitat for wolverines is likely closely linked to the suitability of habitats to support their primary food sources (ungulates, snowshoe hares, porcupines, marmots). Maintaining these habitats near adequate thermal and security cover (generally mature and old forest structural stages) will be important to securing seasonal foraging areas for wolverines. In mountainous regions, this will entail planning for seasonal prey across several biogeoclimatic zones (e.g., ICH, ESSF, AT).
- ❖ Maintain suitable denning sites. Suitable sites are secure and undisturbed, and have the appropriate structure (see "Important habitats and habitat features" above). These need to be close to reliable food sources (carrion from late winter avalanches, prey) and are likely best supplied in the ecotone of the ESSF/ESSFp/ATp.
- ❖ Minimize disturbance at suitable denning sites. Logging should not occur near identified avalanche chutes or late-winter areas for caribou. Forestry operations should not occur in these areas between March and June when females are more sensitive to human disturbance. In areas without a diversity of elevations (and resulting BEC zones), additional factors will need to be taken into consideration to ensure the provision of secure den sites for wolverines. In relatively flat areas, such as the Fraser Plateau, denning wolverines may be more vulnerable to the effects of habitat alterations because their dens are more likely to occur in harvestable areas.
- ❖ Retain suitable movement and dispersal corridors. Habitat connectivity within and between watersheds is very important for successful daily movements, foraging, and dispersal of wolverines. Connectivity of valley bottom habitats is important, specifically along watercourses. These corridors should be dominated by older forests (stage 6 or 7) and it is important to connect, not only the valley bottom habitats, but also provide movement corridors between the valley bottom and patches of ESSF/AT habitats. Large connectivity corridors should be maintained between refugia where human disturbance is prevalent. These should also be dominated by older forests (stages 5–7).

Additional Management Considertaions

Minimize disturbance from recreational activities (e.g., heli-skiing, snowmobiling) near maternal dens.

Information Needs

1. Ecology in non-mountainous landscapes.
2. Dispersal through fragmented landscapes.
3. Reproductive rates.

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Bighorn Sheep

Ovis canadensis

Original[1] prepared by R.A. Demarchi

Species Information

Taxonomy

Until recently, three species of Bighorn Sheep were recognized in North America: California Bighorn Sheep (*Ovis canadensis californiana*), Rocky Mountain Bighorn Sheep (*O. canadensis canadensis*), and Desert Bighorn Sheep (*O. canadensis nelsoni*). As a result of morphometric measurements, and protein and mtDNA analysis, Ramey (1995, 1999) recommended that only Desert Bighorn Sheep and the Sierra Nevada population of California Bighorn Sheep be recognized as separate subspecies. Currently, California and Rocky Mountain Bighorn sheep are managed as separate ecotypes in British Columbia.

Description

California Bighorn Sheep are slightly smaller than mature Rocky Mountain Bighorn Sheep (McTaggart-Cowan and Guiguet 1965). Like their Rocky Mountain counterpart, California Bighorn Sheep have a dark to medium rich brown head, neck, and dorsal body with a short black tail and a white muzzle, rump, and ventral patches. Both sexes have sturdy muscular bodies and strong necks that support horns that curve back in females and are much larger and curled around in males. The most consistent anatomical feature distinguishing the California ecotype from the Rocky Mountain ecotype is the presence of a continuous black or brown dorsal stripe dividing the white rump patch to the to the tip of the tail (Toweill 1999).

Distribution

Global

The genus *Ovis* is present in west-central Asia, Siberia, and North America (and widely introduced in Europe). Approximately 38 000 Rocky Mountain Bighorn Sheep (Wishart 1999) are distributed in scattered patches along the Rocky Mountains of North America from west of Grand Cache, Alberta, to northern New Mexico. They are more abundant and continuously distributed in the rainshadow of the eastern slopes of the Continental Divide throughout their range.

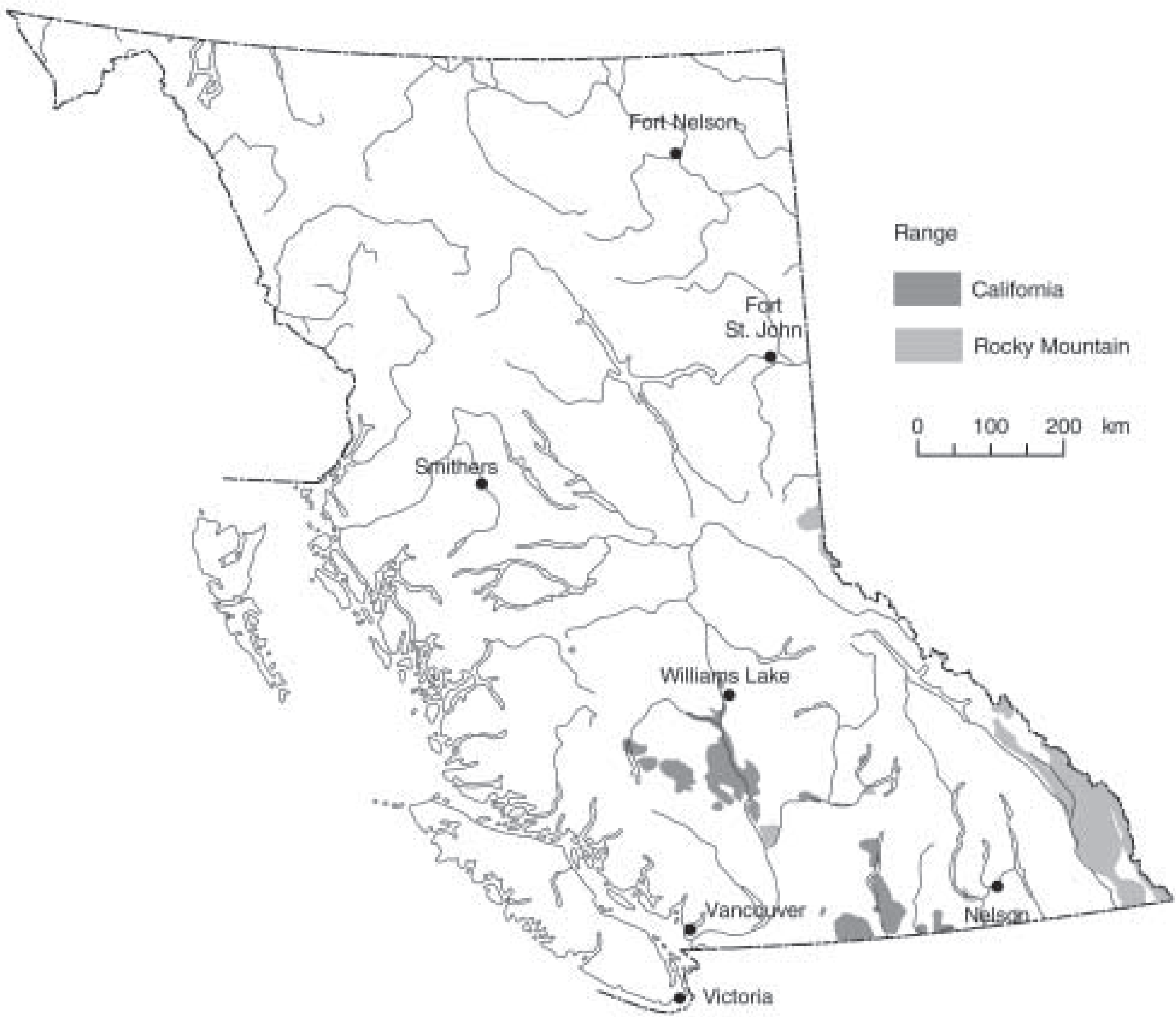
California Bighorn Sheep were extirpated from most of the United States by epizootic disease contracted from domestic sheep in the 1800s with a small number living in California until 1954 (Buechner 1960). Since 1954, Bighorn Sheep have been reintroduced from British Columbia to California, Idaho, Nevada, North Dakota, Oregon, Utah, and Washington, resulting in their re-establishment in much of their historic range. By 1998, California Bighorn Sheep were estimated to number 10 000 (Toweill 1999).

British Columbia

British Columbia's major native Rocky Mountain Bighorn Sheep population is distributed in herds in the Rocky Mountains of the East Kootenay region of southeastern British Columbia between the Kicking Horse River in the north and the U.S. border in the south, including one small herd that ranges into Montana east of Eureka during the summer months. British Columbia's population is connected at both extremes and at scattered locations along its range with sheep herds in Alberta. Separate herds winter in

1 Volume 1 account prepared by D. Spaulding.

Bighorn Sheep
(Ovis canadensis)



Note: The map is based on current knowledge of the species' distribution. This species may or may not occur in all areas indicated.

either province, with several small herds wintering on or immediately adjacent to the summit of the continental divide (Kakwa, Simpson River, Ewin Ridge, Sheep Mountain, Deadman Pass, and Crowsnest Pass herds). There are introduced herds of Rocky Mountain Bighorn Sheep in the Spences Bridge, Squilax, and Castlegar areas. There is a herd near Salmo as a result of a natural expansion by a transplanted herd from the Hall Mountain area of northeast Washington.

California Bighorn Sheep in British Columbia have undergone a considerable reduction in distribution and abundance since primitive times (Buechner 1960; Sugden 1961). Originally, California Bighorn Sheep were in the arid grasslands of the valleys of the Fraser, Thompson, Nicola, Lower Bonaparte, Okanagan, Ashnola and Similkameen Rivers, along the higher valleys west of the Fraser River, Bridge River, Seton Lake, Anderson Lake, Taseko Lake, Chilko Lake, Tatlayoko Lake, and Mosley Creek (Sugden 1961). California Bighorn Sheep probably disappeared in the Thompson, Nicola, and lower Bonaparte before Euro-Asian contact (Sugden 1961). Significant reductions in populations have since occurred in the Similkameen (i.e., Ashnola) and Okanagan areas.

California Bighorn Sheep were successfully reintroduced to the Thompson River watershed above Kamloops Lake in the 1960s, and to the Kettle-Granby watershed in the 1980s. Today, British Columbia's native California Bighorn Sheep population is distributed in herds in the Okanagan-Similkameen, Thompson, Fraser, and Kettle-Granby river watersheds. These populations are not continuously connected as they are fragmented into herds that have limited interchange and are considered separate metapopulations (Demarchi et al. 2000).

Ecoprovinces and ecosections

California ecotype

CEI: CAB, CCR, CHP, FRB, WCU
SOI: OKR, NOB, NOH, NTU, PAR, SCR, SOB, SOH, STU, THB

Rocky Mountain ecotype

SBI: HAF, NHR, SHR
SIM: COC, CPK, EKT, FRR, NPK, SCM, SFH, SPK
SOI: NTU, PAR, THB

Biogeoclimatic units

California ecotype

AT: p, un
BG: xh1, xh2, xh3, xw1, xw2
ESSF: dv, dvp, xc, xcp, xv
IDF: dk1, dk2, dk3, dk4, dm1, mw2, xh1, xh2, xm, xw
MS: dc1, dc2, dm1, dm2, xk, xv
PP: dh1, xh1, xh2
SBS: mh

Rocky Mountain ecotype

AT: p, un
BG: xh2, xw1
ESSF: dk, dkp, mm2, mv2, wc1, wc3, wc4, wm, xc, xcp
ICH: dw, mk1, mw2
IDF: dk1, dk2, dm2, un, xh2
MS: dk, xk
PP: dh2, xh2
SBS: dh

Forest region and districts

	Forest districts	
Forest region	**California ecotype**	**Rocky Mountain ecotype**
Southern Interior:	100 Mile House, Arrow Boundary, Cascades, Central Cariboo, Chilcotin, Kamloops, Okanagan Shuswap	Arrow Boundary, Cascades, Columbia, Headwaters, Kamloops, Kootenay Lake, Okanagan Shuswap, Rocky Mountain,
Northern Interior:		Prince George, Peace

Broad ecosystem units

AC, AB, AG, AM, AU, BS, DF, DL, DP, EF, FP, LP, MS, OV, PP, RO, SD, SG, SM, SS, TA

Elevation

The California ecotype generally occurs between 300 to 2800 m; whereas the Rocky Mountain ecotype generally occurs between 500 and 3000 m but does occur as low as 175 m at Spences Bridge where they were introduced.

Life History

Diet and foraging behaviour

Valdez and Krausman (1999) present a comprehensive review of the diets of both California and Rocky Mountain Bighorn Sheep. They state that in any given habitat, the percentages of graminoids, forbs, and shrubs in the diet of Bighorn Sheep may vary. Generally, the winter diet of Bighorn Sheep consists of mainly graminoids with lesser consumption of forbs, shrubs, and some conifers. Summer range is often alpine areas with grasses, sedges (*Carex* spp.), and a diversity of forbs used as forage. Grasslands and seral shrublands in the East Kootenay Trench Ecosection provide forage mainly from bunchgrasses such as wheatgrass (*Agropyron* spp.), fescues (*Festuca* spp.), bluegrass (*Poa* spp.), and needle grasses (*Stipa* spp.), and various forbs and shrubs (Davidson 1991).

In the Elk Valley, the diet pattern reflected the phenological plant development from spring to mid-summer. Sheep forced by deep snow to stay on high-elevation winter ranges until early summer consumed proportionately more graminoids (59%) than sheep from grasslands in the mid-elevation Montane Spruce biogeoclimatic zone (28%) (TAESCO 1982). Forbs (57%) and shrubs (14%) dominated the diet of the latter. In comparison, during spring and summer the alpine-wintering sheep used fewer shrubs (3%) but also heavily utilized forbs (36%). Conifers constituted a low percentage of the diet for both although more conifers were used in spring and summer by the alpine-wintering sheep.

In a study near Penticton, the California Bighorn Sheep studied utilized 14 grass species, 47 forbs, and 18 woody species (Wikeem and Pitt 1992). Bunchgrasses such as bluebunch wheatgrass (*Pseudoroegneria spicata*), junegrass (*Koeleria* spp.), and fescues, bluegrass, needle grasses, and various forbs and shrubs were eaten (Blood 1967; Demarchi 1968; Wikeem 1984; Wikeem and Pitt 1992). Scree slopes and cliffs are generally vegetated with shrubs that can be important to foraging such as gooseberry (*Ribes* spp.), cinquefoil (*Potentilla* spp.), sagebrush (*Artemesia* spp.), rose (*Rosa* spp.), maple (*Acer* spp.), saskatoon (*Amelanchier alnifolia*), kinnikinnick (*Arctostaphylos uva-ursi*), juniper (*Juniperus* spp.), and blueberry (*Vaccinium* spp.).

Reproduction

As with most northern ungulates, the rut is timed to optimise the availability of abundant nutritious forage at parturition (Bunnell 1982; Hebert 1973; Thompson and Turner 1982). Typically, in British Columbia rutting occurs from early November to early December with parturition occurring around 175 days after conception beginning in early June, peaking in mid-June, and ending the first week of July (Demarchi 1982; Shackleton 1999). Bighorn Sheep herds that live at high elevation all year appear to rut 1–2 weeks later.

Introduced Bighorn Sheep have the potential to double their numbers in approximately 3 years (Wishart et al. 1998). Pregnancy rates have been shown to be over 90% of adult females and bearing one young per year (Haas 1989; Jorgenson 1992). Fecundity and survival favour rapid population growth at low population density and conservative population strategies at densities approaching carrying capacity (Ricklefs 1982 in Wishart 1999). In addition, the California Bighorn Sheep ecotype occasionally produces twins thereby adding to potential productivity (Blood 1961; Spalding 1966)

Site fidelity

Generally, female Bighorn Sheep show fidelity to home range (Geist 1971; Festa-Bianchet 1986; Stevens and Goodson 1993). Both sexes have a strong home range fidelity to a particular mountain, but generally, ewes return rate to a specific range is higher than males. Geist (1971) found that ewes returned to the same range 90% of the time while rams returned 75% of the time.

Home range

Bighorn Sheep are gregarious but live in sexually segregated groups (Geist 1971). Male Bighorn Sheep use as few as two and as many as six separate home ranges during a year. The ranges of major ram bands can include pre-rut, rutting, mid-winter, later-winter/spring, and summer ranges (Geist 1971). Some Rocky Mountain Bighorn Sheep winter and summer at high elevation but on separate mountains, such as all of the Elk Valley herds. The herds in the East Kootenay Trench, however, winter at low elevation and summer at high elevation. Generally, ewes use two to three seasonal ranges (Wishart 1978; Geist 1971; Shackleton 1973; Festa-Bianchet 1986) but Bighorn ewes can use as many as four ranges including winter, spring, lambing, and summer ranges (Geist 1971; Festa-Bianchet 1986).

Home ranges are usually part of a mountain, or a whole mountain. Of the four ungulate species studied on Premier Ridge in the East Kootenay, Bighorn Sheep were the most localized and specific in their response to environmental factors such as slope and rockiness (escape terrain) and they tended to use small, rather specific areas (Hudson et al. 1975). Home ranges can be as small as 0.8 km^2 in mid-winter or as large as 5.9 km^2 in spring and fall (Geist 1971). The high elevation winter range for the Ewin herd of approximately 150 sheep was 1.4–2 km^2 (TASECO 1982). This means that 0.47–0.50 ha would be required to support one ewe based on grazing capacity (average forage requirement of 30 kg/sheep and a grazing time of 5 months). Kopec (1982) found home ranges averaged 541 ha for ewes and 798 ha for rams in Montana. Ewes' home ranges were the smallest during lambing (47 ha) and largest during the fall, 273 ha. The rams' smallest range was in winter range (averaging 21 ha) and the largest during the spring range (averaging 305 ha). The size of lambing areas ranged from 3 to 150 ha in Idaho (Akenson and Akenson 1992). In Montana, Semmens (1996) estimated home range size for lamb-ewe groups from 6.4 to 32.9 km^2 using radio-telemetry data from three subpopulations.

Movements and dispersal

Seasonal home ranges may vary considerably between Bighorn Sheep herds, not only in size, but also in the distance to other seasonal home ranges. The separation of one seasonal range from another can be one steep gorge or it can be distances of 10–70 or more kilometres between summer and winter ranges for California Bighorn (Blood 1961; VanSpall and Dielman 1997) and 24 to >51 km for Rocky Mountain Bighorn. Ewes in central Idaho migrated 1–40 km from winter ranges to lambing ranges (Akenson and Akenson 1992). Unlike Rocky Mountain Bighorn Sheep observed by Geist (1971), the radio-collared California Bighorn Sheep studied in the Churn Creek watershed (Fraser River meta-population) did not demonstrate a difference between sexes in the timing of either spring or fall migrations. Ewes and rams migrated concurrently between the summer and the rutting/wintering areas, spending approximately 8 months on the winter range (Keystone Wildlife Research 1998). However, high water flows did delay spring migrations of ewes accompanied by lambs.

In late September or early October, large bands of rams move to a fall concentration area where they generally stay from 2 to 5 weeks. From this pre-rut range in the first week of October or the first week in November, they disperse to rutting grounds until the end of December (Geist 1971; TAESCO 1982). At this time some rams will return to pre-rut home range while others move to mid-winter home ranges where they spend 271–303 days (Geist 1971). Some young rams and the ewes will remain at the rutting grounds. By mid-March, rams return to fall concentration areas. In summer, the rams move to salt licks for a few weeks and then to summer range.

Ewes arrive later on the wintering areas and depart earlier, spending 240–268 days on wintering areas (Geist 1971). The fall concentration area or areas immediately adjacent will usually be where the ewes remain in the winter. In late March or April, separate winter/spring range may be used once the snow hardens or is reduced enough to allow movement. Females move to lambing areas in late May or June or, infrequently, at the beginning of July. Pregnant ewes were found to move from higher quality forage to an area of lower quality to provide better protection from predation (Festa-Bianchet 1988). Lambing may take place on the winter range or in a separate lambing range. In late June or early July, barren females, juveniles, and rams move to summer ranges.

Habitat

Structural stage

Ecotype	Foraging	Security & thermal	Lambing	Rutting
California	2–3 & 6–7	4–7	1–3	1–3 & 6–7
Rocky Mountain	2–3 & 6–7	4–7	1–3	1–3 & 6–7

Important habitats and habitat features

Bighorn Sheep use a variety of habitat types within their home ranges. Habitats include open grasslands, alpine, subalpine, shrub-steppe, rock outcrops, cliffs, meadows, moist draws, stream sides, talus slopes, plateaus, deciduous forest, clearcut or burned forest, and conifer forest, all on moderately steep to steep slopes. Use of habitat varies daily and seasonally with changes in requirements for food, rest, safety, thermal cover, rutting, and lambing (Risenhoover and Bailey 1985). Table 1 summarizes coarse habitat requirements used for Bighorn Sheep. Rocky Mountain Bighorn Sheep prefer habitats with steep grasslands and broken krummholz terrain (Demarchi 1986).

California Bighorn Sheep in British Columbia exhibit three seasonal habitat use strategies. The majority of populations winter on low-elevation, southerly exposed slopes close to rocky escarpments or scree slopes, and summer in high elevation alpine and subalpine areas (Blood 1961; Sugden 1961). However, there is a population that spends both summers and winters on high-elevation, windswept alpine ridges and mountains (e.g., the Taseko, Elbow/Dash/Relay, Shulaps, and Yohetta/Tatlow herds) (P. Dielman and F. Harper, pers. comm.). Another herd spends the winters and summers at low elevations along the Fraser River canyon in the Fraser River Basin Ecosection (e.g., the entire Junction herd and part of the Churn Creek, Fraser River East, and Fraser West populations) (Demarchi and Mitchell 1973; Keystone Wildlife Research 1998; F. Harper, pers. comm.).

Table 1. Coarse feature requirements of Bighorn Sheep (after Sweanor et al. 1996)

Habitat requirement	Definition
Escape terrain	Areas with slope >27° and <85°
Escape terrain buffer	Areas within 300 m of escape terrain and areas ≤1000 m wide that are bound on ≥2 sides by escape terrain
Vegetation density	Areas must have visibility >55%, as defined by the mean percentage of squares visible on a 1 m^2 target, divided into 36 equal squares, 14 m from an observer viewing N, E, W, S from a height of 90 cm along a 10 pt, 280 m transect
Water sources	Areas must be within 3.2 km of water sources
Natural barriers	Areas that Bighorn Sheep cannot access are excluded (e.g., rivers >200 ft^3/s, areas with visibility <30% that are 100 m wide, cliffs with >85° slope)
Human use areas	Areas covered by human development are excluded
Man-made barriers	Areas that cannot be accessed due to man-made barriers are excluded (e.g., major highways, wildlife-proof fencing, aqueducts, major canals)
Domestic livestock	Areas within 16 km of domestic sheep and domestic goats are excluded

Thermal and security cover

Forests (pole/sapling to old forest) are used for security and thermal cover. Bighorn Sheep, and most commonly non-habituated groups of rams, use dense conifer forests as hiding cover when disturbed by lightening storms, motorized vehicles, and humans on foot. Mature, open forests provide Bighorn Sheep with important habitats for forage and thermal cover (Demarchi and Mitchell 1973). During a recent low temperature/deep snow event in the Ashnola watershed, California Bighorn Sheep retreated to old-growth Douglas-fir (*Pseusdotosuga menziesii*) forests, presumably to escape deep snow and to seek forage from Douglas-fir needles, twigs, and litter-fall (R. Lincoln, pers comm.). Scree slopes and rock outcrops within coniferous forests are also used as hiding cover by rams during the hunting season, and for thermal cover during hot weather. High elevation wintering Bighorn Sheep retreat to the upper margins of mature montane spruce forest during severe inclement winter weather.

Wintering

Bighorn Sheep depend on natural grasslands such as bunchgrass, ranges (especially bluebunch wheatgrass [*Pseudoroegneria spicata*] and rough fescue [*Festuca scabrella]*) and early successional forest stages: particularly as winter range for all ecotypes (Blood 1961; Sugden 1961; Demarchi and Mitchell 1973; Wikeem 1984; Demarchi 1986; Davidson 1991).

Rocky Mountain Bighorn Sheep winter on low-elevation, southerly exposed slopes close to rocky escarpments or talus slopes (Shackleton 1973; Demarchi 1986). However, two other populations in the East Kootenay winter on high-elevation, wind-swept, alpine, and subalpine ridges (TAESCO 1982; Demarchi 1986; Shackleton 1973) or winter in exposed south-facing grassland slopes at mid-elevation in the montane forest of the Fording Valley (Demarchi 1968, TAESCO 1982). Although the three populations are spatially separated, their habitat and forage requirements are similar (e.g., mineral licks, migration corridors, and proximity to escape terrain for security from predators—especially during lambing).

Use of grasslands and seral shrublands in the East Kootenay Trench ecosections by Bighorn Sheep occurs mainly during winter. Rams often use more marginal habitats on cliffs and rugged terrain (TAESCO 1982).

Lambing

Females move to lambing areas to give birth any time from early May through June, or less frequently, the beginning of July. Lambing may take place on the winter range or in a separate lambing range. Southerly and south-westerly-facing scree slopes and steep rugged terrain interspersed by rock cliffs are commonly used for lambing. Talus slopes and cliffs are commonly sparsely vegetated but provide habitat for lambing, and general security. Lambing range selection may be based on a combination of nutritional and anti-predator constraints. These sites may be sparsely vegetated but provide relatively secure habitat for birthing, nursing, and resting away from both terrestrial and aerial predators. Pregnant ewes were found to move from higher quality forage to an area of lower quality to provide better protection from predation (Festa-Bianchet 1988).

Spring/summer

Summer range is often in high elevation rocky alpine and krummholz areas (Shackleton 1973; Demarchi 1986). In Ewin Creek of the East Kootenay, ewes summered in the lower elevation forests without forming distinct nursing bands (TAESCO 1982). As with the lower elevation wintering herds, the two high elevation wintering ecotypes summer in the alpine and in subalpine forests.

Rutting

For the California ecotype, rutting ranges are often encompassed by the winter and/or lambing areas. For the Rocky Mountain ecotype, large bands of rams move to a fall concentration area or pre-rut range in late September or early October where they generally stay from 2 to 5 weeks. They disperse from this area in the first week of October or the first week in November to rutting grounds that are usually the same areas used as winter range by the ewe-juvenile component of the herd. The rams remain there until mid- to late December. At this time, some rams will return to the pre-rut home range while others move to mid-winter home ranges where they spend 271–303 days (Geist 1971). Some young rams and the ewes and juveniles will remain at the rutting grounds. By mid-March rams return to their fall concentration areas prior to migration to summer range.

Mineral licks and watering holes

Bighorn Sheep return repeatedly to localized areas that are used as mineral licks and watering holes. These are specific to individual herds and individual herds will often use more than one mineral lick or watering hole. Access to potable water in locations secure from predation is important, particularly when ewes are accompanied by suckling lambs.

Mineral licks are an important source of essential minerals for most mountain ungulates. Certain trace minerals such as selenium and copper have been suggested as being limiting in some habitats (Schwantje 1988). This may be especially true for Bighorn Sheep herds in British Columbia because soil mineral content is low throughout their distribution (Van Dyke 1978) and this may result in some forage with low mineral content (Smith 1954). Hebert (1973) found that diets based on high altitude forages had higher levels of essential trace minerals than those at lower altitudes. Mineral content among licks varies considerably (Dormar and Walker 1996) suggesting that (1) various types of licks may serve different needs, and (2) sheep use more than one lick site. Deficiencies of trace minerals such as selenium and copper are responsible for reduced immune function in other ungulate species and may contribute to outbreaks of disease in Bighorn Sheep (Packard 1946; Schwantje 1988).

Conservation and Management

Status

Bighorn Sheep are on the provincial *Blue List* in British Columbia. Their status in Canada has not been determined (COSEWIC 2002).

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

BC	AB	WA	ID	MT	Canada	Global
S2S3	S3	S3S4	S3	S4	N3	G4

Trends

Population trends

The population of California Bighorn Sheep in British Columbia includes five metapopulations, two of which—the south Okanagan and Kettle-Grandby metapopulations—encompass small isolated populations in northern Washington. The population of Rocky Mountain Bighorn Sheep in British Columbia is part of a core-satellite metapopulation of approximately 18 000 Rocky Mountain Bighorn Sheep in British Columbia, Alberta, and part of Montana, with the core situated in Alberta.

A minimum viable population of 125 has been determined for Bighorn Sheep at the subpopulation level (Berger 1990). Of the 10 subpopulations of California Bighorn Sheep in British Columbia, two are extremely small at <20 individuals, one is <125, and seven are ≥125. Of the 14 subpopulations of Rocky Mountain Bighorn Sheep in British Columbia, six are <125 individuals, and eight are ≥125.

British Columbia's California Bighorn Sheep population was estimated to be 3030–3625 in 1998, the last year of record. There was an increasing trend in both numbers and populations of California Bighorn Sheep from the early 1960s through the 1980s (Ritcey and Low 1986) and into the early 1990s (B.C. MELP 1998). The provincial population of California Bighorn Sheep increased from 1760 in 1970 to 3240 in 1985 and then to 4650 in 1990. By 1998, the population had declined to 3630 (B.C. MELP 1998; Toweill and Geist 1999). This sudden decline was largely a result of very low lamb survival amongst herds in the Fraser Basin and a die off caused by severe winter conditions in the Ashnola in 1990–1991. In 1999–2000, the central herd in the south Okanagan near Oliver, B.C., suffered a severe all age die-off, further reducing their numbers and heightening agency and public concerns for future population trends (Harper et al. 2001).

The population size of Rocky Mountain Bighorn Sheep in British Columbia was approximately 3000 in 1996, the most recent year of record. This is the largest size that inventory figures have recorded, although there may have been a larger population pre-historically when grasslands were probably more widespread. The distribution has not changed significantly from the early part of the 20th century.

Regular cyclic die-offs have dramatically affected population numbers and trends, approximately every 20 years beginning in the early 1920s (Davidson 1991). Following recovery of the last, early 1980s die-off, the population trend for Rocky Mountain Bighorn Sheep was generally upward until 1996, but there has been a subsequent decrease.

Reduced lamb survival and other contributing factors continue to be problematic for some herds. For example, a small-scale outbreak of bacterial pneumonia occurred in the Elk Valley in the fall in the late 1990s, however, this appeared to have been self-limiting as there were no further reports of sick or dead sheep following the rut (H. Schwantje, pers. comm.). Also, a significant loss of California Bighorn Sheep was caused by the translocation of mature animals from several herds between the 1950s and 1990s.

Habitat trends

An increasing amount of the traditional winter and spring habitat of Bighorn range is being alienated and/or developed for residential, agricultural, and industrial purposes. Such conflicting land uses have been and will be inevitable, because low elevation bighorn habitat is often some of the most desirable for human development. For the Rocky Mountain Bighorn Sheep, the capability of the habitat has been diminished by permanent factors such as land alienation, highways, subdivisions, and open-pit mines by <10% (Demarchi and Demarchi 1994). The suitable habitat at present is <50% of the capable habitat within the historic distribution because of forest access roads, forest succession, competition with livestock, and human disturbance. In addition to the direct loss of habitat, conifer encroachment onto native grasslands and loss of seral-shrub-grassland range have been accelerated by aggressive fire suppression practices of the provincial Ministry of Forests over the past 40 or more years. Conifer tree encroachment has occurred at a rate of 0.5–2%/yr on low-elevation winter ranges (Davidson 1991). Based on the observations of wildlife managers, the rate of winter habitat change is considered "rapid." California Bighorn Sheep managers have expressed concerns for the loss of habitat through forest fire suppression and forest succession (T. Ethier, D. Jury, D. Low, and J. Youds, pers. comm.). Critical winter range habitat has been significantly reduced throughout the Rocky Mountain Bighorn Sheep's range (≤50%) over the last 70 years. Due to their higher moisture regimes, encroachment has been even greater on spring and fall transition ranges. The loss of transition ranges forces Bighorn to arrive on winter ranges earlier and leave later (increased sedentariness). Overused winter ranges cause nutritional stress and can increase parasite (especially lungworm) infection rates leading to increased lung damage.

Threats

Population threats

Factors predisposing the south Okanagan Bighorn Sheep population to a disease die-off in 1999–2000 include probable disease transmission from domestic sheep, trace mineral deficiencies, habitat effects from urban and agricultural development, weed invasion, fire suppression, increased predation, range depletion, and forage competition with livestock and wild ungulates and harassment by humans and dogs (Harper 2001). Stressors implicated in East Kootenay Bighorn die-offs have included poor nutrition, trace mineral deficiencies, high animal density, inter-specific competition, inclement weather, harassment by humans and dogs, and high levels of parasites.

Livestock ranching is the primary threat to Bighorns through disease transmission, range depletion, and resource competition. A definite cause-and-effect relationship exists between bacteria, such as *Pasteurella* species, carried by domestic sheep and transmitted to mountain sheep. This relationship has been suspected since at least 1954 (Smith 1955) and proven since 1982 (Foreyt and Jessup 1982). *Pasteurella* species, commonly present in domestic sheep, can induce fatal pneumonia in otherwise healthy bighorns from nose-to-nose contact (Foreyt and Jessup 1982; Onderka 1986; Onderka and Wishart 1988).

High levels of lungworm (*Protostrongylus stilesi*) infection can cause high mortality in Bighorn lambs. Although Bighorns and this species of lungworm have coevolved, the developing stages can cause significant damage to lung tissue. Any habitat factor that improves survival of lungworm larvae, their intermediate host (i.e., terrestrial snails), or their rate of ingestion will increase lungworm loads in Bighorns. Higher animal infection rates have been associated with higher soil moisture levels. Irrigated agriculture fields that attract Bighorn Sheep may exacerbate the problem since the high animal density, increased grazing pressure, and increased number of lungworm-carrying snails ingested may lead to higher infection rates (Harper 1995; P. Dielman and H. Schwantje, pers. comm.). Added to this, these sheep may prefer to live year round on such habitat and lose their normal home range movements and behaviour.

The harassment of wildlife by the presence of humans, whether in the form of wildlife viewing stands, aerial censuses, snowmobiles, helicopters, vehicles, or domestic dogs, can add undue stress to vigilant species such as Bighorn Sheep (MacArthur et al. 1982; Krausman and Hervert 1983; Stemp 1983; Legg 1998). During the third trimester and while lactating, ewes are particularly sensitive to human disturbance as they move frequently in search of high quality forage (Wagner and Peek 1999).

Predation is a possible limiting factor for Bighorn populations (Haas 1989). Eight carnivore and raptor species can prey on Bighorn, namely Grizzly Bear (*Ursus arctos*), Black Bear (*Ursus americanus*), Cougar (*Felis concolor*), Bobcat (*Lynx rufus*), Lynx (*Lynx canadensis*), Wolf (*Canis lupus*), Coyote (*Canis latrans*), and Golden Eagle (*Aquila chrysaetos*) (Kennedy 1948; Buechner 1960; Sugden 1961; McTaggart-Cowan and Guiguet 1965). Predation undoubtedly varies over space and time although coyotes, cougar, and grizzly bears are suspected to take a considerable portion of the annual production. Bighorn Sheep are less well adapted to avoiding the stalking and ambush techniques of cougars in rough terrain, particularly where there is tree or rock cover (Wishart 1999). Wehausen (1996) determined that cougar predation reduced the annual adult ewe survival to 62.5% and cougar predation accounted for 100% of all adult ewe mortalities in his study area. Hebert and Harrison (1988) studying California Bighorn Sheep in the livestock-free Junction herd concluded that coyote predation and not range condition, nutrition, stress, parasites, disease, or climate resulted in a significant loss of lambs. Harrison and Hebert (1988) also concluded that cougar predation and not habitat condition or illegal hunting reduced the number and proportion of mature rams in the Junction herd. Evidence was obtained in their study that supported the hypothesis that scavenging of cougar kills by coyotes increased the frequency of predation by cougar.

Livestock operations with inadequate methods of carcass disposal may inadvertently result in an increase or concentration of predators that in turn may lead to increased predation on adjacent Bighorn Sheep populations.

Habitat threats

A large domestic sheep industry and the free ranging of large numbers of horses on Crown range in the early to mid-1900s resulted in damage to fragile low elevation and alpine grasslands important to Bighorn Sheep in the interior in such places as the Yalakom and Ashnola valleys (Demarchi and Demarchi 1987).

Impacts from cattle grazing include reduced forage supply, abandonment of ranges, decreased distance to escape terrain, and altered habitat use patterns (Bissonette and Steinkamp 1996) in addition to depletion of range condition and trampling and fouling of watering holes and mineral licks. Plants may not support a second grazing by cattle if they are to support Bighorn Sheep the following winter and spring. While grazing lands can benefit from judicious management of cattle, they must be carefully managed to ensure Bighorns have the appropriate forage available at the critical times of year on the critical preferred habitats.

California Bighorn Sheep habitat has been permanently lost through subdivision development on traditional sheep range, particularly in the southern Okanagan and also near Grand Forks in the Kettle-Granby, through expansion of vineyards in the southern Okanagan and expansion of alfalfa and ginseng cultivation in the Fraser River Basin. Nearly 9000 ha of native grasslands were converted to agricultural and urban development in the southern Okanagan between 1940 and 1987 with a further 4000 ha projected to be lost over the next 20 years, if present trends continue (Harper et al. 2001).

Rocky Mountain Bighorn Sheep habitat has been permanently lost through urban development at Radium Hotsprings, Fairmont Hotsprings, and Elko and the golf course at Radium. Agricultural developments along the Galton Range and Bull River have been established on traditional Bighorn Sheep range. Acreages and subdivisions between Fairmont Hotsprings and Brisco also have the potential to disrupt north–south migration of Bighorn Sheep along the western edge of the Rocky Mountains (Davidson 1991). Approximately 25% of the winter range for Bighorns in the upper Columbia area has been accessed, subdivided, and developed for housing and industry since the 1940s (Davidson 1991).

Roads and railways (e.g., Highway 97 in Vaseux, Canadian Pacific Railway, Highway #1 at Spences Bridge, Highway #3, and the highway from Radium through Kootenay National Park) occupy habitat, dissect migration routes, and result in direct mortality. Salt used for road maintenance can attract and hold sheep in highway corridors. In some cases, significant numbers of adults have been lost in single seasons.

Industrial developments such as forestry, mining, and hydro-electric developments can result in habitat loss and displacement, disturbance, interference with seasonal movements along established secure corridors, and increases in animal exposure to predation. Helicopter activity associated with seismic work, forestry, and recreation can disturb and displace sheep.

Specific developments that have impacted Bighorn Sheep include the Aberfeldie Dam and Elko Dam; open-pit mining and overburden dumping in the Elk Valley which not only altered but completely destroyed Bighorn Sheep habitat in some areas (Demarchi and Demarchi 1987); Westroc Gypsum mine at Windermere; and Line Creek's open pit coal mine.

Other examples of development that have impacted Bighorn Sheep are historic developments such as the exploration for coal with heavy equipment in the Fernie Coal Basin of the Elk Valley in the late 1960s and early 1970s (Demarchi 1968, 1977), major seismic work throughout the Southern Rockies on both sides of the Continental Divide in the 1950s, and natural gas seismic activity in the Flathead in the 1980s.

Impacts from recreation such as ski resorts, all-terrain vehicles, rock climbing, golf, heli-skiing include habitat loss, disturbance, and foraging efficiency reduction (Stockwell et al. 1991; Bleich et al. 1994). The resulting chronic stress can lead to poor health, reduced growth, and reduced reproductive fitness (Geist 1979). Chronic disturbance can work additively with other habitat and animal factors and lead to immuno-compromised individuals or populations and result in outbreaks of disease. Sheep habituated to human disturbance may be susceptible to increased highway mortality, harassment by people and dogs, and dependency on artificial food sources that may be only temporarily available.

Forest encroachment and fire suppression are reducing suitable habitat by replacing grass, forbs, and deciduous shrubs with conifers. Forest succession can interfere with seasonal movement patterns and grazing behaviour because, as the density of trees increases, the visibility decreases, increasing predation by carnivores relying on stealth. Fire suppression alters the fire ecology of grasslands.

Competition for forage from elk and mule deer on low elevation winter ranges may be substantial

(Smith and Julander 1953). Elk numbers in the East Kootenay increased from about 7000 in 1974 to about 28 000 in 1980 (Davidson 1991). When resources are scarce, Bighorn Sheep ewes may postpone first reproduction (Festa-Bianchet et al. 1995) or reduce maternal care resulting in decreased lamb survival (Festa-Bianchet and Jorgenson 1998).

The introduction and spread of invasive species on grasslands are of great concern because they replace nutritious native forage species with inedible or non nutritious plants.

Legal Protection and Habitat Conservation

Where hunting seasons are permitted, Bighorn Sheep are normally harvested under a general open season male-only with specific horn curl minimums (e.g., full or ¾ curl). Limited entry hunting (LEH) authorizations, quotas, and administrative guidelines are used to regulate hunting in some areas. Limited ewe and lamb hunting are provided where sheep numbers are approaching or have exceeded carrying capacity. Annual management unit estimates, compulsory inspection, 3- to 5-year population monitoring, population modelling, and site-specific surveys are employed by the regional and provincial wildlife managers to monitor and regulate populations. Hunting can be an important management tool for Bighorn Sheep herds due to the potential for dramatic cyclical die-offs associated with exceeding the carrying capacity of ranges. A recent survey of sheep managers in North America indicated ram hunts and ewe hunts may be a cost effective means of controlling populations at or near carrying capacity (Hacker 1999).

The ranges of some herds are protected or partially protected by provincial protected areas including:

- Junction Sheep Range Provincial Park contains the year-round range of the Junction herd
- Churn Creek Park contains the winter range of the Churn Creek herd
- Big Creek/South Chilcotin contains the year-round range of the Park Elbow/Relay herd
- Lac du Bois Grasslands contains the Kamloops Lake peripheral winter range
- Marble Range and Edge Hills Parks contain the limestone summer and winter range of the East Fraser River herd
- Cathedral Provincial Park and the newly established Snowy Mountain Provincial Park contain the Ashnola herd
- Kootenay National Park contains half of the summer, half of the winter, and all of the transitional ranges of the Radium-Stoddart Creek herd
- Yoho National Park encompasses all of the summer range for the Golden herd
- Mount Assiniboine Provincial Park and adjacent Banff National Park encompass the entire range of the Assiniboine herd
- Height of the Rockies Provincial Park encompasses the entire range of the Quarrie and Bingay Creek herds
- Akamina-Kishinena Provincial Park includes the summer range for the Waterton (Alberta) herd
- Kakwa Provincial Park protects the summer range of the Kakwa herd
- Ilgachuz Range herd is protected year round by Itcha Ilgachuz Provincial Park.

The East Columbia Lake Wildlife Management Area and the Crown property on Mount Broadwood protect important Rocky Mountain Bighorn Sheep winter ranges. In addition, private land acquisition programs have acquired the Starr Ranch at Sheep Mountain, the Neilson property at Bull River, and private property at the east side of Columbia Lake. The size of parcels varies from a few hectares of strategically situated land to over 12 000 ha of prime winter range on Mount Broadwood on the Wigwam River. However, private inholdings in the Wigwam area threaten the integrity of the winter range.

Some key California Bighorn Sheep winter and summer ranges are partially or wholly encompassed by Indian Reservations. These include Ashnola (summer range), Vaseux, North Thompson, Dog Creek, and Nemaiah. Range condition on Indian Reservations varies but as many areas are subject to year-round grazing by cattle and/or horses it is generally classed as “fair to poor” condition. In addition, housing, commercial, recreational, and industrial developments such as the proposed 2000 lot subdivision and cable tram to the top of Mount St. Paul at the junction of the North Thomson and South Thompson rivers is expected to reduce the capability of the area to support Bighorn Sheep (F. Harper, pers. comm.). Housing and agricultural developments are among the greatest threats to maintaining the integrity of habitat in the southern Okanagan. Several non-governmental conservation organizations are actively pursuing a private land acquisition program.

A health protocol developed for domestic sheep used for vegetation management in British Columbia and Alberta was developed to ensure healthy domestic sheep access to forest lands for silvicultural purposes. Guidelines have been developed and include a review process whereby wildlife biologists are to document the presence of wild sheep and goat herds near the proposed vegetation management site. If these herds are present, the project is refused. The protocol and guidelines cannot address cattle, nor the presence of domestic sheep and goats on private land adjacent to Bighorn Sheep range. Livestock ranching and agriculture can play important roles the health of Bighorns (i.e., through disease transmission and resource competition). The recommendation of the Northern Wild Sheep and Goat Council is to provide a buffer of at least 4 km between wild and domestic sheep while others recommend 16 km (Sweanor et al. 1996). Recent guidelines used in British Columbia and Alberta are approximately 10 km, depending on natural barriers.

Access management in Bighorn Sheep habitat has centred around snowmobile and ATV uses of winter ranges and the restriction of motor vehicles for hunting. Employing the access provisions of the *Wildlife Act* to regulate road use for specific purposes provides only a partial, temporary solution to overuse of terrain resources and harassment of Bighorn Sheep. Establishing road closures for specific purposes while leaving the road open for other uses has only been a partial and often contentious solution. Critical winter range areas such as Churn Creek and the Junction range require co-ordinated access management plans which include road reclamation. However, new forest developments such as in the Churn Creek watershed threaten the integrity of movement corridors (P. Dielman, pers. comm.; Keystone Wildlife Research 1998).

The Backcountry Recreation Policy of British Columbia Crown Lands and Assets seeks to increase commercialized recreation of backcountry Crown lands. Development of backcountry lodges and helicopter-assisted skiing and hiking can threaten the integrity of Bighorn Sheep summer and winter ranges and movement corridors.

The regional wildlife program of habitat enhancement, which includes prescribed fire, selective logging, tree slashing, tree spacing, forage plant seeding, tree spacing, forage plant seeding, range fertilization, and noxious weed control, has been hampered by a lack of funding. Where they have been conducted, these efforts have been rarely evaluated post-treatment and thus the responses of the habitat to these treatments are largely unknown.

The Ministry of Forests also has an active program of weed control. Herbicide spraying of knapweed (*Centaurea* spp.) has been ongoing at Juniper Heights, Stoddart Creek, Mount Swansea Road, Canal Flats, Premier Ridge, and all range units within the former Cranbrook Forest District since the late 1970s. In 1994 a "weed control" project was undertaken on Juniper Heights to control leafy spurge (*Euphorbia esula*).

Under the results based code, specific regulations address ungulate winter range and mineral licks. Range use plans may address the needs of Bighorn Sheep provided careful planning and monitoring occur.

Identified Wildlife Provisions

A metapopulation approach should be used to strategically plan and manage for Bighorn Sheep with the ultimate goal of maintaining and enhancing Bighorn Sheep populations and habitats. This means developing a plan over a larger scale with adjacent jurisdictions in Alberta and Montana and in higher level planning processes using historic and current geographical distribution of Bighorn Sheep ranges and movement corridors. The Okanagan-Shuswap LRMP Approved Plan provides very complete objectives and strategies for Bighorn Sheep habitat in resource management zones as a good example of higher level planning. Additional efforts will be required such as habitat acquisition, the establishment of wildlife management areas, and reintroductions, where advisable.

Sustainable resource management and planning recommendations

The following recommendations are provided for consideration within strategic level planning processes.

- ❖ Maintain and enhance the viability of Bighorn Sheep populations and habitats over their historic range.
- ❖ Reduce and eliminate where possible the contact of other livestock with Bighorn Sheep. It is recommended that, within 16 km of known Bighorn Sheep ranges, the presence of domestic sheep and goats is avoided to minimize disease transmission and competition for forage.
- ❖ Minimize disturbance during critical times and to critical habitats.
  - Develop and implement access management plans (pre- and post-development) that include deactivation recommendations and recommendations to minimize vehicle access, habitat alienation and abandonment, disturbance to Bighorns, vulnerablility to hunters, and the spread of invasive species.
  - Avoid the use of helicopters to remove timber during critical times. Maintain a helicopter no fly zone within 2 km of key habitat features such as mineral licks and watering holes, rutting and lambing areas, and narrow migration corridors.
- ❖ Miminize recreational activities in critical Bighorn Sheep habitat particularly between April and July and between October and November.
- ❖ Maintain Bighorn access to movement corridors and critical ranges.
- ❖ Maintain Bighorn movement corridors and security or resting areas. It is recommended that these areas be buffered by a minimum of 500 m up to 2000 m.
- ❖ Maintain and enhance or restore appropriate forage species and seral stages of forests and grasslands in a condition suitable for Bighorn Sheep.
  - Maintain at least 50% of each Bighorn Sheep winter range in late seral/climax condition bunchgrass dominated communities with abundant, tall grass (easily accessible above snow cover) for winter forage.
  - In areas that have been logged, reforest at reduced stocking rates that promote understorey development (herbs, grasses, and shrubs).
  - Develop and implement prescribed burn plans to enhance forage availability or improve habitat suitability on winter ranges.
  - Limit removal of browse species by livestock to 10% or less of annual browse growth on Bighorn Sheep ranges.
  - Prevent the introduction of invasive species and control spread on ranges. Revegetation of disturbed sites in sheep habitat should be done using native species mixes.
  - Consider intensive silviculture or habitat enhancement activities (spacing and commercial thinning) to enhance important habitat features in Bighorn Sheep habitat.

Wildlife habitat area

Goals

Maintain the integrity of sensitive sites that are localized and critical for specific herds on sites (portions of ranges) where landscape prescriptions are insufficient.

Feature

Establish WHAs at critical habitats: early spring range, lambing areas, late fall rutting areas, watering holes, movement corridors, resting areas, and security sites and associated escape terrain.

Size and design

The specifics of WHA location, size, exposure, and degree of protection will vary with each herd and site specific factors. The WHA should include a core area that maintains important Bighorn Sheep habitats or habitat features and a management zone to minimize disturbance, and prevent disease transmission from domestic sheep and goats.

General wildlife measures

Goals

1. Exclude domestic sheep or goats.
2. Regulate other livestock and livestock practices especially with regards to forage competition.
3. Prevent the introduction or spread of invasive species.
4. Prevent or minimize motor vehicle access to control and prevent disturbance.
5. Prevent or minimize disturbance.
6. Maintain use and access to movement corridors and critical ranges by Bighorn Sheep.
7. Maintain important habitat features.
8. Maintain riparian vegetation and adjacent range in properly functioning condition.

Measures

Access

- Do not construct roads within core area or management zone.
- Control motor vehicle access in the core area and management zone during critical periods: 1 April to 15 July with a peak during mid-June and during October and November.

Harvesting and silviculture

- Do not harvest or salvage in the corea area except for treatments designed to maintain suitable habitat features as directed by the statutory decision maker.
- Avoid silvicultural activities in the core area during lambing or rutting periods (1 April to 15 July with a peak during mid-June and during October and November).

Pesticides

- Do not use pesticides.

Range

- Plan cattle grazing to maintain desired native shrub and grass structure, stubble height, and browse utilization in the core area.
- Control cattle grazing (timing, distribution, level of use) to prevent excess soil disturbance and the introduction of invasive species in the core area.
- Restrict cattle use in the core area between 15 April and 30 June.
- Minimize cattle use of mineral licks and watering holes in the core area. Fencing may be required by the statutory decision maker.
- Do not locate salt or mineral licks, watering troughs, or other range developments in the core area.
- Exclude domestic sheep or goats in the core area and management zone.

Recreation

- Do not develop trails, roads, or recreation sites in the core area or management zone.

Additional Management Considerations

Monitor recreational activities (e.g., ice climbing, snowmobiling) in critical Bighorn Sheep habitat and plan procedures for restricting or preventing their development or expansion.

Do not locate helicopter landing sites and backcountry recreation developments on or within 2 km of critical habitats for Bighorn Sheep.

Do not allow snowmobiles or ATVs or other motorized vehicles on critical Bighorn Sheep habitat.

Maintain a no fly zone for helicopter and fixed-wing air craft on critical habitats for Bighorn Sheep.

Maintain a 2 km distance from Bighorn Sheep for helicopters, fixed-wing aircraft, snowmobiles, and ATVs.

Restrict dogs on critical Bighorn Sheep habitat when occupied.

Prescribed burning may be necessary to maintain or enhance vegetation density.

Information Needs

1. Metapopulation conservation analysis over time to better understand the subpopulation dynamics and movement dynamics of the subpopulations in British Columbia.
2. Research on lamb survival, disease, predation, mineral sites, habitat use patterns and efficacy of habitat enhancement and impacts of human disturbance.
3. Impacts of helicopter activity.

Cross References

Badger, Burrowing Owl, "Columbian" Sharp-tailed Grouse, Flammulated Owl, Fringed Myotis, Gillett's Checkerspot, Grasshopper Sparrow, "Great Basin" Gopher Snake, Great Basin Spadefoot, Grizzly Bear, "Interior" Western Screech-Owl, Lewis's Woodpecker, Long-billed Curlew, Prairie Falcon, Racer, "Sagebrush" Brewer's Sparrow, Sage Thrasher, Sandhill Crane, Short-eared Owl, Sonora Skipper, Spotted Bat, Tiger Salamander, Western Rattlesnake, Westslope Cutthroat Trout, White-headed Woodpecker, Yellow-breasted Chat

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Caribou

Rangifer tarandus

Original prepared by Deborah Cichowski, Trevor Kinley, and Brian Churchill

Species Information

Taxonomy

Rangifer tarandus includes seven extant subspecies: Reindeer (*R. tarandus tarandus*), Wild Forest Reindeer (*R. tarandus fennicus*), and Svalbard Reindeer (*R. tarandus platyrhynchus*) in Eurasia; and Barren-ground Caribou (*R. tarandus groenlandicus*), Alaskan Caribou (*R. tarandus granti*), Peary Caribou (*R. tarandus pearyi*), and Woodland Caribou (*R. tarandus caribou*) in North America.

The Woodland Caribou includes several ecotypes, which have no formal taxonomic designation but are defined on the basis of distinct patterns of habitat use and diet/feeding behaviour. The three ecotypes described in this account are known as Mountain Caribou, Northern Caribou, and Boreal Caribou (Heard and Vagt 1998) and can be distinguished from each other by the combination of three inter-related features (Table 1).

Description

Woodland Caribou are a large, dark subspecies with short, heavy antlers (Banfield 1961) occurring in parts of boreal, cordilleran, and southeastern arctic Canada. There has been no scientific description specific to the three caribou ecotypes in British Columbia.

Distribution

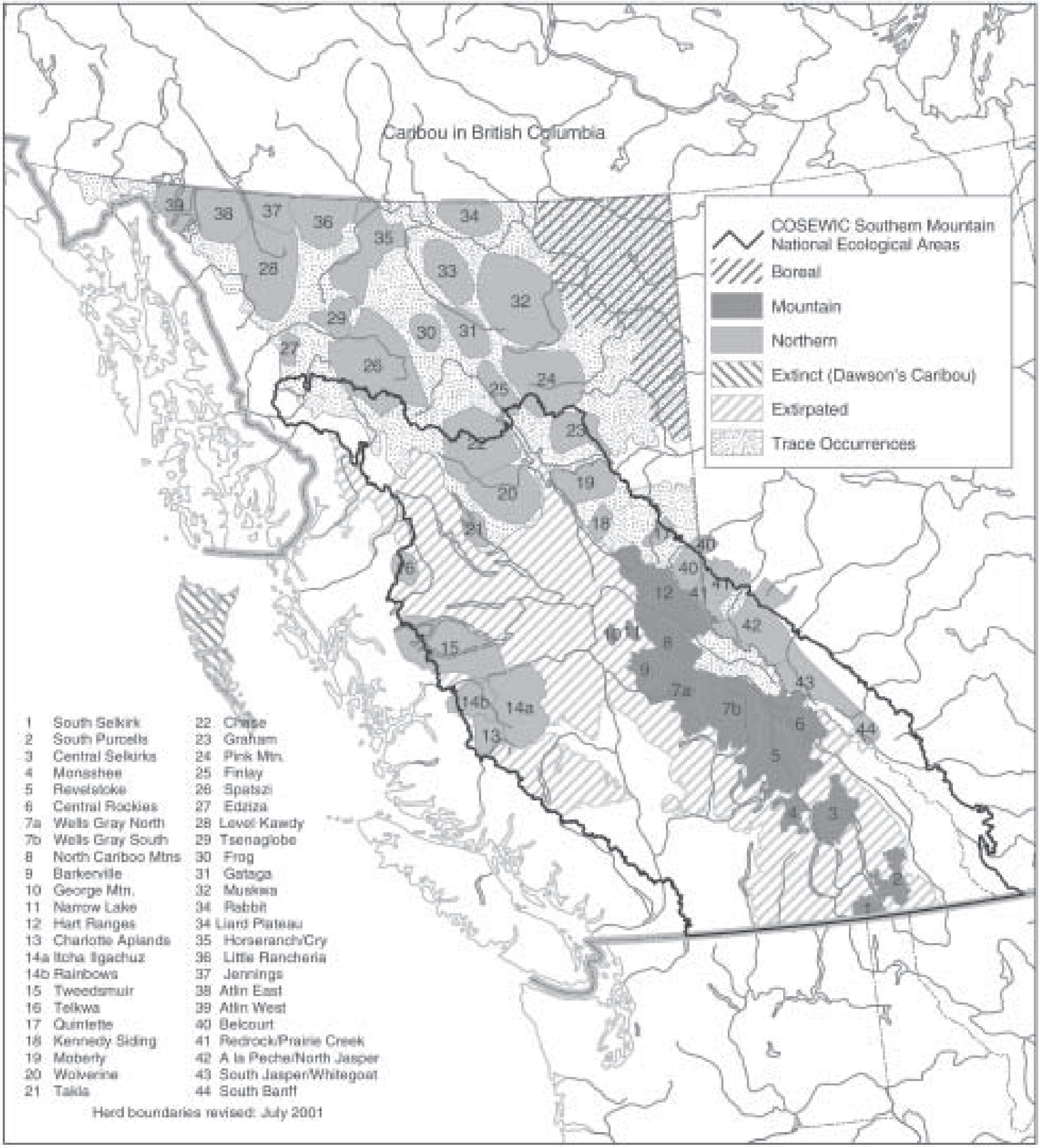
Global

Rangifer tarandus has a circumboreal distribution. In northern Europe and Asia, this species is known as Reindeer, and includes domestic, semi-domesticated, and wild populations. In North America, the species is known as Caribou and exists primarily in the wild. Extant wild subspecies in North America are:

1. Barren-ground Caribou from just south of the treeline northward in northernmost Saskatchewan and Manitoba, the Northwest

Table 1. Features of caribou ecotypes in British Columbia

Feature	Mountain Caribou	Northern Caribou	Boreal Caribou
Occurrence	Mountainous deep-snowpack portion of southeastern British Columbia known as the Interior Wet Belt	Mountainous and adjacent plateau areas with relatively low snowpacks in west-central and northern Interior British Columbia	Peatlands (muskeg) in lowland plateau portion of northeastern British Columbia, east of the Rocky Mountains, with relatively low snowpack
Winter diet	Consists almost entirely of arboreal hair lichen, with use of terrestrial lichen and other ground-based foods only in early winter	Consists mostly of terrestrial lichens with use of arboreal lichens dependent on snow conditions	Consists mostly of terrestrial lichens with some use of arboreal lichens
Seasonal movements	Generally involve little horizontal distance but strong elevational shifts	Generally involve both horizontal distance and elevational shifts	Generally involve horizontal distance but no strong elevational shifts although for some local populations, winter and summer ranges may overlap


Caribou in British Columbia
COSEWIC Southern Mountain National Ecological Areas
Boreal
Mountain
Northern
Extinct (Dawson's Caribou)
Extirpated
Trace Occurrences
1 South Selkirk
2 South Purcells
3 Central Selkirks
4 Monashee
5 Revelstoke
6 Central Rockies
7a Wells Gray North
7b Wells Gray South
8 North Cariboo Mtns
9 Barkerville
10 George Mtn.
11 Narrow Lake
12 Hart Ranges
13 Charlotte Aplands
14a Itcha Ilgachuz
14b Rainbows
15 Tweedsmuir
16 Telkwa
17 Quintette
18 Kennedy Siding
19 Moberly
20 Wolverine
21 Takla
22 Chase
23 Graham
24 Pink Mtn.
25 Finlay
26 Spatsizi
27 Edziza
28 Level Kawdy
29 Tsenaglobe
30 Frog
31 Gataga
32 Muskwa
34 Rabbit
34 Liard Plateau
35 Horseranch/Cry
36 Little Rancheria
37 Jennings
38 Atlin East
39 Atlin West
40 Belcourt
41 Redrock/Prairie Creek
42 A la Peche/North Jasper
43 South Jasper/Whitegoat
44 South Banff
Herd boundaries revised: July 2001

Territories, Nunavut, and western Greenland, totaling over 1 million;

2. Alaska Caribou in northern Yukon and much of Alaska, totalling ~1 million;
3. Peary Caribou on the Arctic islands of the Northwest Territories and western Nunavut, totalling ~2000;
4. Woodland Caribou in southern Yukon, southwestern Northwest Territories, northern, west-central and southeastern British Columbia, extreme northeastern Washington, extreme northern Idaho, west-central and northern Alberta, boreal portions of Saskatchewan and Manitoba, and the boreal and arctic portions of Ontario, Quebec, and Newfoundland and Labrador, totalling over 1 million.

Of the three Woodland Caribou ecotypes in British Columbia, Mountain Caribou occur in part of the Columbia Mountains, Idaho, and Washington, and a small portion of the west slope of the Rocky Mountains in British Columbia. Northern Caribou are found in mountainous and adjacent low elevation plateau areas in west-central British Columbia and in northern British Columbia west of and in the Rocky Mountains. Boreal Caribou are found in relatively flat boreal forests east of the Rocky Mountain in northeastern British Columbia.

British Columbia

Mountain Caribou in British Columbia occur regularly in portions of the Rocky Mountains' west slope from the Anzac River to the Morkill River, and from the Wood River drainage to the Bush Arm of Kinbasket Lake, although there are sporadic occurrences between the Morkill and Wood rivers. They also occur in the Columbia Mountains, including parts of the Cariboo Mountains, Quesnel Highlands, Shuswap Highlands, Monashee Mountains north of Whatshan Lake, Selkirk Mountains, and parts of the Purcell Mountains north of Highway 3.

Northern Caribou occur in west-central British Columbia, in and around the Itcha, Ilgachuz, Rainbow, and Trumpeter mountains as well as in and around northern Tweedsmuir Provincial Park and Entiako Provincial Park and Protected Area. They also occur in the Telkwa Mountains and around the northern part of Takla Lake. Northern Caribou are somewhat contiguous in distribution from the Williston Lake area north to the Yukon border and northwest to Atlin, and southeast along the east side of the Rocky Mountains to the Alberta border near Kakwa Park.

Boreal Caribou are found in approximately 15% of the province east of the Rocky Mountain foothills from the Yukon border east of the Liard River as far south as the Wapiti River Drainage downstream of its junction with the Red Deer River. The western boundary is indistinct but is approximately along the Liard River from the Yukon, North West Territories' boundary upstream as far as the junction with the Dunedin River, and then generally southeast to Fort St John. No caribou were likely to have or will live in the drier aspen forests along the lowlands near the Peace River although the occasional transient has been seen in these areas.

Forest regions and districts

Mountain Caribou		Northern Caribou		Boreal Caribou	
Region	**District**	**Region**	**District**	**Region**	**District**
Southern Interior	100 Mile House Arrow Boundary Central Cariboo Columbia Headwaters Kootenay Lake Okanagan Shuswap Quesnel Rocky Mountain	Southern Interior Norther Interior	Chilcotin Quesnel Fort Nelson Fort St. James Mackenzie Nadina Peace Prince Geroge Skeena Stikine Vanderhoof	Northern Interior	Peace Fort Nelson
Northern Interior	Prince George	Coast	North Island		

Ecoprovinces and ecosections

Mountain Caribou	Northern Caribou	Boreal Caribou
SBI: HAF SIM: BBT, BOV, CAM, CCM, CPK, EPM, NKM, NPK, QUH, SCM, SHH, UFT	BOP: HAP, KIP CEI: BUB, BUR, CHP, NAU, NEU, WCR, WCU COM: CRU, KIR, NAB, NAM NBM: CAR, EMR, HYH, KEM, LIP, MUF, SBP, STP, TAH, TEB, TEP, TUR, WMR SBI: BAU, ESM, HAF, MAP, MIR, PEF, SOM SIM: FRR TAP: MUP	BOP: CLH, HAP, KIP TAP: ETP, FNL, MAU, MUP, PEP, TLP

Biogeoclimatic units

ICH, ESSF, and AT occur over the majority of Mountain Caribou range and are used to varying degrees. Caribou in the northern end of the distribution (Hart Ranges, Narrow Lake, George Mountain, Barkerville, and North Cariboo Mountains local populations) use the SBS instead of or in addition to ICH. In portions of the South Purcell local population, the MS zone occurs in place of ICH, but there is very little use of the MS there.

Northern Caribou use a wide range of biogeoclimatic subzones and variants, partly because of the extent of their distribution throughout northern and west-central British Columbia. AT is used by most Northern Caribou local populations during both winter and summer. In the northern part of British Columbia, low elevation forested winter ranges occur in the BWBS zone and higher elevation ranges occur in the SWB. In north-central British Columbia, Northern Caribou low elevation winter ranges occur in SBS and BWBS, with high elevation ranges in ESSF. In west-central British Columbia, low elevation winter ranges occur in SBS, SBPS, and to some extent in the MS with high elevation ranges in the ESSF. In addition, some Northern Caribou summer range in west-central British Columbia lies within the MH at higher elevations and CWH at lower elevations.

Boreal Caribou can occur in all of the variants of the BWBS with the possible exception of the BWBSdk2.

However, the majority occur in the BWBSmw1 and BWBSmw2, which contain the wetter site series that include "peatlands" or "muskeg."

Mountain Caribou	Northern Caribou	Boreal Caribou
ESSFdk	BWBSdk1	BWBSmw1
ESSFmm	BWBSdk2	BWBSmw2
ESSFp	BWBSmw1	BWBSwk2
ESSFun[a]	BWBSwk1	BWBSwk3
ESSFvc	BWBSwk2	
ESSFvv	CWHws2	
ESSFwc	ESSFmv2	
ESSFwk	ESSFmv3	
ESSFwm	ESSFmv4	
ICHmk (limited)	ESSFwc3	
ICHmm	ESSFwk2	
ICHmw	ESSFwv	
ICHvk	ESSFwv1	
ICHwk	MHmm2	
MSdk	MSxv	
	SBPSmc	
SBSvk	SBPSmk	
SBSwk	SBPSxc	
	SBSdk	
	SBSmc2	
	SBSmc3	
	SBSmk1	
	SBSmk2	
	SBSwk2	
	SBSwk3	
	SWBmk	
	SWB (undiff)	

a A distinct subzone or variant occurs in some locations between the ESSF proper and the ESSFp, with a lower boundary where alpine larch and heathers begin (T. Braumandl, pers. comm.). This "undifferentiated" subzone has not yet been named but tentative site series for it have been identified in parts of the Kootenay region.

Broad ecosystem units

Degree of use of broad ecosystem units (BEUs) varies between local populations.

Mountain Caribou		Northern Caribou		Boreal Caribou
AH[a]	ME[c]	**AC**	**HP**	**BB**
AM	RD[c]	**AS**	**LP**	**BG**
AN[b]	RE[b,c]	**BA**	**LS**	**BL**
AT	RR	**BB**	**MI**	**BP**
AU[b]	SF[c]	**BK**	**OW**	**LP**
AV	SK	**BS**	**RD**	**LS**
EF	**SM**	**CD**	**RE**	**PR**
ER	TA[b]	**CF**	**RR**	**WL**
EW	TC[b]	**CS**	**SP**	
FP	TR[b]	**CW**	**SR**	
GL[b]	WB[c]	**FR**	**TA**	
IH	WG	**FS**	**TF**	
IS	WP[c]	**GB**	**UR**	
LL[b]		**GL**	**UV**	
LS[b]				

a Units in bold are used most consistently among local populations.

b Units used for travel or resting only.

c Units used by three or fewer local populations.

Elevation

Mountain Caribou activity is most concentrated in the upper portion of the ESSF zone, at ~1500–2100 m. However, elevation use varies by local population, year, season, and individual. Local populations occurring near the centre of current range and in areas with greater extremes of elevation tend to make more extensive use of elevations as low as 600 m for foraging, particularly in early winter and spring. Caribou in other locations are more likely to use lower elevations mainly as they cross valleys between high-elevation ranges. Sometimes elevations >2500 m are used, particularly in the summer.

Northern Caribou are found at a variety of elevations depending on season and local population. During winter, Northern Caribou are generally found either at high elevations above treeline on windswept alpine slopes or at lower elevations in forested habitat. Due to the extent of Northern Caribou range in British Columbia, lower elevation forested habitat can range from about 500 to 1500 m depending on local population. High elevation winter habitat generally ranges from 1500 m to over 2000 m. Some high elevation winter range also includes subalpine forests. During summer, Northern Caribou may be found as low as 500 m in coastal areas in west-central British Columbia to over 2500 m in mountainous areas in most local population ranges.

Boreal Caribou are found in relatively flat boreal forests in northeastern British Columbia where they occupy all elevations in that area from about 400 to 1200 m.

Life History

Diet and foraging behaviour

The late-winter diet of Mountain Caribou consists almost entirely of *Bryoria* spp., with some *Alectoria sarmentosa* and possibly *Nodobryoria oregana*. They are able to sustain themselves on this low-protein diet (*Bryoria* has only about 4% crude protein; Rominger et al. 1996), for roughly half of the year (Rominger et al. 2000). The dependence on arboreal hair lichens is probably the result of several factors. Hair lichens are usually abundant in old forests, which have historically been extensive in the interior Wet Belt, while terrestrial lichens are not. Furthermore, deep snowpacks in this region preclude cratering for most of the winter while providing lift to allow caribou to reach lichen higher in the trees. The use of forbs and graminoids increases dramatically in the spring season. Summer food consists of a wide variety of forbs, graminoids, lichens, fungi, and the leaves of some shrubs. Depending on location and year, early winter foraging may be largely restricted to the same hair lichen species as during late winter, particularly those on windthrown trees or branches, but generally also includes a variety of winter-green shrubs, forbs, graminoids, and terrestrial lichens.

During winter, Northern Caribou forage primarily by cratering through the snow for terrestrial lichens of the genera *Cladina*, *Cladonia*, *Cetraria,* and *Stereocaulon*. *Cladina* spp. are preferred but the other genera are also selected. Northern Caribou also feed on arboreal lichens opportunistically as they travel between terrestrial lichen sites or seek arboreal lichens in forested wetlands and along wetland fringes where arboreal lichens are abundant. Arboreal lichen use increases as snow hardness increases later in winter with melt/freeze conditions. During milder winters, frequent melt/freeze episodes could make cratering for terrestrial lichens difficult earlier in the winter, especially when ice crusts form close to the ground, forcing caribou to increase their reliance on arboreal lichens. *Bryoria* spp. are the most abundant arboreal lichens on most Northern Caribou winter ranges. Because of the relatively low snowpacks on most Northern Caribou winter ranges, caribou can forage on terrestrial lichens either in low elevation forested habitats, or on windswept alpine slopes. Similar to Mountain Caribou, the use of forbs and graminoids increases dramatically in the spring season and summer food consists of a wide variety of forbs, graminoids, lichens, fungi, and the leaves of some shrubs.

Less is known about Boreal Caribou foraging behaviour in British Columbia; however, Boreal Caribou, like Northern Caribou, also appear to forage primarily on terrestrial lichens and to a lesser extent on arboreal lichens during winter. Winter foraging occurs primarily in very open forests in peatlands and to a lesser extent in nearby lichen-rich pine stands where available. Presumably, summer food also consists of a wide variety vegetation.

Reproduction

The mating system of Woodland Caribou is polygynous, with dominant bulls breeding with a number of cows in late September to mid-October. Rutting group size varies between ecotype with up to a dozen for Mountain Caribou, up to 20 (or more) for Northern Caribou, and generally <5 for Boreal Caribou. Woodland Caribou in British Columbia exhibit a number of anti-predator strategies during calving including calving alone in isolated, often rugged locations (Mountain, Northern), calving on islands in lakes in low elevation forested habitat (Northern, possibly Boreal), calving in large muskegs where the number of predators and other prey are low (Boreal), and dispersing away from other caribou and prey in low elevation forested areas (Boreal) (Shoesmith and Storey 1977; Bergerud et al. 1984a; Bergerud and Page 1987).

The productivity of caribou is low compared with deer and moose because caribou only have one young per year and calves and most yearlings commonly are not pregnant. The population growth rate (l) rarely exceeds 1.26, or 26% per year. Pregnancy rate of females ranges from 90 to 97% (Seip and Cichowski 1996). Gestation is about 230 days, and calves are born in late May or early June. Calves are notably precocious, moving with their mothers shortly after birth. Calf mortality during the first few months of life is high, often 50% or greater. Causes of calf mortality may include predation, abandonment, accidents, and inclement weather. Calves generally make up 27–30% of the population at birth, but by recruitment age (1 yr old, after which mortality generally stabilizes to adult levels), their proportion is generally <20%.

Site fidelity

Fidelity patterns are complex. Some cows calve in the same location repeatedly, while others shift locations annually. Similarly, rutting sites may be occupied each year or only sporadically. Home ranges rarely remain fixed throughout an animal's life. Individual caribou typically use a predictable series of activity centres over a season or several years, but most eventually make temporary or permanent shifts to new areas. From spring through early winter, individuals may travel with several other caribou temporarily, and then shift to another band. Membership in late-winter aggregations is also inconsistent between years. At the local population level, fidelity to broad landscapes is stronger, but even at this scale there are occasional shifts of individuals and groups to areas that were not used for the past several years. Consistent use of mineral licks has been reported.

Home range

For Mountain Caribou, minimum convex polygon home ranges of 150–600 km^2 are typical, but vary from <100 to >800 km^2. For Northern Caribou, home range sizes are highly variable depending on local population size and the horizontal movement distance between summer and winter ranges. In northern and north-central British Columbia home ranges average 1100–1900 km^2 for some local populations and 150 km^2 for another (Hatler 1986; Terry and Wood 1999; Wood and Terry 1999; Poole et al. 2000). For Boreal Caribou in Alberta, home ranges averaged 710 km^2 (Stuart-Smith et al. 1997).

Movements and dispersal

Mountain Caribou

During late winter (Table 2), Mountain Caribou aggregate in open stands in or near the ESSF parkland, feeding predominantly on *Bryoria*. While there is often abundant arboreal lichen at lower elevations, the tendency to use higher elevations may result from a combination of the increased lift and support provided by a deeper snowpack, the predominance

Table 2. Approximate dates for Mountain Caribou seasons[a]

Season	Approximate dates: Stevenson et al. (2001)	Approximate dates: Simpson et al. (1997)
Late winter	mid-January – April	mid-January – mid-April
Spring	mid-April – late May	mid-April – May
Summer	June – late October	June – October
Early winter	late October – mid-January	November – mid January

a Seasonal changes are often marked by distinct elevation shifts, and actual dates vary between local-populations, individuals, and years (see Apps et al. 2001).

of *Bryoria* rather than *Alectoria*, the near absence of wolves and cougars (which typically follow the more abundant ungulates to lower elevations in the winter), and the improved ability to see remaining predators (e.g., wolverines) in the open stands typical of higher elevations. During spring, the snowpack at this elevation loses its ability to support caribou, and individuals or small groups move to either exposed sites in the upper ESSF or AT or snow-free elevations in the ICH or lower ESSF to feed on newly emerged green vegetation. In June, pregnant cows ascend individually to high, exposed locations in the ESSF or AT to calve. Such sites offer safety from most predators and relief from biting insects. During summer, caribou typically occur in small groups within the upper ESSF and AT, although there is periodic summer use of the lower ESSF in many local populations, particularly in late August or early September. From mid-September through October, Mountain Caribou beginning aggregating again for the rut. As snow accumulates in early winter, rut groups break up and most local populations shift down slope into the ICH to mid-ESSF, where snow depths are reduced due to lower elevation and greater canopy closure. Foraging at this time is variable. Arboreal lichen on windthrown trees and branches is heavily used, and caribou also crater for terrestrial lichens and winter-green forbs and shrubs such as falsebox (*Pachistima myrsinites*). As snow depth exceeds 50 cm, cratering becomes less energetically efficient and caribou move into late-winter habitat. Habitat shifts between early winter and late winter may occur as a series of events, with downward movement after major snowfalls followed by upward movement as the snow consolidates, until caribou more permanently settle into late-winter habitat in about January.

Most Mountain Caribou appear to stay within the local population in which they were born. In fact, the 13 recognized local populations may under-represent the true number of areas between which there is no to very limited movement. However, temporary movements are occasionally reported between local populations, from established local populations into unused areas, and even into the range of other ecotypes.

Northern Caribou

Although Northern Caribou are characterized by feeding primarily on terrestrial lichens during winter, local populations in British Columbia exhibit variable seasonal movement and habitat use strategies. Some local populations migrate long distances between summer and winter ranges while others do not. Use of high elevation versus low elevation winter ranges differs between local populations, and within local populations between winters. Variation in seasonal behaviour reflects differences in topography, snow accumulation, and availability of low elevation winter ranges between areas. In general, Northern Caribou habitat use in British Columbia can be described using four seasonal time periods similar to Mountain Caribou. Exact dates vary for each population depending on local conditions.

Snowfall in November triggers caribou movement out of high elevation summer ranges to lower elevation early winter ranges. Early winter ranges may be adjacent to the summer range or some distance away. At this time, caribou continue to seek out terrestrial forage and avoid deeper snow accumulations where terrestrial forages are difficult to access. Fall migration between summer and winter ranges tends to be diffuse as caribou migrate in response to snow accumulation.

During early winter, snow depth at low elevations may be highly variable between years. In general, snow depth on low elevation winter ranges is lowest during early winter and gradually increases as the winter progresses. Shallower snow depths in early winter allow caribou to use the higher and more open portions of their forested plateau winter ranges (Itcha-Ilgachuz), or low elevation forested habitats (Wolverine) that are abandoned as snow accumulates during mid- to late-winter.

By mid- and late-winter, caribou have moved to low elevation forested winter ranges, or high elevation alpine/subalpine winter ranges to feed primarily on terrestrial lichens. In low elevation forested habitat, caribou prefer forests where terrestrial lichens are abundant; these are often on drier sites or sites with low productivity and in older forests (80–250 yr). Caribou also feed on arboreal lichens opportunistically as they travel between terrestrial lichen sites or seek arboreal lichens in forested wetlands and along wetland fringes where arboreal lichens are abundant. At higher elevations, caribou prefer windswept alpine slopes for cratering for terrestrial lichens. Subalpine forests are also used for arboreal lichen feeding, and to a lesser extent, terrestrial lichen feeding.

By late April, caribou that migrate between winter and summer ranges begin moving back to calving and summering areas. Spring migration is more concentrated than fall migration both geographically and temporally. During spring, caribou migrate along relatively snow-free low elevation routes to reach summer ranges (Cichowski 1993; Johnson et al. 2002). Caribou that winter at higher elevations move to lower elevations in spring to take advantage of an earlier green-up. Spring ranges may be adjacent to late-winter ranges or may be a function of migration patterns. Female caribou reach calving areas by late May and calve in early June. Most caribou calve at higher elevations in alpine or subalpine habitat where food availability and quality is relatively poor to reduce predation risk since predators focus on other prey that remain at lower elevations where more nutritious forage is available.

During summer, caribou prefer high elevation habitats but can be found in a variety of habitats at all elevations because snow does not limit movement, and herb and shrub forage are abundant. Consequently, Northern Caribou are highly dispersed during summer, more so than during any other season. During the rut in October, some caribou move to rutting areas at higher elevations while others rut within their summer ranges. Portions of some local populations concentrate on rutting ranges, usually in open alpine or subalpine habitat.

Although studies of radio-collared Northern Caribou populations indicate that range use by adjacent local populations may overlap, especially during winter, all radio-collared caribou return to their summering areas. Northern Caribou may potentially be dispersing between local populations but no studies have yet reported any evidence of dispersal by radio-collared animals.

Boreal Caribou

Boreal Caribou do not appear to live in discrete herds but exist in small, dispersed, relatively sedentary bands throughout the year (Edmonds 1991; Heard and Vagt 1996). Although there is no specific published information on movements and habitat use by Boreal Caribou in British Columbia, studies from Alberta provide some general information that could be extrapolated to British Columbia. Boreal Caribou in northern Alberta make extensive movements or "wander" throughout the year (Hornbeck and Moyles 1995; Stuart-Smith et al. 1997) but most do not appear to make predictable seasonal migrations (Dzus 2001). Therefore, winter and summer ranges typically overlap and habitat use does not differ by season (Dzus 2001).

Habitat

Table 3 summarizes habitat characteristics of Woodland Caribou ranges in British Columbia. All habitat features are required to support Woodland Caribou populations.

Structural stage

For Mountain Caribou, structural stage 7 is consistently preferred throughout most of the year for forage, predator avoidance (typically good lines of sight and only dispersed populations of other ungulates), ease of travel, snow interception in early winter, and possibly heat avoidance in the summer (Apps and Kinley 2000a, 2000b, 2000c; Apps et al. 2001). Structural stage 6 also provides useful habitat, particularly the older and more open end of the stage. Other structural stages are used to varying degrees. Structural stage 1a and 1b are used for calving sites when occurring in rough terrain (June), predator avoidance (good line of site), insect avoidance (spring and summer), and resting areas. Structural stages 2 and 3a provide moderate to high forage value in spring and summer but also provide forage for other ungulates, especially below treeline. The least valuable stands to caribou are those in stages 3b, 4, and 5, where line of site is poor for

Table 3. General habitat requirements for Mountain Caribou, Northern Caribou, and Boreal Caribou in British Columbia

Feature	Mountain Caribou	Northern Caribou	Boreal Caribou
Winter food supply	Access to an adequate supply of accessible arboreal lichen	Access to an adequate supply of terrestrial and arboreal lichens	Access to an adequate supply of terrestrial and arboreal lichens
Snow conditions	Snow conditions that allow caribou to travel on top of the snowpack in subalpine areas where they can access arboreal lichens and where avalanche danger is low	Snow interception by forest canopy to allow movements within the winter range	Snow conditions and frozen ground conditions to allow movements through peatlands
Winter range	Large tracts of winter range where caribou can exist at low densities as an anti-predator strategy and rotate their winter ranges		
Calving habitat	Relatively undisturbed high elevation calving habitat where caribou can disperse widely and calve in isolation away from predators	Relatively undisturbed high elevation calving habitat or low elevation forested calving habitat on islands where caribou can disperse widely and calve in isolation away from predators	Large tracts of relatively undisturbed peatland complex calving habitat where caribou can disperse widely and calve in isolation away from predators

predator avoidance and forage value is generally low for caribou but can be high for other ungulates, especially moose (3b). In some cases, these stages may form partial barriers to movement and act to isolate adjacent patches of habitat from one another. Structural stage use by Northern Caribou is similar to Mountain Caribou except that Northern Caribou may forage in structural stage 5, where, in some areas and ecosystems, forage (terrestrial lichens) may be abundant. Less is known about Boreal Caribou; however, they appear to prefer structural stages 1a to 3a, 6, and 7 within muskeg complexes and 6 and 7 in adjacent pine–lichen forests throughout the year.

Important habitats and habitat features

Security and foraging

Security and foraging habitat are typically the same thing for Woodland Caribou on the forested portions of their ranges, at least at broader spatial scales. For Mountain and Northern Caribou, both functions are provided by large, contiguous patches of old forest and for Boreal Caribou, both functions are provided by the older forest component of peatland (muskeg) complexes. Specific values of such areas are as follows:

1. There are generally fewer Elk (*Cervus elaphus*), Deer (*Odocoileus* spp.) or Moose (*Alces alces*) within old-growth forests on Mountain and Northern Caribou ranges and within peatland complexes on Boreal Caribou ranges than in or near non-forested areas (avalanche tracks, meadows, shrubby riparian zones, recent clearcuts), as this more abundant suite of other ungulate species tends to concentrate in early-seral sites with abundant shrubs and forbs. Thus, the predators of other species also tend to occur less commonly within old forest than at the edge or outside of old forest or in peatland complexes. For Northern and Mountain Caribou, habitat fragmentation due to the creation of early seral patches within old forest is likely to bring other prey species close to caribou, resulting in a greater incidence of predator encounters (Kinley and Apps 2001). The potential for increased prey populations on some very dry Northern Caribou ranges may be somewhat reduced where shrub

regeneration following disturbance is less pronounced (e.g., Itcha-Ilgachuz caribou winter range). Similarly, in undisturbed areas for Boreal Caribou, habitat fragmentation due to the creation of linear disturbance and the connection of early seral patches by linear disturbances within peatland complexes is likely to provide "predator trails" and bring other prey species closer to caribou, resulting in a greater incidence of predator encounters (Dyer 1999; Kinley and Apps 2001). This pattern is consistent with that found among other caribou ecotypes, in which the major habitat variable that affects numbers is space to avoid predation (Bergerud 1980; Bergerud et al. 1984a; Bergerud 1992).

2. Old forests typically have good visibility relative to younger forests, due to open stand architecture, leading to an improved ability to detect those predators that do occur there. For Boreal Caribou, peatlands also have good visibility.
3. Arboreal hair lichen such as *Bryoria* are usually abundant only in older forests. Terrestrial lichens such as *Cladina*, *Cladonia,* and *Cetraria* are often most abundant in mature and older forests but are also abundant in younger forests on some site types.
4. Old trees with large crowns provide good snow interception, which facilitates cratering and movement during early winter (Mountain Caribou, Northern Caribou, Boreal Caribou) and winter (Northern Caribou, Boreal Caribou).
5. For Mountain and Northern Caribou, the more contiguous that foraging habitat is, the less energy is expended in moving between patches.
6. For Mountain Caribou, sunlight is screened before reaching understorey plants in old forests with heavy canopies, reducing the development of unpalatable or harmful compounds in forage plants (Rominger et al. 2000) and increasing the retention of moisture to maintain plant vigour during summer dry periods.
7. Old forests and peatland complexes provide a cooler microclimate during summer.
8. The suite of forage plants in old forest is different than that available in other habitat types.

Thus, old forests provide far more than simply lichen for late-winter foraging, and old forests are selected across seasons and a range of spatial scales. On Mountain Caribou ranges, old stands of subalpine fir (*Abies lasiocarpa*) and Engelmann spruce (*Picea engelmannii*) are widely used among caribou of all local populations, including both closed-canopy and parkland stands across a range of soil moisture conditions (see "Broad ecosystem units" above). However, tree species composition shows some variability between regions. On Northern Caribou ranges, old stands of lodgepole pine (*Pinus contorta*) or lodgepole pine and white spruce (*Picea glauca*) in low elevation forested habitat are widely used by most local populations. Boreal Caribou commonly use large patches of peatland with disconnected old forest.

Mountain Caribou also use alpine habitat during summer and Northern Caribou use alpine habitat during summer and winter. Boreal Caribou do not have access to alpine habitats and therefore do not use them. Alpine habitats also provide both forage and security features. During summer, emergent vegetation provides nutritious forage and open vistas provide good visibility for detecting predators. For Northern Caribou, during winter windswept alpine slopes also provide access to terrestrial lichens and good visibility for detecting predators.

For Woodland Caribou generally, the risk of predation is further reduced by existing at very low population densities of ~0.03–0.12 caribou/km^2 (Edmonds 1988; Seip 1991; Bergerud 1992; Stuart-Smith et al. 1997). The availability of extensive range space is thought to be an important habitat characteristic that allows Woodland Caribou to avoid predation (Bergerud 1980; Bergerud et al. 1984). All three ecotypes of Woodland Caribou use "space" to avoid predation, especially during calving. Mountain and Northern caribou move into high elevation habitat, forgoing nutritious forage at lower elevations to seek out remote locations for calving, separated from other caribou and prey, and predators.

Breeding

Calving sites and rut locations are also vulnerable habitat elements, but predicting their locations by habitat type is not feasible. Calving sites are dispersed, may vary between years, and appear to be defined primarily on the basis of isolation from other caribou, other ungulates, and predators. Rutting sites are likely to be more consistent between years, but can be effectively located only with site-specific knowledge gained by monitoring individual caribou local populations.

The most critical aspect of Mountain Caribou and Northern Caribou ranges is access to undisturbed high elevation calving range. In fact, access to undisturbed high elevation calving ranges where caribou can distance themselves from other prey and predators, is the common feature among Mountain Caribou and Northern Caribou local populations that exist today. Historically occurring local populations of Mountain Caribou and Northern Caribou without access to high elevation calving ranges no longer exist in British Columbia.

Mineral licks

Another vulnerable habitat element is mineral licks. Licks are consistently used between years, but can be effectively located only by monitoring individual local populations of caribou.

Conservation and Management

Status

In British Columbia, Mountain Caribou are on the provincial *Red List*, Boreal Caribou are on the provincial *Blue List*, and Northern Caribou in the Southern Mountains National Ecological Area (SMNEA) and in the Northern Mountains National Ecological Area (NMNEA) are on the provincial *Blue List* (Table 4). In Canada, all Woodland Caribou within the entire SMNEA, including all Mountain Caribou and some Northern Caribou local populations in British Columbia, are considered *Threatened* (COSEWIC 2002). Boreal Caribou are also considered Threatened and Northern Caribou in the NMNEA are considered of *Special Concern*.

Trends

Population trends

Mountain caribou

About 99% of the world's 1900 Mountain Caribou live within British Columbia. The B.C. Ministry of Water, Land and Air Protection considers Mountain Caribou to occur as 13 local populations within a metapopulation of 1900 (Hatter et al. 2002). Six of those local populations have 50 or fewer individuals, and 8 are declining; no local populations are increasing (Table 5).

According to local population risk assessment criteria, seven local populations are considered Endangered, one local population is considered Threatened, and five local populations are considered Vulnerable. About 43% of the historic range of Mountain Caribou is no longer occupied, and it is believed that populations have been reduced correspondingly. One estimate of the pre-colonial population of Mountain Caribou (excluding the United States) is 5000–6000 (Demarchi 1999).

Northern caribou

In 2002, there were an estimated 5235 Northern Caribou within the SMNEA and 11 000 Northern Caribou within the NMNEA in British Columbia (Table 6). While numbers may have increased slightly since the late 1970s, it is likely that some of the "apparent" increase is from more intensive survey effort, combined with recent radio-telemetry studies, which has enabled a more reliable status assessment of this ecotype.

Currently, Northern Caribou in the SMNEA are distributed within 13 local populations, which form two metapopulations. The west-central metapopulation includes the Charlotte Alplands, Itcha-Ilgachuz, Rainbows, Tweedsmuir-Entiako, and status of three local populations was unknown. Four local populations have 100 or fewer animals. According to local population risk criteria, two local populations are considered Endangered, six local populations are considered Threatened, four local populations are considered Vulnerable, and one local population is considered Not At Risk. An overall increase in

Table 4. Summary of Woodland Caribou status in British Columbia

	Status			
Ecotype	**Global**	**Provincial**	**COSEWIC (May 2002)**	**BC status**
Dawson Caribou	G5TX	SX	Extinct	Extinct
Mountain Caribou	G5T2Q	S2	Threatened	Red
Northern Caribou (SMNEA)	G5T4	S3S4	Threatened	Blue
Northern Caribou (NMNEA)	G5T4	S3S4	Special Concern	Blue
Boreal Caribou	G5T?	S3	Threatened	Blue

Table 5. Current population estimate (2002), trend, risk status, and density of Mountain Caribou local populations in British Columbia

Local population	Local population estimate	Recent trend[a]	Local population risk status[b]	Risk criteria[c]	Range[d] (km^2)	Density (no./1000 km^2)
South Selkirks	35	Declining	EN	A1	1 500	23
South Purcells	20	Declining	EN	A1	2 962	7
Central Selkirks	130	Declining	EN	A3	4 813	27
Monashee	10	Declining	EN	A1	2 082	5
Revelstoke	225	Declining	VU	A1	7 863	29
Central Rockies	20	Declining	EN	A1	7 265	3
Wells Gray North	220	Declining	VU	A1	6 346	35
Wells Gray South	325	Stable	VU	A1	10 381	31
North Cariboo Mountains	350	Stable	VU	A1	5 911	59
Barkerville	50	Stable	EN	A1	2 535	20
George Mountain	5	Declining	EN	A1	441	11
Narrow Lake	65	Stable	TR	A1	431	151
Hart Ranges	450	Stable	VU	A1	10 261	44
TOTAL	1 905				62 791	30

a Recent trend defined as trend over last 7 years (1 generation length). Trend based on >20% change.

b At risk status based on Thomas and Gray (2001), draft guidelines for quantitative risk assessment of local populations. EN = Endangered; NAR = Not at Risk; TR = Threatened; VU = Vulnerable.

c Risk criteria (from Thomas and Gray 2001), see Hatter et al. (2002, Appendix 3).

d Current occupied range.

Table 6. Current population estimate (2002), trend, risk status, and density of Northern Caribou local populations in British Columbia

Local population	Population estimate	Recent trend[a]	Local population risk status[b]	Risk criteria[c]	Range[d] (km^2)	Density (no./1000 km^2)
Southern Mountains National Ecological Area						
Charlotte Alplands	50	Declining	EN	A1	2 650	19
Itcha-Ilgachuz	2 500	Increasing	NAR	A1	9 457	264
Rainbows	125	Stable	TR	A2	3 804	33
Tweedsmuir-Entiako	300	Declining	TR	A3, C3	12 811	23
Telkwa	55	Increasing	EN	A1	1 828	30
Quintette	200	Unknown	VU	A1	1 421	141
Kennedy Siding	170	Increasing	VU	A1	1 470	116
Moberly	170	Declining	TR	A2	5 115	33
Wolverine	590	Increasing	VU	A1	8 315	71
Takla	100	Unknown	TR	A1	1 850	54
Chase	575	Stable	VU	A1, A2	11 390	50
Graham	300	Declining	TR	A3	4 734	63
Belcourt	100	Unknown	TR	A1	2 045	49
TOTAL	5 235				66 890	78
Northern Mountains National Ecological Area						
Pink Mountain	850	Declining	VU	A1	11 602	73
Finlay	200	Unknown	VU	A1	3 084	65
Spatsizi	2 200	Stable	NAR	A1	16 929	130
Mount Edziza	100	Unknown	TR	A1	1 281	78
Level-Kawdy	1650	Stable	NAR	A1	12 568	131
Tsenaglode	200	Unknown	VU	A1	3 015	66
Frog	150	Unknown	VU	A1	2 421	62
Gataga	250	Unknown	VU	A1	4 437	56
Muskwa	1 250	Unknown	NAR	A1	16 786	74
Rabbit	800	Unknown	VU	A1	5 936	135
Liard Plateau	150	Stable	VU	A1	5 069	30
Horse Ranch/Cry Lake	850	Stable	VU	A1	9 499	89
Little Rancheria	1 000	Stable	NAR	A1	7 431	135
Jennings	200	Unknown	VU	A1	4 080	49
Atlin East	800	Stable	VU	A1	7 053	113
Atlin West	350	Stable	VU	A1	4 398	80
TOTAL	11 000				115 590	95

a Recent trend defined as trend over last 7 years (1 generation length). Trend based on >20% change.

b At risk status based on Thomas and Gray (2001), draft guidelines for quantitative risk assessment of local populations. EN = Endangered; NAR = Not at Risk; TR = Threatened; VU = Vulnerable.

c Risk criteria (from Thomas and Gray 2001), see Hatter et al. (2002, Appendix 3).

d Current occupied range.

Northern Caribou numbers in the SMNEA has been strongly influenced by the increase of the Itcha-Ilgachuz caribou population over the last 8 years (from 1400 to 2500; $\lambda = 1.075$), which is the largest local population in the SMNEA.

Telkwa local populations. The north-central metapopulation includes the other eight local populations in the SMNEA. In 2002, four local populations were declining, two were stable, four were increasing, and the Currently, Northern Caribou in the NMNEA are distributed within 16 local populations. Metapopulation structure has not yet been assessed for these local populations. In 2002, one local population was declining, seven were stable and the status of eight local populations was unknown. Six local populations have 200 or fewer animals. According to local population risk criteria, 12 local populations are considered Vulnerable and 5 local populations are considered Not At Risk. Little population information is available for many of the Northern Caribou local populations in the NMNEA.

Boreal caribou

The only estimate of Boreal Caribou numbers in British Columbia is 725 (Heard and Vagt 1996). The current estimate is based on that number (Table 7); however, the reliability of this estimate is unknown. Currently, there is no information on metapopulation structure or on population trend. According to COSEWIC criteria, Boreal Caribou in northeastern British Columbia are considered Vulnerable.

Habitat trends

There is little quantitative information on Woodland Caribou habitat trends in British Columbia; however, Woodland Caribou rely on large tracts of older forests where terrestrial and/or arboreal lichens are abundant and where they can use "space" to avoid predators. Industrial activities such as forest harvesting and oil and gas development affect Woodland Caribou habitat through fragmentation and conversion of older forests to early seral stands. The current rate of loss and fragmentation of caribou habitat through forest harvesting, oil and gas development, and natural disturbances (fire and forest insects) appears to be greater than the rate of habitat recruitment.

Threats

Population threats

Threats to Woodland Caribou populations may affect caribou numbers directly through mortality or indirectly through disturbance or displacement resulting in increased energetic costs or mortality risks. Direct threats include predation, hunting, poaching, vehicle collisions, and diseases and parasites. Indirect threats include road development and associated traffic, persistent recreational activities on caribou ranges, and habitat alteration that results in increased mortality risks.

Table 7. Current population estimate (2002), trend, risk status, and density of Boreal Caribou in British Columbia

Local population	Population estimate	Recent trend[a]	Population risk status[b]	Risk criteria[c]	Range[d] (km^2)	Density (no./1000 km^2)
Boreal Caribou	725	Unknown	VU	A1	51 541	14

a Recent trend defined as trend over last 7 years (1 generation length). Trend based on >20% change.

b At risk status based on Thomas and Gray (2001), draft guidelines for quantitative risk assessment of local populations. EN = Endangered; NAR = Not at Risk; TR = Threatened; VU = Vulnerable.

c Risk criteria (from Thomas and Gray 2001), see Hatter et al. (2002, Appendix 3).

d Current occupied range.

Predation

Woodland Caribou populations in British Columbia exist within dynamic and complex predator–prey systems. Wolves appear to be the most significant predator, but bear predation during early summer contributes significant mortality in some areas. Recent studies (see Seip and Cichowski 1996) have found that predation during the summer can be a major cause of caribou mortality. The increase in moose populations in central British Columbia during the 1900s has been associated with long-term declines in the number of some caribou populations and extirpation of caribou from previously occupied areas (Seip and Cichowski 1996). Increased moose populations may have led to caribou declines because moose can sustain wolf numbers even when caribou number decline. In contrast, in a caribou/wolf system, wolf numbers would decline along with any decline in caribou numbers and allow for a subsequent recovery in caribou numbers (Seip 1992a). The susceptibility of caribou to predation may also be influenced by habitat change as favourable moose browsing conditions in cutblocks result in widespread distribution of moose and wolves. Disturbance to the forest (forest harvesting, fire, etc.), whether human-caused or natural, alters the distribution of early seral habitats. Such disturbance could be detrimental to caribou if it increases their contact with predators associated with other ungulates that use early seral stands, such as deer, elk, and moose. Seip (1992a) suggested that wolf predation can eliminate caribou from areas where the wolf population is sustained by other prey species because there is no negative feedback on the number of wolves as caribou numbers decline. If true, this would mean that wolves could persist on moose as they extirpate local caribou populations.

Within a multiple predator–prey system, it is possible for predator numbers to remain relatively high even if predation (or human harvest) has drastically reduced one of the prey species. Caribou are extremely vulnerable to wolf predation compared with most other ungulates (Seip 1991). Caribou usually occur at much lower densities, have larger home ranges, and do not normally use habitats frequented by moose or deer. They also do not use escape terrain as efficiently as mountain sheep or mountain goats, and they have a low reproductive rate relative to moose or mule deer. Therefore, caribou are usually the most vulnerable species in a multiple predator–prey system, the first to decline and the last to recover (Seip 1991). Seip (1992a) suggested that wolf predation can eliminate caribou from areas where the wolf population is sustained by other prey species, because there is no negative feedback on the number of wolves as caribou decline in numbers. Thus, wolves could persist on moose or deer as they extirpate local caribou populations.

Human-caused mortalities

Aboriginal people who are hunting within their traditional territories may legally hunt caribou. There are no legal hunting seasons on Mountain Caribou or Boreal Caribou in British Columbia for resident or non-resident hunters, but poaching and “mistaken identity” shootings probably remove some animals, as do motor vehicle collisions. The extent of this mortality is unknown, although Johnson (1985) found human-caused deaths in the South Selkirks Mountain Caribou local population to equal recruitment in some years. Legal hunting seasons for resident and non-resident hunters exist for most Northern Caribou local populations in the NMNEA. Hunting regulations are generally conservative with either a five-point bull, Limited Entry Hunt regulation, or a combination of both. Hunting mortality is low for most Northern Caribou local populations in the SMNEA with most of the hunter harvest concentrated in the Itcha-Ilgachuz and Chase local populations. There are no legal hunting seasons for seven of the 13 local populations in the SMNEA (Charlotte Alplands, Rainbows, Telkwa, Takla, Kennedy-Siding, Wolverine, Belcourt) and for one of the 16 local populations in the NMNEA (Mount Edziza). Parts of three Northern Caribou ranges fall within No Hunting areas or Caribou Closed areas (Atlin West, Spatsizi, Tweedsmuir-Entiako).

Diseases and parasites

There do not appear to be any diseases or parasites occurring with enough frequency among Mountain Caribou to pose a significant population-level health risk. Parasites reported by McTaggart-Cowan (1951) from caribou elsewhere in British Columbia or adjacent areas of Alberta include caribou nostril-fly or caribou bot fly (*Cephenemyia trompe* = *C. nasalis* = *Oestrus trompe*), caribou warble (*Hypoderma tarandi* = *Oestrus tarandi* = *Hypoderma tarandi*), thin-necked bladderworm (*Cysticercus tenuicollis*), the tapeworm *Cysticercus krabbei*, and pinworm (*Skrjabinema oreamni*). Other caribou parasites in British Columbia include hydatid cysts (*Echinococcus granulosus*) and the nematode *Parelaphostrongylus odocoilei* (H. Schwantje, pers. comm.). Winter ticks (*Demacentor albipictus*) have been recorded on caribou in Alberta (Samuel 1993) so likely also occur on B.C. caribou. Besnoitia (*Besnoitia tarandi*) is a protozoan that forms cysts in the connective tissue of caribou and other intermediate hosts. It can be fatal (Glover et al. 1990) but rarely is, generally resulting only in dermal damage (H. Schwantje, pers. comm.). This parasite was found in 23% of 320 caribou leg pairs examined from British Columbia, but most of the infections were from the far northern part of the province and few had skin lesions (R. Lewis, pers. comm.). Liver flukes (*Fascioloides magna*) have not been recorded from caribou in British Columbia, but occur in caribou of northern Quebec and other ungulates in British Columbia. The risk of liver flukes occurring in caribou is greater when there is overlap with elk or white-tailed deer (F. Leighton, pers. comm.), so their eventual occurrence in Mountain Caribou can be expected due to increasing range overlap with other ungulates. One of the greatest potential risks to Woodland Caribou from parasites may be the meningeal worm (*Parelaphostrongylus tenuis*) in areas where it occurs. It is a parasite of white-tailed deer throughout eastern North America. The adult worms live in the spaces around the brain in white-tailed deer and rarely cause disease. However, when other cervids, such as caribou, are infected the worms migrate to the central nervous system causing severe, usually fatal, neurological disease. Fortunately the parasite has not been found to date west of the Manitoba-Saskatchewan border.

Population size

Within the 12 smallest local populations (local populations ≤100 caribou: seven Mountain Caribou local populations, five Northern Caribou local populations), the most immediate threat is simply low population size. Low numbers increase the probability that a random event (i.e., one predator, one emigration movement, one avalanche, one extreme weather event, a few key animals poached) will remove a large proportion of the breeding population and also increase the chance of creating an unfavourable sex composition. There are no reliable estimates of the minimum viable population size for Woodland Caribou.

Access/Disturbance

One of the major indirect threats to Woodland Caribou populations is increasing road development and access into their habitat (Bergerud 1978; Johnson 1985; Seip 1991). The resulting threat may take several forms. Improved access to the summer calving range may increase risk of disturbance by humans during calving; calving areas are the most sensitive of all habitats for caribou (Seip and Cichowski 1996) and require protection. Historically, overhunting was primarily a result of road access associated with human industrial and recreational development (Bergerud 1978; Stevenson and Hatler 1985). While the more accessible Woodland Caribou populations are currently not hunted, poaching losses, which are most common along roads during hunting season for other game species, remain a concern. Road kills can also be a concern, such as those that have occurred with the opening of Highway 3 across the range of the South Selkirk Mountain Caribou local population (Johnson 1976; Simpson et al. 1994).

The effects of disturbance of human activities on caribou are more difficult to document and remain controversial. Hauling by logging trucks in Ontario apparently caused Woodland Caribou to move out of the haul road areas that were preferentially used by caribou in the years before and after hauling

(Cumming and Hyer 1998). In Alberta, simulated petroleum exploration noise was also found to increase energy expenditure by Woodland Caribou (Bradshaw et al. 1997). Physical disturbance from such exploration, such as roads, drilling sites, and seismic lines resulted in avoidance of habitats well beyond actual development "footprints" (Dyer et al. 2001).

After noting the absence of studies showing that disturbance limits caribou populations, Bergerud et al. (1984b) concluded that disturbance should not pose a major threat provided sufficient space is available for caribou to escape unwelcome stimuli. They qualified this conclusion by adding that there is likely an upper limit to the tenacity of caribou to withstand disturbance. Eight years later, Harrington and Veitch (1992) demonstrated this upper limit for Woodland Caribou in Labrador where calf survival during both calving and post-calving periods was negatively correlated to the exposure of females to low-altitude jet flyovers. This led the authors to suggest that the greatest effects of disturbance on calf survival occur during critical periods when other stressors are also acting. Research on stress effects of recreation specific to caribou requires further development; however, a recent study in Yellowstone National Park (Creel et al. 2002) documented a significant increase in stress-related hormone levels in elk and wolves during the snowmobile season. For elk, these levels increased in concert with the daily number of snowmobiles. The authors also noted that despite these stress responses, there was no evidence that current levels of snowmobile activity were affecting the population dynamics of either species.

Recreation

Studies such as Harrington and Veitch (1992) add support to a growing concern that excessive levels of recreational activity within caribou winter range may place animals under stress and displace caribou from suitable winter habitats (Stuart-Smith et al. 1996). Mountain Caribou local populations and some or portions of Northern Caribou local populations use subalpine or alpine terrain during winter. In some areas, Mountain Caribou habitat overlap snowmobile use areas; areas of heavy use by snowmobiles may displace caribou into less desirable foraging habitat and where mortality risks (i.e., predation, avalanches) are higher. The creation of trails in an area may also render caribou vulnerable to predators (James and Stuart-Smith 2000). Compacted trails such as those created by snowmobiling and snowshoeing may provide easier travel corridors for wolves into late winter caribou habitats (Bergerud 1996). Dumont (1993) found that hikers in the Gaspésie disrupted normal caribou behaviours, and shifted caribou from preferred areas on the summit to wooded areas with higher predation risk.

The increasing interest in recreational snowmobiling, combined with better access from roads to high-elevation cutblocks and more powerful machines that are able to access Woodland Caribou ranges, is believed to represent a significant threat to many Mountain Caribou local populations and some Northern Caribou local populations currently, and a significant threat to other populations in the future as access increases into their ranges. A recent review of the potential impacts of four winter backcountry recreation activities on Mountain Caribou, including snowmobiling, heli-skiing, snowcat skiing, and backcountry skiing, indicated that snowmobiling has the greatest perceived threat to Mountain Caribou (Simpson and Terry 2000). Although there is no documentation in British Columbia that snowmobiling has permanently displaced caribou off winter ranges, a single occurrence of snowmobile use in alpine habitat in the Tweedsmuir-Entiako caribou winter range displaced radio-collared caribou from that area for the duration of the winter (D. Cichowski, pers. obs.).

Industrial activities

Industrial activities may alter predator–prey relationships and potentially could increase the total predation rate of caribou by:

- producing early seral stages with enhanced understorey shrub and forb production which may increase the abundance of other ungulates or change ungulate distribution within Woodland Caribou habitat; specifically:

- increased shrub production at low elevations may increase ungulate populations (e.g., elk, deer, and moose) which in turn may increase predator populations, leading to more predator–prey encounters with caribou during winter;
- increased forb production at higher elevations may attract elk, moose, and deer into caribou habitat during summer; predators following their prey into these higher elevation areas may come into contact with caribou more frequently, leading to increased predation rates on caribou during summer;
- restricting caribou into mature forest habitat patches which may increase the search efficiency of predators; and/or
- providing easier access, through construction of roads, for predators to travel into caribou habitats and prey on caribou (James and Stuart-Smith 2000).

In addition, all threats identified below under "Habitat threats" are threats to population size and viability. There is little or no evidence that Woodland Caribou can be maintained over the long term in areas having relatively high levels of forestry, predation, and recreation activity.

Habitat threats

One of the main long-term threats to Woodland Caribou habitat is the reduction and fragmentation of contiguous old-growth forest, mainly due to industrial activities such as forest harvesting. Fragmentation of old forest and peatland complexes in Boreal Caribou habitat in northeastern British Columbia by oil and gas development is also a concern. Past fires have also contributed to the loss of habitat over large areas, and there are risks of future large fires. Forest insects are also currently playing a larger role in forest renewal on some Northern Caribou ranges. Habitat loss has several effects:

- It reduces the amount of space available for caribou, thereby limiting ecological carrying capacity.
- Terrestrial and arboreal lichen supply (although currently not limiting) may be reduced. Because lichen regeneration is often slow, impacts on lichen supply are often long term.
- It may impact caribou movement patterns.
- By fragmenting habitat, it may decrease the chance of caribou using some portions of the remaining habitat, because parcels tend to be smaller and discontinuous. Alternatively, if the remaining parcels are used, caribou may expend more energy travelling between patches.
- Caribou can become more susceptible to predation as available habitat is compressed and fragmented (see "Population threats").

Forest harvesting

Forest harvesting has been recognized as the greatest concern to Mountain Caribou habitat management over the past 20 years. Early winter habitat in the ICH has always been attractive for forest harvesting due to good forest productivity on those sites. Late winter ESSF habitat has only recently (last 10 yr) become attractive for forest harvesting. Prior to the 1970s there was little industrial activity on low productivity Northern Caribou low elevation winter ranges in British Columbia. Relatively low-value pine forests and the remote location of most of those winter ranges made them unattractive for forest harvesting. Improved road access, developments in log processing that resulted in better utilization of smaller trees, suitable sites for conducting summer logging (dry pine sites) which are often in short supply, and a growing demand for pulp contributed to increased interest in caribou winter ranges for forest harvesting.

Forest harvesting affects Woodland Caribou winter habitat at both the stand and landscape levels. At the stand level, some harvesting and silvicultural techniques disturb lichens. Because lichen regeneration is slow, forest harvesting has long-term implications for caribou winter habitat. Harvesting techniques that minimize disturbance to lichens may help reduce stand level impacts. Although food supply (lichens) is currently not a limiting factor, cumulative impacts of forest harvesting over time could potentially have long-term impacts on food supply. Caribou require an adequate supply of lichens over the landscape to allow for rotation of winter ranges. Forest fragmentation could potentially result in caribou concentrating on portions of their range, thereby depleting lichen reserves over time.

At the landscape level, forest harvesting results in a patchwork of different forest age classes, which leads to avoidance and possibly abandonment of that portion of the winter range (Smith et al. 2000). Caribou populations persist at low densities due to a number of interacting factors, including predation (Bergerud et al. 1984b; Bergerud and Page 1987). Abandoning a portion of a winter range forces caribou to concentrate in a smaller area, which may lead to increased predator efficiency by making them easier for predators to locate (Seip 1991). A patchwork of early seral and mature forests may also enhance habitat for other prey species such as moose that prefer early seral forests, which could lead to increased predator numbers and increased predation on caribou (Seip 1992a). Potential indirect effects of forest harvesting and habitat fragmentation on caribou populations through increased energetic costs and predation risk are discussed in the "Population threats" section.

Although caribou winter habitat must provide adequate amounts of terrestrial lichen, it is now recognized that food is not the primary limiting factor, and that the distribution of both the summer and winter habitats on the landscape, and the ability of caribou to become spatially separated from predators, particularly during the summer months, are the most important factors to the long-term persistence of Northern Caribou (Seip and Cichowski 1996). Forest harvesting practices that produce a patchwork of different forest age classes linked with a network of roads may contain enough lichens to support a caribou population, but probably will not provide an environment where caribou can effectively avoid predators and poachers. The threat from increasing predation may also be exerted at broader scales, independent of issues of fine-scale habitat changes. Predation risk has probably increased over roughly the past century due both to larger numbers of predators at the regional level and less spatial separation due to habitat fragmentation at the stand or landscape level. Ongoing forest harvesting by conventional means may make this situation more severe.

The ability of caribou to move through fragmented habitats or barriers is not well known. However, Smith et al. (2000) documented that Northern Caribou avoid portions of their winter range that have been fragmented by logging. Large human-caused fire-created openings 10–15 km wide have isolated the Narrow Lake and George Mountain local populations of Mountain Caribou (Simpson et al. 1997; Heard and Vagt 1998). Highways and roads may also limit caribou movements, particularly to female and young caribou moving between seasonal ranges (Simpson et al. 1994). Caribou north of Revelstoke appear unwilling to venture south of the Canadian Pacific Railway tracks and the Trans-Canada Highway, possibly due to the rail and highway corridors or to the dense, second-growth stands (Simpson et al. 1997). However, caribou appear to regularly cross Highway 16, east of Prince George, between the North Cariboo Mountains and the Hart Ranges (D. Heard, pers. comm.), and caribou elsewhere in the world make regular migrations through greatly varied habitat conditions. Even if caribou do cross fragmented habitats, there may be costs associated with increased energy expenditure required to locate isolated foraging patches, as well as increased exposure to human-caused harassment and mortality.

Although little information is available on Boreal Caribou in British Columbia, resource extraction in the form of forestry, petroleum and natural gas exploration and production, mining (coal, peat, and potentially diamonds), and agricultural expansion are all recognized as potentially having negative impacts on Boreal Caribou in Alberta (Dzus 2001).

Natural disturbances

Fire and forest insects are important disturbance factors on many Northern Caribou ranges. Fire suppression has resulted in reduced fire impacts on most woodland caribou ranges in central

British Columbia over the last 40 years, although fire disturbance has likely had greater impacts on caribou ranges in the northern part of the province. Recently, mountain pine beetles have affected a significant portion of the Tweedsmuir-Entiako Northern Caribou range. Although the effects of mountain pine beetles on caribou habitat and winter range use are not known, mountain pine beetles could potentially result in increased or decreased lichen productivity depending on site conditions. A reduction in the forest canopy and consequently snow interception could have implications to caribou movement and foraging during winter. Eventual blowdown of beetle-killed trees could also have implications for caribou movement. Larger mountain pine beetle outbreaks are often managed through increased forest harvesting efforts; extensive salvage logging also occurs soon after beetle attack. Winter ranges not located in protected areas will likely be subjected to increased forest harvesting and salvage if mountain pine beetle outbreaks occur, leading to concerns over the additive effects of mountain pine beetles, forest harvesting for mountain pine beetle management, and salvage logging of mountain pine beetle killed forests on caribou winter ranges.

Climate change

Climage change has the potential to affect Caribou habitat through changes to natural disturbance regimes and vegetation structure which may ultimately lead to changes in lichen abundance.

Legal Protection and Habitat Conservation

All Woodland Caribou in British Columbia are protected from willful killing, wounding, and taking, and legal harvesting is regulated under the provincial *Wildlife Act*. Hunting of Mountain Caribou and Boreal Caribou is prohibited while hunting for 22 of the 29 Northern Caribou local populations is currently permitted.

Protected areas, both provincial and federal, provide habitat protection from industrial activities and unroaded wilderness. Some of the larger protected areas occurring in Woodland Caribou ranges are Wells Gray Provincial Park, Glacier National Park, Tweedsmuir Provincial Park, Itcha-Ilgachuz Provincial Park, Entiako Provincial Park and Protected Area, Spatsizi Plateau Wilderness Provincial Park, Stikine River Provincial Park, and Mount Edziza Provincial Park.

Under the results based code, specific regulations address winter range and mineral licks.

Land use plans (LUP) or land and resource management plans (LRMP) have been developed for all areas where Mountain Caribou and Boreal Caribou regularly occur and for most areas where Northern Caribou occur (see Cichowski 2003). Resource management zone (RMZ) objectives from these have been or are being considered for designation as higher level plans or establishment of legal objectives under the *Land Act*.

Mountain caribou

For Mountain Caribou, each LUP or LRMP requires or allows for:

- zones where there will be no or very limited timber harvest;
- zones where modified timber harvest to maintain habitat values will occur; and
- areas with no special provisions for caribou.

However, guidelines have not been developed according to provincial standards, and the level of habitat protection varies regionally (Table 8). The great majority of recently occupied Mountain Caribou range within the Cariboo-Chilcotin Land Use Plan area is now within (in descending order) provincial parks, no-harvest zones, or modified-harvest zones and the Mountain Caribou Strategy provides specific and detailed guidance on silvicultural systems (Youds et al. 2000). The Prince George and Robson Valley LRMPs have included most of the caribou habitat within interim deferral areas and to a lesser degree, in parks. The Kamloops LRMP area is immediately adjacent to Wells Gray Provincial Park so caribou there have habitat security within Wells Gray and a few new parks, and 20–33% of the caribou zone outside of parks is to be maintained

Table 8. Current approaches to Mountain Caribou habitat management within LRMPs and LUPs

LRMP/LUP	Approach
Cariboo-Chilcotin	No-harvest and modified-harvest zones, each of which is mapped.
Kootenay-Boundary	No-harvest and modified-harvest zones conceptual only. Overall management areas are mapped, but precise locations of zones are not (in progress).
Prince George	No-harvest and modified-harvest zones, each of which is mapped (but no-harvest zones may become available for modified harvest, pending results in areas now designated for modified harvest).
Robson Valley	No-harvest and modified-harvest zones, each of which is mapped (but no-harvest zones may become available for modified harvest, pending results in areas now designated for modified harvest).
Kamloops	Similar to Kootenay/Boundary but based on the retention of old-growth attributes, not old-growth forests per se, and partial cutting is preferred but not required in non-reserve areas.
Okanagan-Shuswap	Identifies OGMAs to be maintained as reserves and also identifies research areas, which may later become reserves, conventional harvest areas, or modified-harvest areas, pending research results.

with old-growth attributes. The Okanagan-Shuswap LRMP allots approximately 20% of the caribou resource management zone to Old-Growth Management Areas (OGMAs) and about 3% to new or existing parks, with a further 20% deferred as research areas. The Kootenay-Boundary Land Use Plan allocates 40–50% of the operable portion of caribou management areas for reserves or modified harvest, and perhaps 10% of the total occupied caribou range is in new or existing provincial and federal parks.

Mountain Caribou have been a major consideration in the designation of OGMAs, but these often overlap with lands that were already, or would otherwise have been, reserved for caribou, so generally do not add additional protection. In the Okanagan-Shuswap LRMP, all permanent caribou reserves are OGMAs. Areas that are currently considered inoperable provide additional habitat for each local population of caribou, but the extent of these is likely to be reduced as technological or economic conditions change.

Access management approaches and (for most plans) guidelines for alternative silvicultural systems are less specific than habitat protection guidelines and are typically not included in higher level plans. Local decisions on alternative silviculture will presumably be guided mainly by the recommendations for managers guidebook (Stevenson et al. 2001). Interim guidelines for access and disturbance management relative to new commercial recreation tenures have been developed (MELP 2000).

A recovery strategy for the entire Mountain Caribou metapopulation has recently been completed (Hatter et al. 2002) and a recovery action plan specific to the South Purcell local population is currently being developed (Kinley 2000). Plans for other local populations may be developed in the future as determined by Regional Action Groups (Hatter et al. 2002). The recovery strategy and proposed recovery action plan for the South Purcell local population do not create any additional legal obligations. However, they do indicate an intent to maintain Mountain Caribou, consistent with the federal-provincial National Accord for the Protection of Species at Risk, and will provide a benchmark from which to measure regional and sub-regional management plans. Several factors influencing caribou population viability that do not fall within the results based code or do so only partially are addressed in recovery plans, including population goals for predators and alternate prey species, and motorized recreation management.

Northern caribou

Current strategies to protect local populations of Northern Caribou and habitat have been mostly developed independently for each population and are reflected in regional land and resource management plans (Chicowski 2003). Although there is no province-wide strategy that guides management direction for all local populations of Northern Caribou, planning efforts have often been co-ordinated between land use planning processes that share a common caribou winter range. However, core caribou ranges for some local populations, and corridor/linkage areas between local populations still must be mapped and considered in various plans.

Some form of caribou habitat management guideline(s) or planning/operational direction is in place in most MWLAP regions that support Northern Caribou. Currently, an LRMP process is underway for the Morice Forest District which includes portions of three Northern Caribou local populations in the SMNEA (Tweedsmuir-Entiako, Telkwa, Takla) and a Strategic Resource Management Plan is being developed for the Dease/Liard portion of the Bulkley-Cassiar Forest District. Only two areas remain without regional level management plans: the Nass portion of the Kalum Forest District, which includes a small portion of the Spatsizi caribou local population's range; and the Atlin-Taku region of the Bulkley-Cassiar Forest District, which includes four local populations (Atlin West, Atlin East, Jennings, Level-Kawdy).

Prescriptions vary by planning area and local populations of caribou although communication between planning processes has resulted in mostly consistent prescriptions for local populations of caribou whose ranges straddle planning areas. Most plans consist of a combination of protected area or no-harvest zone in portions of each caribou range, with varying degrees of industrial activity within the rest of the range. Although unprotected portions of most caribou ranges have some special management status, large portions of some ranges are located in general resource management zones or even enhanced resource management zones.

In most of the land use plans, caribou and caribou habitat management are a high priority. District-wide Caribou Management Strategies were developed in the Mackenzie, Cassiar-Iskut-Stikine, and Fort St. James LRMPs. In the Lakes, Vanderhoof, and Bulkley LRMPs, caribou management strategies are concentrated within resource management zones that encompass most of the caribou range found in those districts. The Cariboo-Chilcotin Land Use Plan also defines a regional level Northern Caribou Strategy, that provides specific direction on all aspects of caribou management including mountain pine beetle infestations (Youds et al. 2002). The Dawson Creek, Fort St. John, Fort Nelson, and Prince George LRMPs do not contain specific district wide strategies for managing caribou and caribou habitat; instead, caribou management guidelines have been developed for individual resource management zones. However, portions of the Fort St. John, Fort Nelson, and Mackenzie LRMP areas are included within the Muskwa-Kechika Management Area, which includes special provisions for access management and resource extraction. Many of the protected areas established under the *Environmental Land Use Act* within the Muskwa-Kechika Management Area contain provisions for road corridors and most of the area outside of protected areas is under special management.

Although large-scale mountain pine beetle outbreaks have occurred or may potentially occur in most caribou winter ranges in the central part of the province, most of the land use plans provide little guidance for mountain pine beetle management on caribou winter ranges. Potential additive effects of mountain pine beetles, mountain pine beetle management, and salvage logging are of concern.

In general, most Northern Caribou management prescriptions in these plans focus on:

- avoiding critical habitats through no harvesting or special management;
- providing large contiguous areas of mature and old forest;
- conducting harvesting strategies that emulate natural disturbances;

- maintaining forest structure and age classes close to natural disturbance patterns;
- creating large forest harvesting openings and concentrating them in time and space to minimize industrial activity on caribou ranges;
- using forest harvesting and silvicultural systems that enhance retention and recovery of terrestrial lichens; and,
- developing recreation and access management strategies that limit or prohibit recreational activities and access in specific areas during critical seasons.

Boreal caribou

Boreal Caribou range in British Columbia falls within two forest districts with completed LRMPs: the Fort Nelson LRMP and the Fort St. John LRMP. There are no district-wide caribou management strategies and strategies for Boreal Caribou are primarily contained in individual resource management zones. In the Fort Nelson LRMP, most of the Boreal Caribou range is in enhanced resource development zones with the southwestern portion in general resource development zones; provisions for caribou are included under general provisions for wildlife. In the Fort St. John LRMP, most of the Boreal Caribou range is in general management zones with a small portion in enhanced resource development, and the southern portion in the agriculture/settlement zone. Provisions for caribou vary between resource management zones with some zones with caribou-specific provisions and others with general wildlife provisions. Lack of management strategies specifically for Boreal Caribou is likely partially due to the lack of knowledge about this ecotype in British Columbia.

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

A conservation assessment should be conducted for Woodland Caribou metapopulations to determine the relative risk to long-term persistence of each metapopulation and ecotype based on current management guidelines, and also on a range of potentially more or less stringent guidelines. LRMPs and LUPs provide a suitable scale of management for Woodland Caribou because individual caribou are wide-ranging and use a variety of sites within and between years, yet each local population occurs within a reasonably well-defined geographic and habitat range. Furthermore, regional differences in Woodland Caribou ecology and in forest harvesting history indicate that detailed management direction is best provided through a series of regional plans than through a single provincial plan. However, broad approaches are best standardized at a provincial scale to ensure better understanding of the purpose of areas given special designation for caribou, and to ensure that all regional plans meet the basic requirements of Woodland Caribou. The following recommendations should be considered when existing higher level plans are periodically reviewed and revised.

- ❖ Conduct local conservation assessments (including risk assessments) for the local population or area under consideration. The assessment should consider risks to the individual local population and the metapopulation based on current guidelines, and therefore determine the relative need for no-harvest relative to modified-harvest and conventional-harvest zones, and effects of resource exploration activities.
- ❖ Identify areas that should be designated as no-harvest zones, where there will be no or very limited harvest, and/or modified-harvest zones, where partial cutting that maintains habitat values may occur. Within the no-harvest zones, include inoperable areas that are suitable for caribou, in addition to appropriate operable areas.
- ❖ Map the final boundaries of no-harvest zones or modified-harvest zones at 1:20 000.
- ❖ For Mountain Caribou, where plans currently advocate or permit the use of extended-rotation clearcuts (typically 240 yr), either via conventional blocks or strip harvesting, consider a shift to a mix of permanent no-harvest zones and conventional harvest (no caribou constraint) zones, and formalize this as an option in the plans. The percentage of the plan area potentially shifted from long-rotation to no-harvest should

be calculated on the basis of modelling long-term timber production reductions that would otherwise result from the extended rotation. The advantages of smaller permanent no-harvest zones versus larger areas on extended rotations would be:

– no new economic impact relative to existing extended rotation assumptions, yet retention of a large portion of the planning area as caribou habitat;
– a greater assurance that designated habitat would in fact provide suitable habitat because it would be of natural origin and older age, rather than originating as a plantation with a maximum age of 160–240 years;
– fewer roads and off-road access points;
– long-term spatial certainty regarding the areas that would provide caribou habitat, which would simplify planning and allow caribou to develop traditions of use; and
– overlapping of benefits to other obligates of very old forests.

The disadvantage is that less gross area would be managed for caribou. This option should also be considered in cases where long-rotation group- or single-tree selection is currently planned, although there are likely to be fewer benefits in changing to the mixed no-harvest/conventional harvest scenario in such instances. For plans that currently recommend the use of clearcut harvesting with moderate block sizes (~1–40 ha), consider a shift to guidelines requiring partial cutting through single-tree selection or group selection or, as a secondary option, a mix of very large cutblocks and very large reserves as outlined in Stevenson et al. (2001). This will reduce the degree of landscape fragmentation relative to an equivalent area of moderate-sized clearcut blocks, and should therefore reduce the enhancement of habitat for other ungulates and allow caribou to separate themselves from predators.

❖ For plans in which habitat-influenced predation risk is not explicitly identified as an issue relative to forest harvesting, it should be added to revised versions of the plans.
❖ Revise existing guidelines for movement routes based on new research. Add guidelines to plans currently lacking them. As research indicates differences in habitat requirements for providing long-term genetic connectivity between local populations versus regular local intra- or interseasonal movement, modify plans to ensure that the terminology and guidelines are appropriate for the type of movement intended to be facilitated.
❖ Revise access management guidelines based on new research. Add access guidelines to plans currently lacking them. Do not create new roads or upgrade existing roads in areas where forests have been reserved as caribou habitat. To the extent possible, deactivate or close existing roads in areas reserved or managed for caribou when the roads are no longer required for industrial activities. Guidelines for the management of both commercial and non-commercial mechanized backcountry recreation should be adopted, based on the interim management guidelines recommended by Simpson and Terry (2000).
❖ Ensure a mechanism is included to allow the boundaries or locations of no-harvest and modified-harvest zones to be modified as additional information becomes available about caribou distribution, habitat use, risks associated with various management options, and requirements for long-term viability. This mechanism should also allow boundary changes necessary for the recovery of currently depressed local populations, including augmentation with additional animals or the establishment of new bands of caribou.

Wildlife habitat area

Goal

To temporarily secure critical Woodland Caribou habitat features that have not been yet been addressed through strategic or landscape level planning. As existing plans are amended or developed, WHAs established for Woodland Caribou should be considered for inclusion within legal objectives of the revised plans or new plans.

Feature

Establish WHAs at mineral licks, rutting or calving sites (if used repeatedly), and small areas of "matrix" habitat necessary for connectivity between winter foraging areas (if used repeatedly). Preferably, WHAs should be established in areas of suitable caribou habitat where:

- no-harvest zones and modified-harvest zones are not sufficiently large to maintain or restore viable caribou local populations as indicated by a conservation assessment; or
- there is a high level of uncertainty that this is the case; or
- critical habitat features not addressed within an existing regional or sub-regional plans are determined to be of high value or high use.

WHAs designated under the provincial timber supply impact limit (1% by district) for the Identified Wildlife Management Strategy will only be established within threatened or endangered local populations, except for sites where there is no timber supply impact or the site is considered provincially significant and approved by the Director of the Biodiversity Branch, B.C. Ministry of Water, Land and Air Protection. Normally, WHAs will only be established to protect critical habitat features deemed important to the long-term persistence of the local population.

For matrix habitat connectivity, WHAs should be located immediately adjacent to protected areas or areas designated under strategic land use plans for caribou management.

Size

Larger WHAs will almost always be of greater benefit to caribou than smaller WHAs, primarily because increased size improves the ability of caribou to avoid predation. When WHAs are established in matrix habitat for connectivity, they should be roughly 100–1000 ha. In most cases, calving sites, rutting areas, and mineral licks may be adequately managed in areas of 50–300 ha. For calving sites on islands, the entire island should be considered for inclusion within a WHA. The appropriate size for a WHA will be determined in part by whether it is possible to link to existing habitat and the degree of disturbance that is expected adjacent to the WHA.

Design

Design WHA to minimize the amount of edge, and consider habitat use and the needs of the local population. The size of the area included within the WHA to reduce disturbance will depend on topographic barriers and vegetative cover.

General wildlife measures

Goals

1. Minimize predation risk.
2. Maintain critical habitat features (e.g., mineral lick, undisturbed travel corridor or calving or rutting areas).
3. Minimize disturbance.

Measures

Access

- Do not construct roads or trails.

Harvesting and silviculture

- Do not harvest WHAs established for mineral licks, rutting, and calving sites. For matrix habitat, develop a management plan that is consistent with the general wildlife measures goals.

Pesticides

- Do not use pesticides.

Recreation

- Do not develop recreation sites or trails.

Additional Management Considerations

Guidelines for the management of both commercial and non-commercial mechanized backcountry recreation should be adopted, based on the interim management guidelines recommended by Simpson and Terry (2000). (See MWLAP Web site at http://wlapwww.gov.bc.ca.)

In addition to reducing the effect of predation through forest management that minimizes fragmentation and habitat creation for other ungulates, large mammal species should be managed with the goal of locally reducing the number of other ungulates and associated predators, where such species were historically rare or absent.

If motor vehicle collisions (Highways 3, 5, and 16, Alaska Highway) are identified as a significant source of mortality in some local populations, and kill locations and timing are consistent, seasonal speed zones should be instituted.

Information Needs

1. Metapopulation conservation assessment/risk analysis relative to a range of management options.
2. Long-term suitability of areas cut through modified harvest to support caribou, with reference to both forage and predation risk.
3. Relative contribution to predation of regional increases in alternate prey numbers versus stand level or landscape level habitat fragmentation.

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Plant Communities

Hybrid White Spruce/Ostrich Fern

Picea engelmannii × glauca/Matteuccia struthiopteris

Original prepared by J. Pojar, S. Flynn, and C. Cadrin

Plant Community Information

Description

This forested community has a fairly open canopy dominated by large hybrid white spruce (*Picea engelmannii* x *glauca*), but also including subalpine fir (*Abies lasiocarpa*), black cottonwood (*Populus balsamifera* ssp. *trichocarpa*), and paper birch (*Betula papyrifera*). Mountain alder (*Alnus incana* ssp. *tenuifolia*), red-osier dogwood (*Cornus stolonifera*), red elderberry (*Sambucus racemosa* ssp. *pubens*), and devil's-club (*Oplopanax horridus*) dominate the vigorous shrub layer. The well-developed herb layer includes an abundance of ostrich fern (*Matteuccia struthiopteris*), horsetails (*Equisetum* spp.), stinging nettle (*Urtica dioica*), enchanter's-nightshade (*Circaea alpina*), northern golden-saxifrage (*Chrysosplenium tetrandrum*), one-leaved foamflower (*Tiarella trifoliata* var. *unifoliata*), and large-leaved avens (*Geum macrophyllum*). Moss cover is low, and consists primarily of leafy mosses (*Mnium* spp.) and *Brachythecium*. See DeLong (1996), and Steen and Coupé (1997) for more information.

This community occupies toe and level slope positions with medium-textured to somewhat fine-textured (sandy to loamy), fluvial deposits. Sites are usually on or near floodplains and subject to persistent seepage and periodic flooding. Soils are moist to very moist (relative within subzone), and have a rich to very rich nutrient regime.

Distribution

Global

Restricted to British Columbia, occurring only in the SBSmh, a rather small (ca. 108 000 ha) subzone in the central interior.

British Columbia

This community is restricted to floodplains and toe slopes of the Fraser River valley, from Alexandria and Hydraulic north to Prince George, and of the Quesnel River valley downstream of Quesnel Forks.

Forest regions and districts

Northern Interior: Prince George

Southern Interior: Central Cariboo, Quesnel

Ecoprovinces and ecosections

CEI: CAP, QUL

SBI: NEL

Biogeoclimatic unit

SBS: mh/08

Broad ecosystem unit

WR

Elevation

450–750 m

Plant Community Characteristics

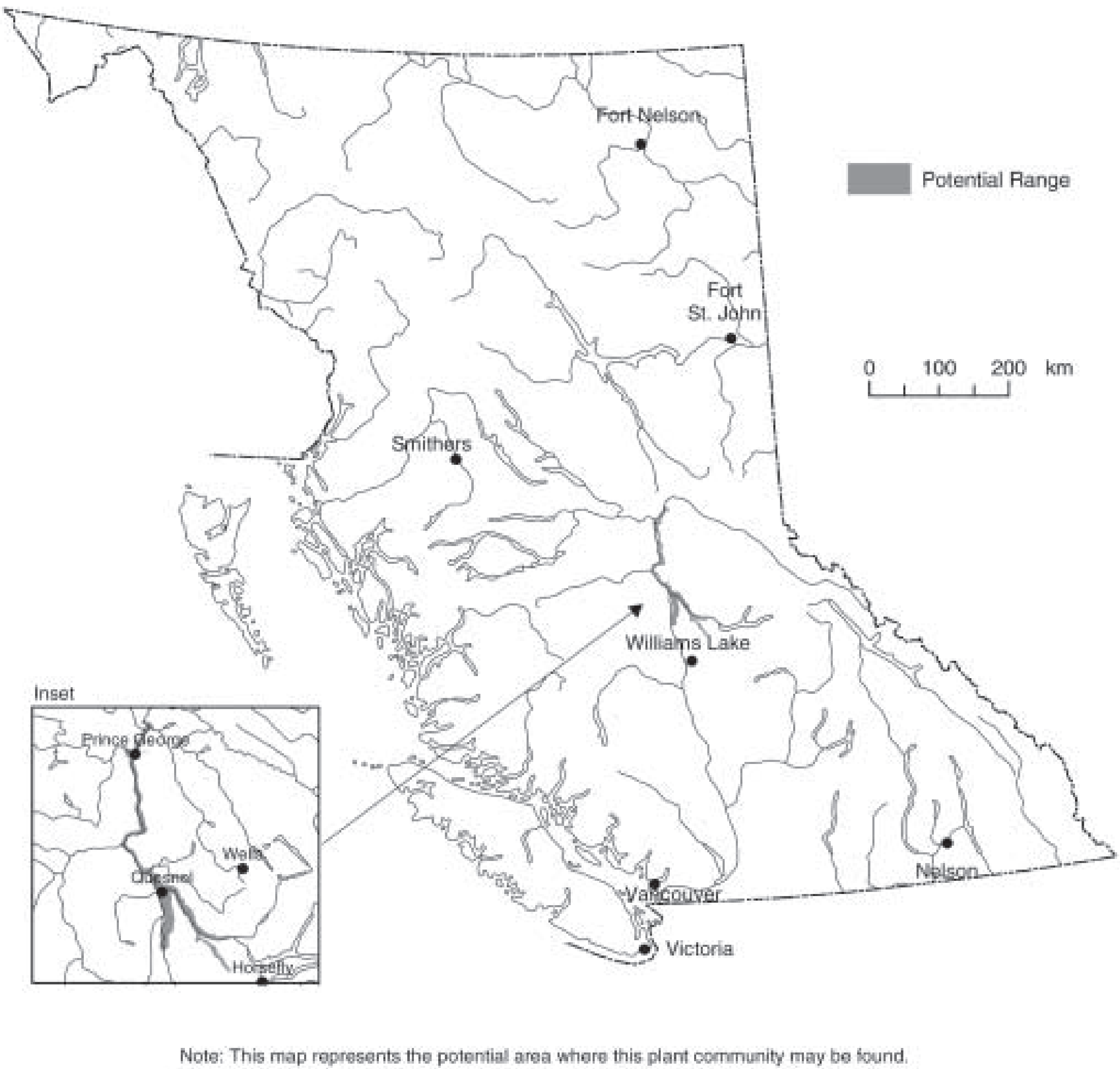
Structural stage

6: mature forest (some of the more structurally complex stands, usually >80 years)

7: old forest (>140 years)

Hybrid White Spruce / Ostrich Fern

(Picea engelmannii x glauca / Matteuccia struthiopteris)



Note: This map represents the potential area where this plant community may be found. The map is based on the Ecoregion and Biogeoclimatic ecosystem classifications as well as current knowledge of the distribution of the plant community. This plant community occurs as localized areas within the range represented.

Natural disturbance regime

Frequent stand-initiating events (NDT3) (MOF and MELP 1995), wildfire (although these valley bottom forests are less likely to burn than those on adjacent uplands), major floods, windthrow, and erosion. Overbank floods occur occasionally, as part of the natural hydrological regime. Fairly frequent direct mortality of individual or small groups of trees due to bark beetles, root rots, and defoliating insects, or indirect mortality via predisposition of attacked trees to blowdown.

Fragility

Moderately fragile. Soils typically are deep, medium-textured, moist, and nutrient-rich. The soils are moist to wet, however, and sometimes occur on unstable landforms, and so are susceptible to mass movements and water table changes, especially those triggered by land clearing or forestry activity such as road building. Overbank floods occur occasionally, but are part of the natural hydrological regime. The ecosystems should recover relatively quickly after stand-destroying disturbances, provided biological legacies such as snags and large downed logs persist on site and there has been no damage or displacement of soil materials. These rich moist sites are prone to sudden growth of shrubs after major disturbances, which can result in deciduous "brush" competition with conifers, delays in forest regeneration and slower forest recovery after disturbance.

Conservation and Management

Status

The hybrid white spruce/ostrich fern plant community is on the provincial *Red List*. In British Columbia this community is ranked S2 and its global status is proposed as G2.

Trends

Although widespread, this small, linear ecosystem is uncommon within a localized range. It has been seriously depleted and old and mature stands continue to decline in distribution. Ecologists estimate that <20 high quality occurrences remain. This trend is likely to continue.

Threats

The SBSmh is a small subzone with a history of disturbance by humans and many productive forest sites have been logged. Its high value as timber has resulted in serious depletion. Significant areas of the subzone (including this community) have also been cleared for agriculture, ranching, and rural settlement. Climate change may also be a threat.

Connectivity of old forest habitat in the subzone is a serious conservation issue, especially along the major riparian corridors where the hybrid white spruce/ostrich fern community occurs, particularly on the extensive private timber lands.

Legal Protection and Habitat Conservation

There is no legal protection for plant communities except for those within protected areas and parks.

There may be some representation in Fraser River and Fort George Canyon parks, but occurrences need verification. The SBSmh as a whole has only 2% (~2200 ha) of its area protected.

The *Forest Practices Code* guidelines for riparian management areas would apply to many of the occurrences, but may be too narrow to provide adequate protection. Old growth management areas may protect some occurrences if old forest retention objectives cannot be met in the non-timber harvesting land base.

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

The distribution of this community has always been patchy and dynamic, but few old patches now remain and few young patches are being recruited. It occurs as small patch forests and most typically as linear systems along creeks, streams, and floodplains of larger rivers. It is recommended to:

- ❖ maintain water flow and hydrological conditions supporting this plant community and, where possible, preserve or restore natural flood cycles that historically maintained this community;
- ❖ maximize connectivity of old forest within the SBSmh;
- ❖ maintain or recover at least 20 occurrences in good condition across the range of the plant community;
- ❖ maintain or restore occurrences to as close to natural condition as possible and practical; and
- ❖ wherever possible, protect remaining occurrences through the placement of old growth management areas.

Wildlife habitat area

Goal

Maintain or recover known occurrences that could not be addressed through landscape level planning and the designation of old growth management areas.

Feature

Establish WHAs at occurrences that have been confirmed by a registered professional in consultation with the B.C. Conservation Data Centre or Ministry of Forests regional ecologists. Priority for WHAs should be any old or mature (structural stage 6 and 7) within younger stands to attain a minimum 5 ha and in a relatively natural state. As a lower priority, establish WHAs within younger, relatively undisturbed forests and riparian systems that include this plant community to recover community to climax condition. Select areas that are or have (in order of priority):

- the oldest, most structurally complex secondary forests available;
- intact hydrological processes that are relatively lightly damaged and can be expected to recover to a more natural state;
- part of a network of reserve areas; and
- adjacent to natural occurrences of other plant communities.

Size

The size of the WHA should be based on the extent of the plant community occurrence. Typically occurrences of this plant community are linear and are between 5 and 80 ha along rivers and streams.

Design

The WHA should include the entire occurrence of the community plus ±80 m (approximately two tree heights) along the upland side of the linear occurrence or surrounding the small patch toe slope occurrences. Boundaries should be designed to minimize edge effects and to the extent possible, be delineated along windfirm boundaries.

General wildlife measures

Goals

1. Maintain or restore plant community to a natural state (i.e., same species composition, physical structure, including coniferous canopy and deciduous composition, and ecological processes as natural examples of the plant community; see Steen and Coupé 1997).
2. Maintain or restore the natural hydrological regime within WHA. Seepage, fluctuating and seasonally high water tables, and occasional major overbank floods are fundamental to the ecology of these riparian ecosystems.
3. Maintain or enhance old forest structure (i.e., large old trees, range of tree sizes, large snags, down logs, canopy depth and roughness, multiple vegetation strata, horizontal patchiness of understorey) (Spies 1998).
4. Maintain open forest-interior conditions.
5. Prevent physical disturbance, especially of the soil.
6. Minimize introduction and spread of invasive species.

Measures

Access

- Do not develop roads or trails.

Harvesting and silviculture

- Do not harvest or salvage except when required to create a windfirm edge.
- Do not remove non-timber forest products.

Pesticides

- Do not use pesticides.

Range

- Plan livestock grazing (timing, level of use, distribution) to meet general wildlife measure goals. Fencing could be required by the statutory decision maker to meet goals, to recover community, or for restoration treatments.
- Do not place livestock attractants within WHA.

Recreation

- Do not develop recreational sites, trails, or facilities.

Additional Management Considerations

Minimize impacts to vegetation, soils, and hydrology in areas immediately surrounding WHA. These considerations apply particularly to land clearing, and road location, construction, and maintenance.

Information Needs

1. Further inventory and confirmation of classification to clarify the extent of this community.
2. Mapping and assessment of the structural stage, successional dynamics, quality, and integrity of the remnant occurrences.
3. Identification of candidate forests for recruitment.

Cross References

Bull Trout, Fisher

References Cited

B.C. Ministry of Forests and B.C. Ministry of Environment, Lands and Parks (MOF and MELP). 1995. Biodiversity guidebook. Victoria, B.C. Forest Practices Code of B.C. guidebook.

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Western Redcedar/Devil's-club/Ostrich Fern

Thuja plicata/Oplopanax horridus/Matteuccia struthiopteris

Original prepared by J. Pojar, S. Flynn, and C. Cadrin

Plant Community Information

Description

This moist forested community has a canopy dominated by western redcedar (*Thuja plicata*), with some hybrid white spruce (*Picea engelmannii* × *glauca*), subalpine fir (*Abies lasiocarpa*), black cottonwood (*Populus balsamifera* ssp. *trichocarpa*), and paper birch (*Betula papyrifera*). The shrub layer is dominated by devil's-club (*Oplopanax horridus*), and has a moderate cover of thimbleberry (*Rubus parviflorus*). Black gooseberry (*Ribes lacustre*) and Douglas maple (*Acer glabrum*) are also present, typically with low cover. The dense herb layer is dominated by oak fern (*Gymnocarpium dryopteris latifolia*), one leaved-foamflower (*Tiarella trifoliata* var. *unifoliata*), enchanter's-nightshade (*Circaea alpina*), and toothed wood fern (*Dryopteris carthusiana*). Ostrich fern (*Matteuccia struthiopteris*), lady fern (*Athyrium filix-femina*), common miterwort (*Mitella nuda*), and meadow horsetail (*Equisetum pratense*) are present with moderate cover. Coastal leafy moss (*Plagiomnium insigne*) dominates the poorly developed moss layer. See Meidinger et al. (1984, 1988) and DeLong et al. (1996) for detailed descriptions.

This community occupies lower, toe, and level slope positions with medium- to coarse-textured (coarse loamy to sandy) fluvial deposits. Sites are usually on or near floodplains and subject to seepage and periodic flooding. Most commonly they are middle and high bench fluvial terraces. Soils are moist to very moist (relative within subzone) with imperfect to poor drainage, and have a medium to rich nutrient regime.

Distribution

Global

Western redcedar/devil's-club/ostrich fern is restricted to British Columbia, and reportedly occurs only in the ICHvk2, a rather small (ca. 113 640 ha) variant in east-central British Columbia.

British Columbia

This community is sparsely distributed as small patches on lower valley walls along the Fraser River between Dome Creek and the Bowron River, above Slim Creek between the Fraser River and Tumuch Lake, and above Walker Creek/Goodson Creek between the McGregor and Torpy rivers. It can also be found on southwest aspects above the McGregor River between Mount Sir Alexander and Gleason Creek, and along the Torpy River on the lower slopes of the McGregor Range and Bearpaw Ridge.

Forest region and district

Northern Interior: Prince George

Ecoprovinces and ecosections

SBI: MCP, SHR
SIM: BOV, CAM, UFT

Biogeoclimatic unit

ICH: vk2/05

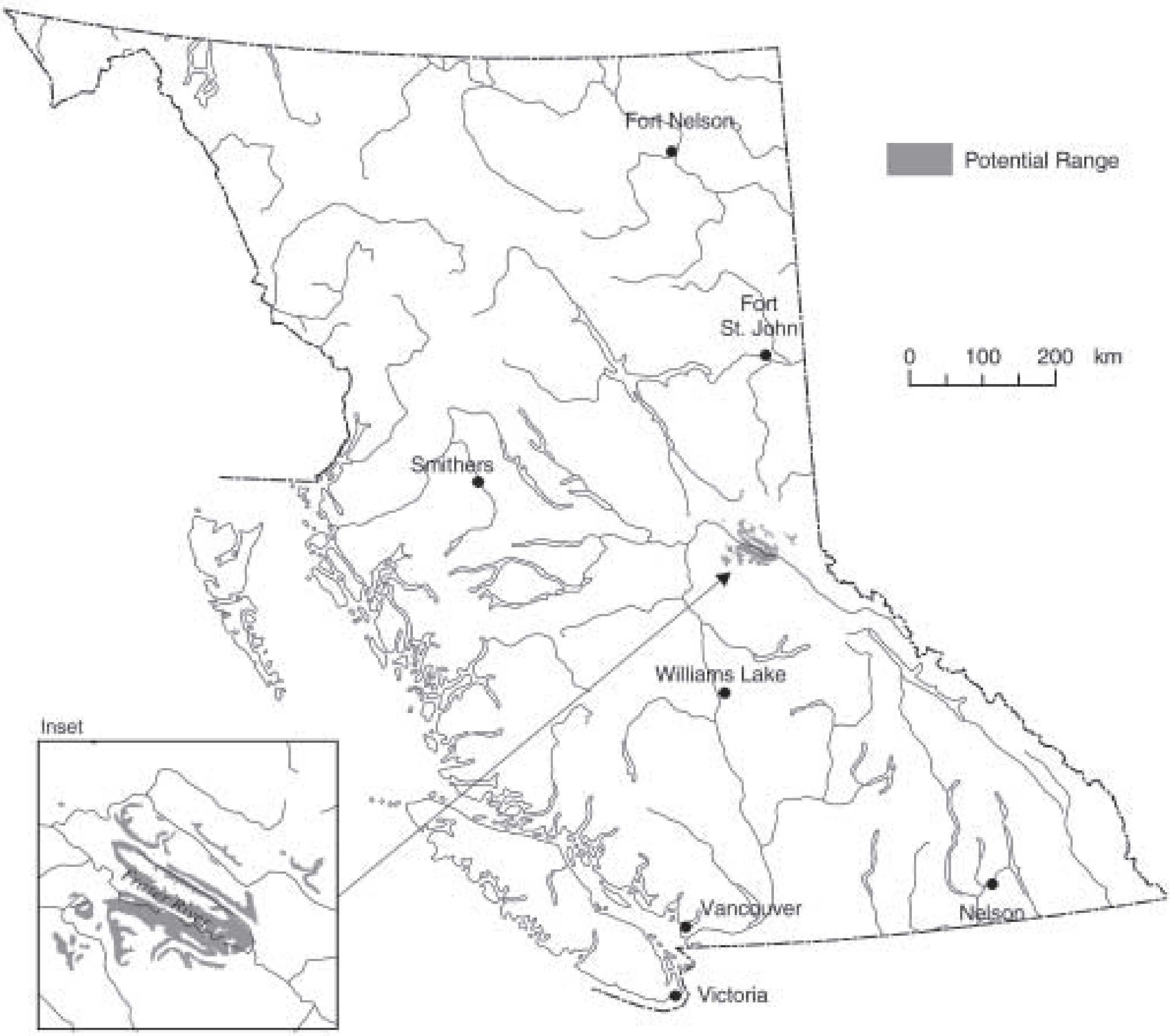
Broad ecosystem units

IH, RR

Elevation

680–1000 m

Western Redcedar / Devil's-club / Ostrich Fern
(Thuja plicata / Oplopanax horridus / Matteuccia struthiopteris)



Note: This map represents the potential area where this plant community may be found. The map is based on the Ecoregion and Biogeoclimatic ecosystem classifications as well as current knowledge of the distribution of the plant community. This plant community occurs as localized areas within the range represented.

Plant Community Characteristics

Structural stage

6: mature forest (more structurally complex stands, usually >150 years)

7: old forest (>250 years)

Natural disturbance regime

Rare stand-initiating events (NDT1) (MOF and MELP 1995) including wildfire (although these valley bottom forests are less likely to burn than those on adjacent uplands), major floods, insect epidemics (e.g., hemlock looper [*Lambdina fiscellaria*] and green-striped forest looper [*Melanolophia imitate*], although they attack western hemlock primarily), and windthrow. Fairly frequent direct mortality of individual or small groups of trees due to root rots, defoliating insects, and bark beetles, or indirect mortality via predisposition of attacked trees to blowdown.

Fragility

Very fragile. Soils typically are deep, medium- to coarse-textured, moist to very moist, and at least moderately nutrient rich. Hence these sites are less susceptible than finer-textured poorer sites to degradation due to soil compaction, erosion, and nutrient losses. However, their valley bottom location makes these ecosystems obvious targets for road locations and harvesting. The soils are imperfectly to poorly drained and have at least periodically high water tables, and sometimes occur on unstable materials, so are susceptible to water table changes and to small mass movements, especially those triggered by land clearing or forestry activity such as road building. Overbank floods occur occasionally, but are part of the natural hydrological regime. The ecosystems rebound vigorously after stand-destroying disturbances. But they take a long time (two to three centuries at least) to attain old-growth conditions, and will do so within the lifetime of a redcedar tree only if biological legacies such as snags and large downed logs persist on site. These rich moist sites are also prone to outbursts of shrubbery and to growing season frosts after major disturbances, which can result in deciduous "brush" competition with conifers, delays in forest regeneration, and slower forest recovery after disturbance.

Conservation and Management

Status

The western redcedar/devil's-club/ostrich fern plant community is on the provincial *Red List* in British Columbia. In British Columbia this community is ranked S1S2. Its global status is proposed as G1G2.

Trends

Perhaps stable for now. Ecologists estimate that <10 high quality occurrences remain. The community was probably always rare but has been seriously depleted and its old structural stage is in peril. Further decline may now be arrested due to some new protected areas and riparian management guidelines. But the trend is uncertain and, with so few occurrences, the risk of losing these old flood-plain forests is very high. Although, the distribution of this community has probably always been patchy and dynamic, few old patches now remain and few young patches are being recruited.

Threats

This community is naturally rare within a small range, and typically occurs in small patches or strips. The fairly high timber values of the ICHvk2 in general (including the ICHvk2/05) have resulted in serious depletion of this community by logging. Parts of the subzone (including some of this community) have been cleared for ranching, forest harvesting and minor human settlement on small parcels of private land. The subzone is bisected by the transportation corridor of the CN Railway and Highway 16; the railroad in particular has affected these valley bottom ecosystems. Connectivity of old forest habitat is a serious conservation issue, especially along the major riparian corridors where this plant community occurs.

Legal Protection and Habitat Conservation

There is no legal protection for plant communities except for those occurring within protected areas and parks.

Some representation in Sugarbowl–Grizzly Den, Slim Creek, and perhaps Kakwa parks. The ICHvk2 as a whole has 10% (10 926 ha) of its area protected, but not much of that total would include this restricted and rare community.

The *Forest Practices Code* guidelines for riparian management areas presumably would apply to most of the occurrences, but could be too narrow to provide adequate protection. Old growth management areas may protect some occurrences provided old forest retention objectives cannot be met in the non-timber harvesting land base.

Identified Wildlife Provisions

Strategic management recommendations

- ❖ Maintain water flow and hydrological system of the surrounding landscape. The occurrence of this community as a linear system dependent on adjacent water flows and upland drainage requires consideration of the larger landscape context.
- ❖ Maximize connectivity of riparian systems and upland/riparian linkages within the ICHvk2.
- ❖ Maintain or recover at least 20 occurrences in good condition across the range of the plant community.
- ❖ Maintain or restore occurrences to as close to natural condition as possible and practical.
- ❖ Wherever possible, protect remaining occurrences through the placement of old growth management areas and riparian management guidelines.

Wildlife habitat area

Goals

Maintain or recover known occurrences that could not be addressed through landscape level planning and the designation of old growth management areas.

Feature

Establish WHAs at occurrences that have been confirmed by a registered professional in consultation with the B.C. Conservation Data Centre or Ministry of Forests regional ecologists. Priority for WHAs should be any old (structural stage 7) occurrences within a young stand of sufficient stream length and upland buffering to attain a minimum of 5 ha or any mature (structural stage 6) linear occurrences in a relatively natural state and where the watercourse is undisturbed for a significant upstream distance. As a lower priority, establish WHAs within younger, relatively undisturbed forests including this plant community to recover the community to climax condition along stable river systems. Select areas that are or have (in order of priority):

- the oldest, most structurally complex secondary forests available;
- intact hydrological processes that are relatively lightly damaged and can be expected to recover to a more natural state;
- part of a network of reserve areas; and
- adjacent to natural occurrences of other plant communities.

Size

The size of the WHA should be based on the extent of the plant community occurrence. Typically occurrences of this plant community are between 5 and 50 ha.

Design

The WHA should include the entire occurrence of the community plus ±100 m (approximately two tree heights) surrounding the occurrence along the upland boundary of the stream. Boundaries should be designed to minimize edge effects and to the extent possible, be delineated along windfirm boundaries. Typically the trees on these sites have shallow rooting, and the stands are prone to windthrow.

General wildlife measures

Goals

1. Maintain or restore plant community to a natural state (i.e., same species composition, physical structure, and ecological processes as natural examples of the plant community; see Meidinger et al. 1984; DeLong et al. 1996).
2. Maintain or enhance old forest structure (i.e., large old trees, range of tree sizes, large snags, down logs, canopy depth and roughness, multiple vegetation strata, horizontal patchiness of understorey) (Spies 1998).
3. Maintain or restore the natural hydrological regime of the WHAs. Seepage, fluctuating and seasonally high water tables, and occasional major overbank floods are fundamental to the ecology of these riparian ecosystems.
4. Maintain open forest-interior conditions.
5. Prevent physical disturbance, especially of the soil.
6. Minimize introduction and spread of invasive species.

Measures

Access

- Do not develop roads or trails.

Harvesting and silviculture

- Do not harvest or salvage except when required to create a windfirm edge.
- Do not remove non-timber forest products.

Pesticides

- Do not use pesticides.

Recreation

- Do not develop recreational sites, trails, or facilities.

Additional Management Considerations

Minimize impacts to vegetation, soils, and hydrology when operating adjacent to WHA. These considerations apply particularly to land clearing, and road location, construction, and maintenance.

Information Needs

1. Further inventory and confirmation of classification to clarify the extent of this community.
2. Mapping and assessment of the structural stage, successional dynamics, quality, and integrity of the remnant occurrences.
3. Identification of candidate forests for recruitment.

Cross References

Bull Trout, Fisher, Grizzly Bear

References Cited

B.C. Ministry of Forests and B.C. Ministry of Environment, Lands and Parks (MOF and MELP). 1995. Biodiversity guidebook. Victoria, B.C. Forest Practices Code of B.C. guidebook.

DeLong, C., D. Tanner, and M.J. Jull. 1996. Draft field guide insert for site identification and interpretation for the southeast portion of the Prince George Forest Region. B.C. Min. For., Prince George, B.C.

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Meidinger, D.V., A. McLeod, A. MacKinnon, C. DeLong, and G. Hope. 1988. A field guide for identification and interpretation of ecosystems of the Rocky Mountain Trench, Prince George Forest Region. B.C. Min. For., Victoria, B.C. Land Manage. Handb. 15.

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Acronyms

asl	above sea level
ATV	all terrain vehicle
BEC	biogeoclimatic ecosystem classification
BEU	broad ecosystem unit
CCLUP	Cariboo-Chilcotin Land Use Plan
CDC	Conservation Data Centre
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CWD	coarse woody debris
dbh	diameter at breast height
FPC	Forest Practices Code
FRPA	*Forest and Range Practices Act*
GBMA	Grizzly Bear Management Area
GBPU	Grizzly Bear Population Unit
GWM	general wildlife measure
HLP	higher level plan
IWMS	Identified Wildlife Management Strategy
LTAC	Long-term Activity Centre
LWD	large woody debris
MOF	Ministry of Forests
MSRM	Ministry of Sustainable Resource Management
MWLAP	Ministry of Water, Land and Air Protection
NDT	natural disturbance type
OGMA	old growth management area
PFA	post-fledging area
RBC	results based code
RISC	Resource Information Standards Committee
RMA	riparian management area
RMZ	resource management zone
SD	standard deviation
SDM	statutory decision maker
s.e.	standard error
slv	snout-to-vent length
sp.	species (singular)
spp.	species (plural)
ssp.	subspecies
TAC	IWMS Technical Advisory Committee
TEM	Terrestrial ecosystem mapping
UWR	ungulate winter range
WAP	watershed assessment procedure
WHA	wildlife habitat area
WTP	wildlife tree patch

Glossary

For more definitions, refer to Glossary of Forest Terms web page (http://www.for.gov.bc.ca/hfd/library/documents/glossary/index.htm).

account: Specific information on taxonomy, distribution, life history, status, and management recommendations for Identified Wildlife.

age class: Any interval into which the age ranges of trees, forests, stands, or forest types is divided for classification and use; forest inventories commonly group trees into 20-year age classes.

allospecies: A group within one species composed by differences caused by territorial spread. They are becoming a species on there own.

Biogeoclimatic Ecosystem Classification: A hierarchical ecosystem classification system which has three levels of integration—regional, local, and chronological—and which combines climatic, vegetation, and site factors.

biogeoclimatic units: Units of a hierarchical ecosystem classification system having three levels of integration—regional, local, and chronological—and combining climatic, vegetation, and site factors.

biological diversity: The diversity of plants, animals, and other living organisms in all their forms and levels of organization, including the diversity of genes, species, ecosystems, and evolutionary and functional processes that link them.

Blue List: A list, prepared by the Ministry of Sustainable Resource Management, Conservation Data Centre, of elements considered to be vulnerable in British Columbia. Vulnerable elements are of special concern because of characteristics that make them particularly sensitive to human activities or natural events. Blue-listed elements are at a lower level of risk than red-listed elements.

broad ecosystem unit: A permanent area of the landscape, meaningful to animal use, that supports a distinct kind of dominant vegetative cover, or distinct non-vegetated cover. These units are defined as including potential (climax) vegetation and any associated successional stages (for forests and grasslands).

coarse woody debris: Decaying wood on the ground that provides special microclimates and breeding habitat for a wide variety of organisms.

COSEWIC: An organization comprised of representatives from each provincial and territorial government wildlife agency which determines the national status of wild species, subspecies, varieties, and nationally significant populations that are considered to be at risk in Canada.

costal grooves: A series of vertical grooves on the sides of salamanders, between the fore- and hind limb.

deactivate: Road deactivation is an engineering issue that involves application of techniques to stabilize the road prism, restore or maintain the natural drainage patterns, and minimize sediment transport to protect neighbouring resources at risk from potential landslide and sedimentation events.

desired plant community: A plant community that produces the kind, proportion, and amount of vegetation necessary for meeting or exceeding the stated objectives for a site according to a range use plan. The desired plant community must be consistent with the capability of the site to produce the vegetation through management, land treatment, or a combination of the two. The desired plant community takes into account multiple values, such as economics, biodiversity, water quality, wildlife/fisheries, forage, and recreation.

diameter at breast height: A measurement taken at approximately breast height (~1.5 m) and used as the standard for describing the diameter of a tree.

ecoprovince: An area with consistent climate or oceanography, relief, and plate tectonics.

ecosection: An area with minor physiographic and macroclimatic or oceanographic variation.

element: A species or a plant community. The term "species" includes all entities at the taxonomic level of species, such as subspecies, plant varieties, and interspecific hybrids.

Endangered: A COSEWIC designation indicating a species facing imminent extirpation or extinction.

epikarst: The uppermost layer of a karstified rock in which a large proportion of the fissures have been enlarged by solutional erosion.

extinct: A species that no longer exists.

follicle: A dry fruit derived from a single carpel, splitting open along the ventral suture at maturity.

fragility: Ability of the plant community to recover from disturbances.

gravid: When females are carrying fertilized eggs.

general wildlife measure: A management practice established for an area, by order, by the Minister of Water, Land and Air Protection, for (a) a category of species at risk, (b) a category of regionally important wildlife, or (c) a category of specified ungulate species.

hyporheic: An area of gravel and other sediments under or next to the streambed with water flowing through.

Identified Wildlife: A subset of species at risk and regionally important wildlife established by the Minister of Water, Land and Air Protection.

Identified Wildlife Management Strategy: A strategy enabled under the *Forest and Range Practices Act* to address the management of Identified Wildlife. The Strategy is comprised of two companion documents: *Accounts and Measures for Managing Identified Wildlife* and *Procedures Framework for Managing Identified Wildlife*.

Indeterminate: A COSEWIC designation for species that have been evaluated, but not enough information about them is available to determine their status.

inflorescence: A cluster of flowers**.**

instar: An insect stage between molts (growth).

invasive species: Species that are non-native or alien to the ecosystem under consideration, and whose introduction causes or is likely to cause economic or environmental harm or harm to human health.

karst: Terrain, generally underlain by limestone or dolomite (carbonate rocks), in which the topography is formed chiefly by the dissolving of rock, and which may be characterized by sinkholes, sinking streams, closed depressions, subterranean drainage, and caves.

lacustrine: Pertaining to a lake.

large woody debris: Woody debris in a stream, lake, or wetland setting, during at least part of the year, with a diameter of 10 cm or greater and a length of 2 m or greater.

livestock attractant: a substance or structure that draws livestock, including salt/minerals, supplements, water developments and cattle oilers.

Natural Disturbance Type: An area that is characterized by a natural disturbance regime.

NatureServe Explorer: An organization dedicated to providing reliable information on species and ecosystems for use in conservation and land use planning.

neotene: Amphibian larvae that mature to adult size without losing their external gills. They are sexually mature, obligate water-dwelling individuals.

Not at risk: A COSEWIC designation for species that have been evaluated and deemed not currently at risk.

occurrence: A location representing a habitat that sustains or otherwise contributes to the survival of a population (e.g., a south-facing slope that provides winter range for 10 elk would be considered a single occurrence, not 10).

old field: A field that has been left to grow.

old growth management area: A spatially identified area that is subject to old growth management objectives.

ovigerous: Bearing eggs.

oviparous: Reproduces by laying eggs.

ovoviviparous: Reproduces by eggs which remain in the female's body until ready to hatch. When the young emerge, they are born live.

parotid glands: Paired glands in the form of large bumps. In toads, these are located behind the eyes on the neck and secrete toxic substances used for defense.

perigynium: Special sac which encloses the achene in sedges; plural, peryginia.

periphyton: Attached algae.

petal: One of the segments of the corolla of a flower.

pinna: A leaflet or primary division of a pinnate leaf or frond: plural, pinnae.

pinnate: Compound leaf, with leaflets arranged on two sides of a common axis.

plant community: The plant community element, used by the Conservation Data Centre and this guidebook, is based on the plant association concept (V.J. Krajina and students): an abstract unit based on sample plots of climax vegetation that possess similar vegetation structure and native species composition, and occur repeatedly on similar habitats.

platform: With birds, the term is used to describe a nest type that is a flat structure (i.e., for Marbled Murrelets platforms are large limbs or deformities with epiphyte cover).

Predictive Ecosystem Mapping: A method of predicting ecosystem occurrence on the landscape given basic inventory information and expert knowledge.

properly functioning condition: Refers to: the ability of a stream, river, wetland or lake and its riparian area to (a) withstand normal peak flood events without experiencing accelerated soil loss, channel movement or bank movement, (b) filter runoff, and (c) store and safely release water, and when uplands associated with the riparian area exhibit (d) vegetation and biological processes, (e) infiltration rates and moisture storage, and (f) stability that is appropriate to soil, climate and landform.

raceme: An unbranched type of inflorescence presenting a symmetrical display of stalked flowers, with older flowers towards the base.

Red List: A list, prepared by the Ministry of Sustainable Resource Management, Conservation Data Centre, of elements being considered for or already designated extirpated, endangered, or threatened. Extirpated taxa no longer exist in the wild in British Columbia, but occur elsewhere. Endangered taxa are facing imminent extirpation or extinction. Threatened taxa are likely to become endangered if limiting factors are not reversed.

regionally important wildlife: A category of species under FRPA (s.105) established by the Minister of Water, Land and Air Protection, by order, if satisfied that the species a) is important to a region of British Columbia, b) relies on habitat that requires special management that is not otherwise provided for in this regulation, and c) is vulnerable to impacts from forest practices or range practices.

rehabilitation (access measure): Rehabilitation of a road is typically done in accordance with a silviculture prescription or logging plan, and is normally carried out concurrently with, or following, deactivation to restore the affected area to a productive site for growing crop trees.

rhizome: A rootlike subterranean stem, commonly horizontal in position, which usually produces roots below and sends up shoots from the upper surface.

riparian habitat: The area adjacent to a watercourse, lake, swamp, or spring that is influenced by the availability of water and is generally critical for wildlife cover, fish food organisms, stream nutrients, and large organic debris, and for streambank stability.

sepal: One of the individual leaves or parts of the calyx of a flower.

seral stages: The stages of ecological succession of a plant community (e.g., from young stage to old stage). The characteristic sequence of biotic communities that successively occupy and replace each other by which some components of the physical environment become altered over time.

snag: Standing dead or partially dead tree.

snout-vent length: A standard measurement of body length. The measurement is from the tip of the snout to the vent and excludes the tail.

Special Concern: A COSEWIC designation indicating a species of special concern because of characteristics that make it particularly sensitive to human activities or natural events.

Species at risk: A category of species under FRPA (s.105) established by the Minister of Water, Land and Air Protection, by order, if satisfied that the species in the category are endangered, threatened or vulnerable.

stalk: Stem or main axis of a plant.

stigma: Part of the pistil (female organ), which receives the pollen.

structural stage: Describes current vegetation focusing on the age class of the ecosystem in question. Stuctural stage will depend on subzone designation and vegetative species.

supercilium: A line of feathers above the eye.

Terrestrial Ecosystem Mapping: The stratification of a landscape into map units according to a combination of ecological features, primarily climate, physiography, surficial material, bedrock geology, soil, vegetation, and disturbance.

Threatened: A COSEWIC designation indicating a species likely to become endangered if limiting factors are not reversed.

tragus: A flap of skin at the base of the external ear.

watershed assessment procedure: An analytical procedure designed to help forest managers understand the type and extent of current water-related problems that may exist in a watershed, and to recognize the possible hydrological implications of proposed forestry and related development or restoration in that watershed.

wildlife habitat area: The Identified Wildlife Management Strategy provides foresters and ranchers with management practices for managing habitats for Identified Wildlife. The management practices must be followed within areas set aside for a particular species or plant communities. These areas are called "wildlife habitat areas" and are officially designated by the Minister of Water, Land and Air Protection.

wildlife habitat feature: A localized feature established, by order, by the Minister of Water, Land and Air Protection. Includes features such as fisheries sensitive features, marine sensitive features, significant mineral licks or wallows, and Bald Eagle, Osprey, and Great Blue Heron nests.

wildlife tree: A standing live or dead tree with special characteristics that provide valuable habitat for the conservation or enhancement of wildlife. Characteristics include large diameter and height for the site, current use by wildlife, declining or dead condition, value as a species, valuable location, and relative scarcity.

wildlife tree retention area: An area specifically identified for the retention and recruitment of suitable wildlife trees. It can contain a single wildlife tree or many.

Yellow List: List of vertebrates that are considered "not at risk" within the province.

Appendix 1. Technical Advisory Committee

Technical Advisory Committee (TAC)
09/99 – 11/02

Non-government representatives

BC Cattlemen's Association
David Borth

BC Endangered Species Coalition/ Federation of BC Naturalists
Elaine Golds

BC Environmental Network
Paula Rodriquez de la Vega (09/99 – 02/02)
Colin Campbell (since 03/02)

BC Wildlife Federation
Carol Hartwig (to 06/02)

BC Mining Association
Ken Sumanik (09/99 – 06/01)

Canadian Association of Petroleum Producers
Craig Popoff

Coast Lumber Manufacturing Association
Wayne Wall

Council of Forest Industries
Gilbert Proulx
Kari Stuart-Smith (since 04/02)

Federation of BC Woodlot Associations
Bill Hadden

University of British Columbia
Geoff Scudder

Government representatives

Ministry of Forests, Range Branch
Doug Fraser

Ministry of Forests, Forest Practices Branch
Brian Nyberg
Wayne Erickson (since 06/01)

Ministry of Water, Land and Air Protection, Biodiversity Branch
Susanne Rautio (09/99 – 09/00)
Stewart Guy (since 09/00)
Kathy Paige
Eric Lofroth (09/99 – 09/00)

Ministry of Sustainable Resource Management, CDC
Andrew Harcombe

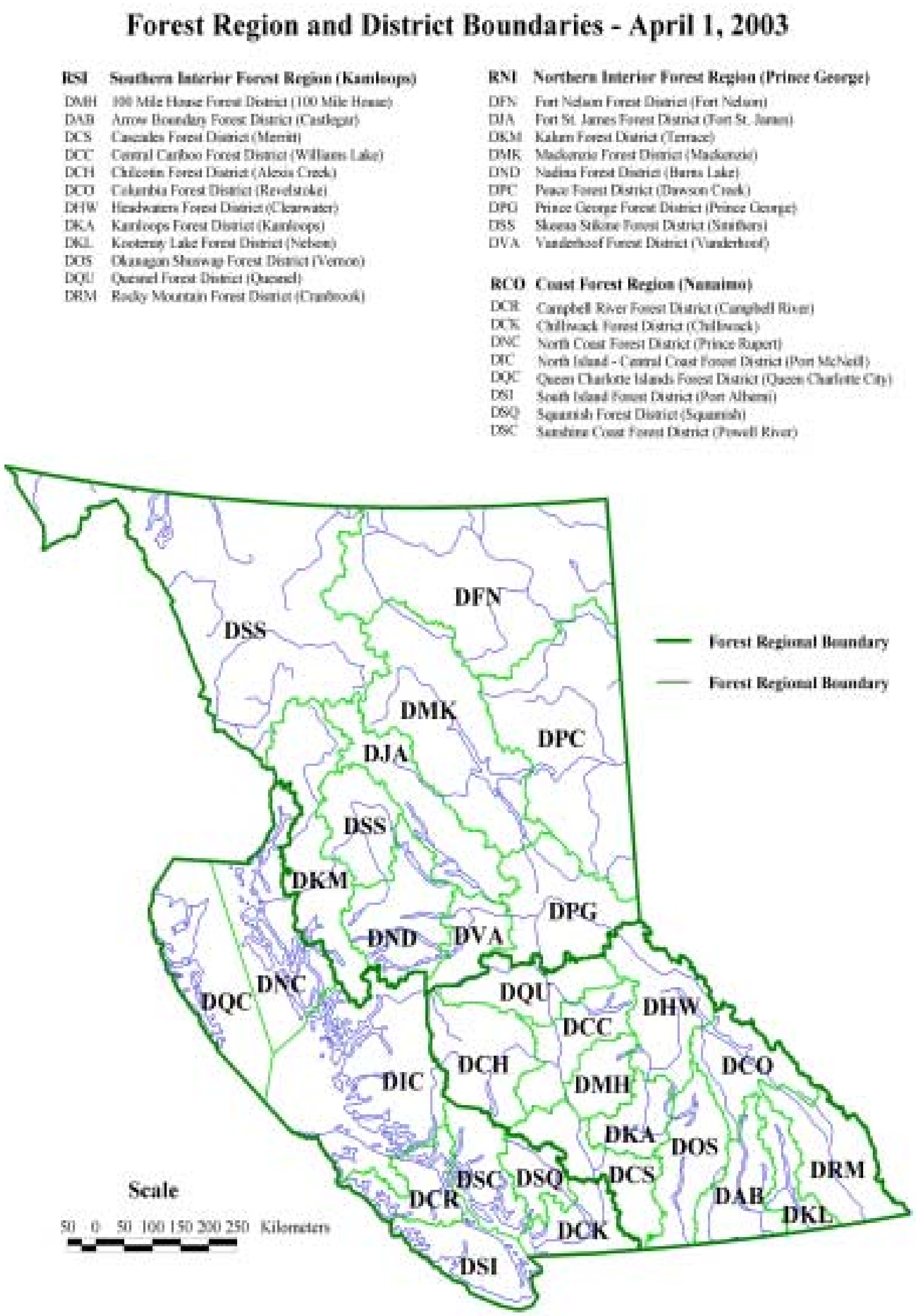
Ministry of Fisheries, Research
Gordon Haas (09/99 – 09/00)

Appendix 2. Summary of Volume 1 element changes

Element	IWMS priority (2003)	Included in IWMS (V. 2003)
American Bittern	Lower priority	No
American White Pelican	Highest priority	Yes
Ancient Murrelet	Intermediate priority	Yes
Bighorn Sheep	Intermediate priority	Yes
Bobolink	Lower priority	No
Bull Trout	Highest priority	Yes
Cassin's Auklet	Intermediate priority	Yes
Coastal Tailed Frog	Intermediate priority	Yes
Douglas-fir/Alaska Oniongrass	Intermediate priority	Yes
Ferruginous Hawk	Research required	No
Fisher	Intermediate priority	Yes
Grasshopper Sparrow	Intermediate priority	Yes
"Great Basin" Gopher Snake	Intermediate priority	Yes
Grizzly Bear	Intermediate priority	Yes
Keen's Long-eared Myotis	Highest priority	Yes
Lewis's Woodpecker	Intermediate priority	Yes
Long-billed Curlew	Intermediate priority	Yes
Marbled Murrelet	Highest priority	Yes
Mountain Beaver	Intermediate priority; use wildlife habitat feature designation	No
Night Snake	Lower priority	No
Pacific Water Shrew	Intermediate priority	Yes
Ponderosa Pine – Black Cottonwood – Nootka Rose – Poison Ivy	Lower priority	No
Ponderosa Pine – Black Cottonwood – Snowberry	Lower priority	No
Prairie Falcon	Intermediate priority	Yes
"Queen Charlotte" Goshawk	Highest priority	Yes
Racer	Intermediate priority	Yes
Rocky Mountain Tailed Frog	Intermediate priority	Yes
Sage Thrasher	Intermediate priority	Yes
"Sagebrush" Brewer's Sparrow	Intermediate priority	Yes
Sandhill Crane	Intermediate priority	Yes
Trumpeter Swan	Lower priority	No
Vancouver Island Marmot	Highest priority	Yes
Water Birch – Red-osier Dogwood	Highest priority	Yes
Western Grebe	Lower priority	No
White-headed Woodpecker	Intermediate priority	Yes
Yellow-breasted Chat	Intermediate priority	Yes

The following yellow-listed species were not assessed at this time: Mountain Goat, Northern Goshawk – *atricapillus* ssp., and Rubber Boa. These species were considered of lower priority and were not included so that highter priorities could be addressed. They may be considered once the regionally important wildlife list has been updated (last update was 1994) and a detailed evaluation and ranking, similar to that done for the red- and blue-listed elements (see Element Selection), is completed.

Appendix 3. Ministry of Forests administrative boundaries



Appendix 4. Ecoprovince and ecosection codes (Version 1.7)

Code	Ecoprovince/Ecosections
COM	**Coast and Mountains Ecoprovince**
CBR	Central Boundary Ranges
CPR	Central Pacific Ranges
CRU	Cranberry Upland
DIE	Dixon Entrance
EPR	Eastern Pacific Ranges
HEL	Hecate Lowland
HES	Hecate Strait
KIM	Kimsquit Mountains
KIR	Kitimat Ranges
MEM	Meziadin Mountains
NAB	Nass Basin
NAM	Nass Mountains
NBR	Northern Boundary Ranges
NIM	Northern Island Mountains
NPR	Northern Pacific Ranges
NWC	Northwestern Cascade Ranges
NWL	Nahwiti Lowland
OUF	Outer Fiordland
QCL	Queen Charlotte Lowland
QCS	Queen Charlotte Sound
QCT	Queen Charlotte Strait
SBR	Southern Boundary Ranges
SKP	Skidegate Plateau
SPR	Southern Pacific Ranges
VIS	Vancouver Island Shelf
WIM	Windward Island Mountains
WQC	Windward Queen Charlotte Mountains
GED	**Georgia Depression Ecoprovince**
FRL	Fraser Lowland
GEL	Georgia Lowland
JDF	Juan de Fuca Strait
LIM	Leeward Island Mountains
NAL	Nanaimo Lowland
SGI	Southern Gulf Islands
SOG	Strait of Georgia
SAL	**Southern Alaska Mountains Ecoprovince**
ALR	Alsek Ranges
ICR	Icefield Ranges
SIM	**Southern Interior Mountains Ecoprovince**
BBT	Big Bend Trench
BOV	Bowron Valley
CAM	Cariboo Mountains
CCM	Central Columbia Mountains
COC	Crown of the Continent
CPK	Central Park Ranges
EKT	East Kootenay Trench
ELV	Elk Valley
EPM	Eastern Purcell Mountains
FLV	Flathead Valley
FRR	Front Ranges
MCR	McGillivray Ranges
NKM	Northern Kootenay Mountains
NPK	Northern Park Ranges
QUH	Quesnel Highland
SCM	Southern Columbia Mountains
SFH	Selkirk Foothills
SHH	Shuswap Highland
SPK	Southern Park Ranges
SPM	Southern Purcell Mountains
UCV	Upper Columbia Valley
UFT	Upper Fraser Trench
SOI	**Southern Interior Ecoprovince**
GUU	Guichon Upland
HOR	Hozameen Range
LPR	Leeward Pacific Ranges
NIB	Nicola Basin
NOB	Northern Okanagan Basin
NOH	Northern Okanagan Highland
NTU	Northern Thompson Upland
OKR	Okanagan Range
PAR	Pavilion Ranges
SCR	Southern Chilcotin Ranges
SHB	Shuswap Basin
SOB	Southern Okanagan Basin
SOH	Southern Okanagan Highland
STU	Southern Thompson Upland
THB	Thompson Basin
TRU	Tranquille Upland

Code	Ecoprovince/Ecosections	Code	Ecoprovince/Ecosections
CEI	**Central Interior Ecoprovince**	**BOP**	**Boreal Plains Ecoprovince**
BUB	Bulkley Basin	CLH	Clear Hills
BUR	Bulkley Ranges	HAP	Halfway Plateau
CAB	Cariboo Basin	KIP	Kiskatinaw Plateau
CAP	Cariboo Plateau	PEL	Peace Lowland
CCR	Central Chilcotin Ranges	**NBM**	**Northern Boreal Mountains Ecoprovince**
CHP	Chilcotin Plateau	CAR	Cassiar Ranges
FRB	Fraser River Basin	EMR	Eastern Muskwa Ranges
NAU	Nazko Upland	HYH	Hyland Highland
NEU	Nechako Upland	KEM	Kechika Mountains
QUL	Quesnel Lowland	KLR	Kluane Ranges
WCR	Western Chilcotin Ranges	LIP	Liard Plain
WCU	Western Chilcotin Upland	MUF	Muskwa Foothills
TAP	**Taiga Plains Ecoprovince**	NOM	Northern Omineca Mountains
ETP	Etsho Plateau	SBP	Southern Boreal Plateau
FNL	Fort Nelson Lowland	SIU	Simpson Upland
MAU	Maxhamish Upland	STH	Stikine Highland
MUP	Muskwa Plateau	STP	Stikine Plateau
PEP	Petitot Plain	TAB	Tatshenshini Basin
TLP	Trout Lake Plain	TAH	Tagish Highland
SBI	**Sub-Boreal Interior Ecoprovince**	TEB	Teslin Basin
BAU	Babine Upland	TEP	Teslin Plateau
ESM	Eastern Skeena Mountains	THH	Tahltan Highland
HAF	Hart Foothills	TUR	Tuya Range
MAP	Manson Plateau	WHU	Whitehorse Upland
MCP	McGregor Plateau	WMR	Western Muskwa Ranges
MIR	Misinchinka Ranges		
NEL	Nechako Lowland		
NHR	Northern Hart Ranges		
NSM	Northern Skeena Mountains		
PAT	Parsnip Trench		
PEF	Peace Foothills		
SHR	Southern Hart Ranges		
SOM	Southern Omineca Mountains		
SSM	Southern Skeena Mountains		

Appendix 5. Biogeoclimatic ecological classification unit codes

Code	Zone
AT	Alpine Tundra
BG	Bunchgrass
BWBS	Boreal White and Black Spruce
CDF	Coastal Douglas-fir
CWH	Coastal Western Hemlock
ESSF	Engelmann Spruce–Subalpine Fir
ICH	Interior Cedar-Hemlock
IDF	Interior Douglas-fir
MH	Mountain Hemlock
MS	Montane Spruce
PP	Ponderosa Pine
SBPS	Sub-Boreal Pine–Spruce
SBS	Sub-Boreal Spruce
SWB	Spruce–Willow–Birch

Subzones are designated by 2 letters. The first letter indicates the precipitation regime:

x	very dry
d	dry
m	moist
w	wet
v	very wet

The second letter indicates continentality on the coast (CWH and MH):

h	hypermaritime
m	maritime
s	submaritime

and temperature regime in the interior (all other zones):

h	hot
w	warm
m	mild
k	cool
c	cold
v	very cold

For example,

CWHwh	Coastal Western Hemlock wet hypermaritime subzone
IDFww	Interior Douglas-fir wet warm subzone
BGxh	Bunchgrass very dry hot subzone

Appendix 6. Broad ecosystem units of British Columbia

Adapted from *Standards for Broad Terrestrial Ecosystem Classification and Mapping for British Columbia: Classification and Correlation of the Broad Habitat Classes used in 1:250,000 Ecological Mapping* (RIC 1998). See http://srmwww.gov.bc.ca/risc/pubs/teecolo/bei/assets/bei.pdf for more detailed descriptions.

Code	Name[1]	Description	BEC units
AB	Antelope-brush Shrub/ Grassland	Typically an open to dense, dry shrubland, generally lacking trees, that is dominated by drought-tolerant shrubs, most prominently antelope-brush and perennial grasses. Found at lower elevations, between 250 and 700 m; limited to the southern portion of the Okanagan Valley, mainly south of Penticton, extending to the U.S. border.	*BGxh1 PPxh1 PPdh2*
AC	Trembling Aspen Copse	Typically a dense deciduous or broad-leaved forest with a shrub-dominated understorey which includes plant communities that succeed through shrub thickets to an edaphic climax of trembling aspen; found in association with shrub/grasslands or grasslands. Found at lower elevations, between 330 and 1150 m, throughout the major river valleys of the Fraser Plateau and the Thompson–Okanagan Plateau, as well as in the Okanagan Valley and portions of the East Kootenay Trench.	*BGxw1 BGxw2 IDFdk1 IDFdk3 IDFdk4 IDFxh1 IDFxh2 IDFxm PPdh2 PPxh1 SBPSmk SBPSxc*
AD	Sitka Alder – Devil's-club Shrub	Typically a Sitka alder shrub community with a lush fern understorey, which occurs on steep slopes within the northern portion of the Interior Cedar-Hemlock zone. Typically found at lower elevations, between 150 and 1000 m, on the leeward side of the Coast Mountains, in river valleys.	*ESSFwk1 ICHmc1 ICHvc ICHwc*
AG	Alpine Grassland	Typically a high elevation, northern, grassland habitat, characterized by lush bunchgrass growth, with forbs, sedges, and terrestrial lichens. This unit is only found in the alpine tundra (AT) zone in most of the mountain ranges in the province.	
AH	Alpine Heath	Typically a high elevation dwarf shrubland habitat, characterized by cold resistant vegetation, consisting of mountain-heathers, forbs, graminoids, and lichens. This unit is only found in the alpine tundra (AT) zone in most of the mountain ranges in the province.	
AM	Alpine Meadow	Typically a high elevation, herbaceous community, dominated by moisture-loving forbs and/or sedges, on wetter sites in alpine areas. This unit is only found in the alpine tundra (AT) zone in most of the mountain ranges in the province.	

1 Broad ecosystem unit names contain the dominant and/or characteristic climax and seral species.

Code	Name[1]	Description	BEC units
AN	Alpine Sparsely Vegetated	Typically a high elevation, sparsely vegetated habitat, characterized by a mixture of rocky slopes and a sparse cover of grasses, lichens, and low shrubs. This unit is only found in the alpine tundra (AT) zone in most of the mountain ranges in the province.	
AS	Alpine Shrubland	Typically a high elevation, shrubland habitat, characterized by a dense cover of deciduous shrubs with graminoids, forbs, and terrestrial lichens. This unit is only found in the alpine tundra (AT) zone in most of the mountain ranges in the province.	
AT	Alpine Tundra	Typically a high elevation, open to dense herbaceous or dwarf shrubland habitat, characterized by cold-resistant vegetation consisting of low dwarf shrubs, graminoids, hardy forbs, and lichens. This unit is only found in the alpine tundra (AT) zone in most of the mountain ranges in the province.	
AU	Alpine Unvegetated	Typically a high elevation habitat dominated by rock outcrops, talus, steep cliffs, and other areas with very sparse vegetation of grass, lichens, and low shrubs. This unit is only found in the alpine tundra (AT) zone of the mountain ranges in the province.	
AV	Avalanche Track	Typically a dense shrub- or herb-dominated ecosystem where periodic snow and rock slides have prevented coniferous forest establishment, and abundant moisture is available for much of the growing season. Avalanche tracks characteristically begin in the alpine or subalpine zones where there is abundant snow accumulation and steeply sloping valley walls. There are no definite elevational limits, upper or lower. Slope breaks and snow accumulation determine the downslope extent of each avalanche track.	*AT CWHds1 CWHds2 CWHmm2 CWHms2 CWHvm1 CWHvh2 CWHvm2 CWHwm CWHws2 CWHxm MHmm1 MHmm2 BWBSdk BWBSmw BWBSvk BWBSwk ESSFdc ESSFdk ESSFmc ESSFmk ESSFmm ESSFmv ESSFmw ESSFvc ESSFwc ESSFwk ESSFwm ESSFwv ESSFxc ESSFxv ICHmc ICHmk ICHmm ICHmw ICHvc ICHvk1 ICHwc ICHwk IDFww MHmm1 MHmm2 MHwh MSdk MSxv SBPSmc SBSdh SBSmc SBSmk SBSvk SBSwk SWBdk SWBmk*

Code	Name[1]	Description	BEC units
BA	Boreal White Spruce –Trembling Aspen	Typically a dense, broad-leaved, mixed, or coniferous mixed forest with shrub- and herb-dominated understories, which includes plant communities that succeed through trembling aspen seral forests to a white spruce climax. Found in the northeastern portion of the province, from the intersection of the Rocky Mountains and the Alberta border north to the Yukon and Northwest Territories. Found at lower elevations, between 300 and 1050 m, in the more northerly locations. In the southern portions, it occurs at higher elevations, between 750 and 1050 m.	*BWBSmw1 BWBSmw2*
BB	Black Spruce Bog	A bog wetland class that typically is a sparse to open, treed organic wetland, with a peat moss-dominated understorey, black spruce and sometimes, tamarack. Found at low to mid-elevations, between 300 and 1250 m. It is common throughout the Taiga and Boreal Plains, Northern Boreal Mountains, Sub-Boreal Interior, Nass Basin, Southern Rocky Mountain Trench, and Fraser Plateau.	*BWBSdk1 BWBSdk2 BWBSmw1 BWBSmw2 BWBSwk1 BWBSwk2 BWBSwk3 ICHmc2 ICHmm ICHvk2 ICHwk3 SBPSdc SBPSmc SBPSmk SBSdh SBSdk SBSdw2 SBSmk1 SBSdw3 SBSmc2 SBSmc3 SBSmw SBSvk SBSwk1 SWBmk*
BG	Sphagnum Bog	A bog wetland class that typically is an unforested wetland, dominated by sphagnum mosses and herbaceous plants, found on poorly drained organic sites. Found throughout the province in poorly drained, wet sites, typically areas that are level or depressional. This very localized habitat is found at elevations ranging from sea level on the north coast to higher elevations (< 1800 m) in the Northern Interior. It is found at much higher elevations in the Southern Interior, usually above 1200 m.	
BK	Subalpine Fir – Scrub Birch Krummholz	Typically a northern, high elevation, stunted tree, open habitat, characterized by islands of subalpine fir intermixed with a dense shrub cover of willows and scrub birch. This unit is found at elevations above the upper limit of the Spruce–Willow–Birch (SWB) zone, approximately 1500 m and below the Alpine Tundra (AT) zone. It occurs throughout the subalpine areas of the Northern Boreal Mountains; small patches are also present in the Northern Omineca and Central Canadian Rocky Mountains, as well as on the Muskwa Plateau.	*SWBdk SWBmk SWBun*
BL	Black Spruce – Lodgepole Pine	Typically an open coniferous forest with shrub, moss, or terrestrial lichen understories, on gently sloping dry or wet sites, usually with lodgepole pine communities that progress to a black spruce climax. Generally found in the northern half of the province, north of 53 N. Located throughout the region east of the Rocky Mountains to	*BWBSdk1 BSBSdk2 BWBSmw1 BWBSmw2 BWBSwk1 BWBSwk2*

Code	Name[1]	Description	BEC units
		the Alberta border and north to the Northwest Territories. It is also found at lower to mid-elevations of the major river valleys in the Skeena, Omineca, and Central Rocky Mountains, as well as in the Fraser Basin, Rocky Mountain Trench, and northern portions of the Fraser Plateau. Typically, the elevation ranges between 350 and 1200 m. The majority of sites are located in cool areas, either low-lying valley floors or on north-facing slopes.	*SBPSdc SBPSmc SBSdw2 SBSdw3 SBSmc2 SBSmc3 SBSmk1 SBSmk2 SBSwk1 SBSwk2 SBSwk3*
BP	Boreal White Spruce – Lodgepole Pine	Typically a dense, boreal coniferous forest which includes plant communities that succeed through lodgepole pine seral forests to a white spruce climax. Found at elevations ranging from 300 to 1200 m throughout the northeastern plains, north of the Rocky Mountain/Alberta border intersection to the Northwest Territories. It also occurs extensively along the walls of major valleys in the northern Boreal Mountains, including the Northern Rocky Mountains, Cassiar Ranges, St. Elias Mountains, and all of the adjacent plateaus.	*BWBSdk1 BWBSdk2 BWBSmw1 BWBSwk1 BWBSwk2 BWBSwk3*
BS	Bunchgrass Grassland	Typically a dense herbaceous habitat dominated by perennial grasses and forbs and generally lacking shrubs or trees. Found at elevations ranging from 300 to 1650 m depending on the amount of moisture present. This unit occurs extensively throughout the lower to mid-elevations of the Southern Interior and southern portion of the Fraser Plateau; including the Fraser River, Thompson and Okanagan basins, as well as the valleys around the Fraser River in the Pavilion Ranges, the Nicola River, and the Similkameen River. More isolated ecosystems are also found in the Granby and Kettle River valleys of the Southern Okanagan Highland and in portions of the East Kootenay Trench.	*BGxh1 BGxh2 BGxh3 BGxw1 BGxw2 ESSFxc IDFdk1 IDFdk3 IDFdk4 IDFdm1 IDFxh1 IDFxh2 IDFxm MSxk PPdh1 PPdh2 PPxh1 PPxh2 SBPSdc SBPSmk SBPSxc SBSdk*
CB	Cedars – Shore Pine Bog	A bog wetland class that typically is an open to dense forest, with moss- and shrub-dominated understories. Sites are found in poorly drained outer coastal areas; often containing a varying mixture of western hemlock, western redcedar, yellow-cedar, and shore pine. Found at lower elevations throughout the coast and mountains, as well as the Georgia Depression, ranging from sea level to 1100 m.	*CDFmm CWHdm CWHds1 CWHds2 CWHmm1 CWHmm2 CWHms1 CWHms2 CWHvh1 CWHvh2 CWHvm1 CWHvm2 CWHwh1 CWHwm CWHws1 CWHws2 CWHxm*
CD	Coastal Douglas-fir	Typically a dense coniferous forest with shrub-dominated understories, including seral plant communities composed of Douglas-fir, which progress directly to climax. Occurs from sea level to ~ 700 m in southwest B.C. including the Gulf Islands, and Vancouver Island, east of the Vancouver Island Ranges and south of Kelsey Bay. It is also found in a narrow strip along the Mainland Coast,	*CDFmm CWHdm CWHds1 CWHmm1 CWHxm CWHds2 CWHmm2*

Code	Name[1]	Description	BEC units
		south of Bella Coola and in the southern portion of the Fraser Valley as well as east and north of Chilliwack into the drainages of the upper Fraser River and the eastern Coast Mountains.	
CF	Cultivated Field	Typically a mixture of farmlands where human agricultural practices of plowing, fertilization, and non-native crop production have resulted in long-term soil and/or vegetation changes. Generally, cultivated fields are located on flat to gently rolling terrain. Soil types and local climatic factors influence the types of crops that can be grown. The majority of the lower elevation plateaus and floodplains in the province are used for agriculture.	
CG	Coastal Western Redcedar – Grand Fir	Typically a dense coniferous forest which includes plant communities that progress through long-lived Douglas-fir seral stages to a varied climax of western redcedar and grand fir. Restricted to low elevations (sea level to ~150 m) along southeastern Vancouver Island from Bowser to Victoria, the Gulf Islands south of Cortes Island, and a narrow strip along the Sunshine Coast.	*CDFmm*
CH	Coastal Western Hemlock – Western Redcedar	Typically a dense coniferous forest, with shrub-dominated understories, found along outer coastal plains. Occurs in a narrow fringe (sea level to 600 m) along the outer coast of southern Vancouver Island widening to cover the northern portion of Vancouver Island, the windward side of the Queen Charlotte Ranges, and the Coast Mountains up the Mainland Coast to the Alaskan border.	*CWHmm1 CWHmm2 CWHvh1 CWHvh2 CWHvm1 CWHvm2 CWHwh1 CWHwh2*
CL	Cliff	Non-alpine, steep unvegetated rock slope. Cliffs are typically located throughout the province, mainly concentrated in mountainous regions. Cliffs are most often associated with many of the alpine units as well as the talus and rocky outcrop units.	
CP	Coastal Douglas-fir –Shore Pine	Typically a dry coniferous forest, characterized by plant communities composed of a sparse shrub layer and a well-developed moss and lichen layer, which proceeds to a Douglas-fir climax. Typical elevation ranges from sea level to approximately 650 m. This unit is found along the Sunshine Coast and in the lower Fraser Valley, extending inland along the major river valleys to its eastern limit in the Coast Mountains.	*CWHds1 CWHds2 CWHms1 CWHms2*
CR	Black Cottonwood Riparian Habitat Class	Typically a dense conifer and deciduous or broad-leaved forest with shrub-dominated understories, which includes plant communities that progress through a varying mixture of shrubs and black cottonwood. Found throughout the province along major rivers where floodplains occur, ranging in elevation from sea level to approximately 600 m.	*CDFmm CWHdm CWHds1 CWHds2 CWHmm1 CWHvm1 CWHxm BGxh1 BGxh2 BGxw2 BGxh3 ICHmc1 ICHmc2 ICHvc ICHwc IDF PPdh1 PPxh2*

Code	Name[1]	Description	BEC units
CS	Coastal Western Hemlock –Subalpine Fir	Typically a northern coastal, cold habitat, characterized by dense coniferous forests of western hemlock, subalpine fir, and spruce with dense shrub, moss, and lichen layers. Occurs in the Coast, Skeena, and Hazelton mountains, the Nass Basin, and the Stikine Plateau; ranging between 100 and 1100 m in elevation.	*ICHmc1 ICHmc1a ICHmc2 ICHvc ICHwc*
CW	Coastal Western Hemlock –Douglas-fir	Typically a dense coniferous forest with fern- or shrub-dominated understories, which includes plant communities that progress through long-lived Douglas-fir seral stages to a western hemlock climax. Found in lower to mid-elevations, ranging from sea level to approximately 700 m, in the southwestern portion of the province.	*CWHdm CWHds1 CWHds2 CWHxm*
DA	Douglas-fir – Arbutus	Typically a dense coniferous forest with shrub-dominated understories, whose plant communities may pass through seral stages with arbutus as a major component after intense fire, to a Douglas-fir climax. Occurs on the eastern side of Vancouver Island south of Kelsey Bay, on the Southern Gulf Islands, and on some of the islands located in Johnstone Strait. It also occurs in the lower Fraser Valley on the south side of the Fraser River as far as Chilliwack and along the Sunshine Coast up to Desolation Sound. It ranges in elevation from sea level to approximately 700 m.	*CDFmm CWHdm CWHxm*
DF	Interior Douglas-fir Forest	Typically a dense coniferous forest with grass- or shrub-dominated understories, which includes plant communities that progress directly to a Douglas-fir climax. Occurs in the Southern Interior at low to moderate elevations in the Interior Douglas-fir biogeoclimatic zone. Elevational limits range between 700 and 1100 m.	*BGxh3 BGxw2 IDFdk1 IDFdk2 IDFdk3 IDFdk4 IDFdm1 IDFdm2 IDFmw1 IDFmw2 IDFxh2 IDFxm IDFxw IDFww SBPSmk SBSdk SBSdw1 SBSdw2 SBSmc1 SBSmh ICHmk1 ICHmk2 ICHmw3 ICHxw MSdk MSdm1 MSdm2 MSxk*
DL	Douglas-fir – Lodgepole Pine	Typically a dense coniferous forest with shrub- or pinegrass-dominated understories, which includes plant communities that progress through a mixture of lodgepole pine and Douglas-fir or trembling aspen to a Douglas-fir climax. Found at lower to middle elevations (between 400 and 1600 m) throughout the central and Southern Interior.	*ICHmk1 ICHmk2 ICHmw1 ICHmw2 ICHmw3 IDFdk1 IDFdk2 IDFdk3 IDFdk4 IDFww IDFdm1 IDFdm2 MSdc MSdm1 MSdm2 MSxk SBSdh SBSdw1 SBSdw2 SBSdw3 SBSmh SBSmm SBSmw SBPSmk SBPSxc*

Code	Name[1]	Description	BEC units
DP	Douglas-fir – Ponderosa Pine	Typically an open to dense coniferous forest with shrub- or bunchgrass-dominated understories, which includes plant communities that progress through a mixture of Douglas-fir and ponderosa pine to a Douglas-fir climax. Occurs at low elevations in the valleys of the Southern Interior, including the Okanagan and Nicola valleys, as well as the valleys of the North and South Thompson, Bonaparte, Fraser, Similkameen, Kettle, and Granby rivers. Typically found at elevations ranging between 450 and 1300 m.	*ICHdw ICHxw IDFmw1 IDFdk1 IDFdk2 IDFdm1 IDFdm2 IDFxh1 IDFxh2 IDFxw PPxh1 PPdh1 PPxh2*
EF	Engelmann Spruce – Subalpine Fir Dry Forested	Typically a dense coniferous forest with shrub-dominated understories, which includes plant communities that may progress through seral lodgepole pine to a varied climax of Engelmann spruce and subalpine fir. In the southern and central Interior of the province, this unit represents the highest elevation forested area. It occurs throughout the Coast Mountains and eastward into the Rocky Mountains, ranging in elevation between 1275 and 2050 m. There is considerable range in upper and lower elevational limits due to climatic and topographic variability.	*ESSFdc1 ESSFdc2 ESSFdk ESSFdv ESSFmc ESSFmm1 ESSFmk ESSFmw ESSFmv1 ESSFmv2 ESSFmv3 ESSFmv4 ESSFwc1 ESSFwc2 ESSFwc3 ESSFwc4 ESSFwk1 ESSFwk2 ESSFwm ESSFvv ESSFwv ESSFxc ESSFxv MSdc*
ER	Engelmann Spruce Riparian	Typically a dense coniferous forest, with shrub- and forb-dominated understories, Engelmann spruce and sometimes black cottonwood; found on floodplains or small riparian areas. Occurs on floodplains and riparian areas throughout the central, southern, and sub-boreal Interiors, as well as in the Southern Interior Mountains and the eastern slopes of the Coast Mountains. Elevational limits range between 1200 and 2000 m in the south, and 900 and 1500 m in the north.	*ESSFdc1 ESSFdk ESSFdv ESSFmc ESSFmk ESSFmm1 ESSFmv1 ESSFmv2 ESSFmv3 ESSFmv4 ESSFmw ESSFvc ESSFwc1 ESSFwc2 ESSFwc3 ESSFwc4 ESSFwk1 ESSFwk2 ESSFwm ESSFwv ESSFxc ESSFxv*

Code	Name[1]	Description	BEC units
ES	Estuary	Typically an unforested tidal wetland dominated by persistent emergent herbaceous species, with open sporadic access to ocean areas and where the seawater is periodically diluted with fresh water derived from land drainage. Estuaries occur along coastal B.C. where perennial rivers flow into the ocean.	*CDFmm CWHdm CWHmm1 CWHms2 CWHvh1 CWHvh2 CWHvm1 CWHwh1 CWHwm CWHws1 CWHxm1 CWHxm2*
EW	Subalpine Fir – Mountain Hemlock Wet Forested	Typically a dense coniferous forest with shrub-dominated understories, which includes plant communities that progress directly to a mixed climax of subalpine fir, mountain hemlock, and sometimes amabilis fir. Generally found in the eastern Kitimat ranges, south/central Hazelton Mountains, southeast Boundary ranges, and northwest Skeena Mountains. The elevational limits range between approximately 900 and 1800 m. There is also a limited amount of this unit on the leeward side of the Pacific ranges as well as in the western Monashee Mountains, between 1275 and 1675 m.	*ESSFmk ESSFmw ESSFvc ESSFvv ESSFwv*
FB	Subalpine Fir – Scrub Birch Forested	Typically a northern, subalpine, open forested habitat, characterized by stands of subalpine fir and white spruce with a dense shrub understorey of willows and scrub birch. This unit is limited to elevations ranging between 1050 and 1500 m. It occurs in the subalpine areas of the Northern Boreal Mountains including the Northern Omineca, Cassiar, St. Elias, and Northern Rocky Mountains, as well as the Stikine, Teslin, and Southern Boreal plateaus.	*BWBSdk1 BWBSdk2 BWBSvk SWBdk SWBmk SWBvk*
FE	Sedge Fen	A fen wetland class is typically an unforested wetland, dominated by sedges, found on poorly drained organic sites. This very localized ecosystem unit generally occurs in small patches throughout all forested zones within the province. It is most commonly found on the interior plateaus and does not occur in the AT zone.	
FP	Engelmann Spruce – Subalpine Fir Parkland	Typically a high elevation mosaic of stunted-tree clumps and herb- or dwarf shrub-dominated openings, occurring above closed forest ecosystems and below the alpine communities. In the southern and central Interior of the province, this unit represents the transition between the Engelmann Spruce – Subalpine Fir (ESSF) and Alpine Tundra (AT) zones. It occurs throughout the Coast Mountains and eastward into the Rocky Mountains, usually present above the ESSF zone (approximate elevation 2050 m). Note that there is considerable range in the upper and lower elevational limits due to climatic variability and differing topography.	*ESSFdc ESSFdk ESSFdv ESSFmc ESSFmm1 ESSFmm2 ESSFmv1 ESSFmv2 ESSFmv3 ESSFwc1 ESSFwc2 ESSFwc3 ESSFvc ESSFwk1 ESSFwk2 ESSFwm ESSFxc ESSFxv*

Code	Name[1]	Description	BEC units
FR	Amabilis Fir – Western Hemlock	Typically a low elevation, dense coniferous forest with fern- or shrub-dominated understories, which includes plant communities that may contain western redcedar as a long-lived seral species, leading to a mixed western hemlock and amabilis fir climax. Commonly occurs at low to middle elevations, between 500 and 1100 m, occasionally down to sea level. This unit is found extensively throughout the major valleys of the windward and leeward portions of the Coast Mountains, Vancouver Island Ranges, and Queen Charlotte Ranges, as well as on the outer coast of southern Vancouver Island and the adjacent northern Gulf Islands.	*CWHmm1 CWHmm2 CWHms1 CWHms2 CWHvh1 CWHvh2 CWHvm1 CWHvm2 CWHws1 CWHws2 ICHmc1a*
FS	Fast Perennial Stream	Typically a freshwater riverine habitat contained within a channel that has continuously moving, fast flowing water, that is bounded by banks or upland habitat and has a high gradient. Distributed throughout the province with a larger proportion of fast flowing streams found at higher altitudes where there is a larger gradient.	
GB	Gravel Bar	Typically a level, unvegetated, or partially vegetated fluvial area along an active watercourse. Found extensively along streams and rivers throughout the province.	
GL	Glacier	Typically a field or body of snow or ice formed in higher elevations in mountainous terrain where snowfall exceeds melting: these areas of snow and ice will show evidence of past or present glacier movement. Glaciers are generally found above 1800 m in the higher elevation biogeoclimatic zones throughout the mountain ranges of the province.	*AT BWBSdk1 CWHds1 CWHwm CWHws2 ESSFmm1 ESSFmw ESSFxv MHmm2 SWBdk SWBmk SWBvk*
GO	Garry Oak	Typically a sparse to open mixed forest, with understories dominated by mosses and a dense mixture of spring wildflowers and grasses growing on shallow, rocky sites. This ecosystem is very limited in distribution, occurring at low elevations along southeast Vancouver Island and the Gulf Islands. Elevational limits range between sea level and approximately 150 m.	*CDFmm*
HB	Coastal Western Hemlock – Paper Birch	Typically a dense mixed forest composed of paper birch, Douglas-fir, western redcedar, and western hemlock with shrub-dominated understories. Occurs at low elevations in submaritime and subcontinental areas north of Knight Inlet, ranging in elevation from valley bottom to approximately 500 m.	*CWHds1 CWHds2*
HL	Coastal Western Hemlock – Lodgepole Pine	Typically an open to dense coniferous forest situated on dry sites with shrub-dominated understories, which includes plant communities that progress through lodgepole pine seral stages to a western hemlock climax. This very uncommon ecosystem type is limited to dry ridge-crests and rocky outcrops along the outer coast to the Alaskan border, including Vancouver Island, the Queen Charlotte Islands, and any of the small coastal islands. It can also be found throughout the coast, western Hazelton, and Skeena mountains, and the Nass Basin. It ranges in elevation between sea level and 1000 m.	*CWHvh1 CWHvh2 CWHvm1 CWHvm2 CWHws1 CWHws2 ICHwc*

Code	Name[1]	Description	BEC units
HP	Mountain Hemlock Parkland	Typically a high elevation, sparse to open mosaic of stunted tree clumps and herbaceous or mountain-heatherdominated openings, that proceeds after disturbance directly to a climax species mix dominated by mountain hemlock. Found at high elevations along the coast, this unit represents the transition between the Mountain Hemlock (MH) and Alpine Tundra (AT) zones. When present, it occurs above the MH zone on the eastern and western slopes of the Vancouver Island Ranges, Queen Charlotte Mountains, and Coast Mountains, as well as the western slopes of the Hazelton Mountains; elevation approximately 1600 m. Note there is considerable range in the upper and lower elevational limits due to climatic variability and differing topography.	*MHmm1 MHmm2 MHwh*
HS	Western Hemlock – Sitka Spruce	Typically a dense coniferous forest along outer coastal sites with shrub-dominated understories, which usually succeeds directly to a mixed climax of western hemlock and Sitka spruce. Occurs along the west and north coast of Vancouver Island and the Queen Charlotte Islands. It is also found throughout the windward portion of the Coast Mountains, extending from Knight Inlet northward into the Boundary Ranges. Typically this unit occurs at elevations ranging between sea level and approximately 600 m.	*CWHds2 CWHvh1 CWHvh2 CWHwh1 CWHwh2 CWHwm*
IG	Interior Western Redcedar	Typically a dense coniferous or mixed forest with extensive shrub- and herb-dominated understories, which includes plant communities that progress through seral Douglas-fir, trembling aspen, and paper birch to a climax of western redcedar and grand fir. ICHxw has a very limited distribution in B.C. It is only found in middle, lower, and toe slope positions, as well as along the valley floor in the southern extremities of the Selkirk and Purcell mountains. Elevational limits range from 450 to 1100 m.	*ICHxw*
IH	Interior Western Hemlock – Douglas-fir	Typically a dense coniferous forest with various shrub- and herb-dominated understories, which includes plant communities that proceed through Douglas-fir, western larch, western white pine, and/or paper birch seral stages to a mixed climax of western hemlock and western red-cedar. Found extensively at low to middle elevations throughout the Columbia Mountains and Highland. Typically ranges in elevation between approximately 400 and 1400 m.	*ICHdw ICHmm ICHmw1 ICHmw2 ICHmw3 ICHvk1 ICHvk2 ICHwk1 ICHwk2 ICHwk3 ICHwk4*
IM	Intertidal Marine	Typically a habitat that consists of ocean overlying the continental shelf and its associated high energy shoreline, with salinities in excess of 18 ppt and a substrate that is exposed and flooded by tides (includes associated splash zone). This unit occurs along the shores of all coastal islands and the mainland, including major inlets, fjords, bays, and open ocean.	*CDFmm CWHdm CWHmm1 CWHms2 CWHvh1 CWHvh2 CWHvm1 CWHwh1 CWHwm CWHws1 CWHxm1 CWHxm2*

Code	Name[1]	Description	BEC units
IN	Intermittent Stream	Typically a freshwater riverine habitat contained within a channel that only periodically has moving water and is bounded by banks or upland habitat. Occurs throughout the province in areas where there is not enough water supply to support perennial flow.	
IS	Interior Western Hemlock – White Spruce	Typically a dense coniferous forest with shrub- and moss-dominated understories, which includes plant communities that may progress through long-lived seral sub-alpine fir, spruce, and lodgepole pine to a climax of western hemlock and western redcedar. Found extensively at low to middle elevations throughout the Columbia Mountains and highlands. Typical range of elevation is between approximately 400 and 1400 m. Small pockets are also present in the Southern Nass Basin and Skeena and Hazelton mountains.	*ICHdw ICHmc2 ICHmm ICHmk3 ICHmw1 ICHmw2 ICHmw3 ICHvk1 ICHvk2 ICHwk1 ICHwk2 ICHwk3 ICHwk4 ICHxw*
LL	Large Lake	Typically a fresh deepwater habitat that includes permanently flooded lakes, usually found in a topographical depression, lacking emergent vegetation except along shorelines, and usually greater than 60 ha.	
LP	Lodgepole Pine	Typically an open lodgepole pine forest with shrub, moss, or terrestrial lichen understories on level, nutrient-poor, coarse-textured soils. Found extensively between 500 and 1600 m, throughout the interior of the province. It occurs in the Southern Interior Mountains, throughout the Columbia range, in the sub-boreal, central, and Southern Interior, as well as throughout the Fraser Plateau, Fraser Basin, Skeena and Omineca mountains, Thompson-Okanagan Plateau, and the leeside of the Pacific Ranges. It is also common within portions of the Taiga and Boreal Plains and Northern Boreal Mountains, and along the North Coast.	*BWBSdk1 BWBSdk2 BWBSmw1 BWBSmw2 BWBSwk1 BWBSwk2 BWBSwk3 ICHmc1 ICHmc2 ICHwk1 IDFdk4 ESSFdc2 ESSFmv1 ESSFwc2 ESSFxc ESSFxv1 MSdk MSdm2 MSdm1 MSxv SBPSdc SBPSmc SBPSmk SBPSxc SBSdh SBSdk SBSdw1 SBSdw2 SBSdw3 SBSmc1 SBSmc2 SBSmc3 SBSmk1 SBSmk2 SBSmm SBSmw SBSvk SBSwk1 SBSwk2 SBSwk3*
LS	Small Lake	Typically a fresh deepwater habitat that includes permanently flooded lakes (and sometimes reservoirs), usually 8 to 60 ha in a topographic depression, with most of the water less than 7 m in depth. Small lakes occur throughout the province in small valleys and basins.	

Code	Name[1]	Description	BEC units
ME	Meadow	A meadow wetland class that typically is a lower elevation herbaceous community, dominated by moisture-loving species, on imperfectly to poorly drained mineral soil sites. Occurs, to a limited extent, at lower elevations throughout the southern portion of the province, including Vancouver Island, the Mainland Coast, and Okanagan and Kootenay regions. It is most commonly found within the Fraser Plateau area. Meadows do occur in most southern biogeoclimatic zones, with the exception of the AT zone.	
MF	Mountain Hemlock – Amabilis Fir	Typically a high elevation, dense coniferous forest with shrub-dominated understories, which proceeds after disturbance directly to a climax species mix of mountain hemlock, western hemlock, and amabilis fir. This unit occurs in high elevation areas along the coast, including the eastern and western slopes of the Vancouver Island Ranges, Queen Charlotte Mountains, and Coast Mountains, as well as the western slopes of the Hazelton Mountains. It is limited to elevations ranging between 800 and 1600 m. Note there is considerable range in the upper and lower elevation due to climatic variability and differing topography.	*MHmm1 MHmm2 MHwh*
MI	Mine	Typically an area where mining exploration is presently taking place or where mining has recently been completed. Mining activity occurs in all regions of the province, covering large or small areas, depending on the minerals that are desired and the terrain. Open pit mining is commonly used for mineral extraction. Open pit mines are holes in the ground, varying in size and shape, which are open to the sky and have been created to extract minerals or aggregates (including gravel pits). Mines can also be in the form of complex underground tunnels, with only a few tunnels that actually connect to the surface, often via a central mine shaft. Another common feature associated with mining activity are mine tailings or rubbly mine spoils. These are areas containing the waste rock or overburden that is discarded in the extraction of ore in a mining operation.	
MR	Marsh	A marsh wetland class that typically is permanently or seasonally inundated and that supports an extensive cover of emergent, non-woody vegetation rooting in mineral-rich substrate. Found in a limited extent throughout lower elevation sites in the province. Marshes generally occur below 800 m.	
MS	Montane Shrub/Grassland	Typically a varied mixture of shrubs, thickets, and herbaceous openings found in steep breaks along lower river valleys. This type of habitat occurs in a very limited extent, usually in small patches throughout many of the river valleys in the province. It typically ranges in elevation between 350 and 1200 m.	*BGxh3 BWBSmw1 BWBSdk1 BWBSdk2 IDFxh1 MSxv SBPSdc SBPSmc SBSdk SBSdw2 SBSmc2 SBSmc3*

Code	Name[1]	Description	BEC units
OA	Garry Oak – Arbutus	Typically a sparse to open mixed forest, with understories dominated by mosses and a dense mixture of spring wildflowers and grasses, growing on shallow, rocky sites. Restricted to rocky areas of the Coastal Douglas-fir (CDFmm) and Coastal Western Hemlock (CWHxm1) biogeoclimatic subzones of southern Vancouver Island and adjacent Gulf Islands, and a few sites in the southern portions of the Fraser Valley.	*CDFmm CWHxm1*
OV	Orchard/Vineyard	Typically an agricultural area used for growing hard and soft fruit crops, with some form of symmetrical arrangement of the trees, shrubs, or vines. Concentrated in very arid regions of the province including the river valleys of the south Fraser, Thompson, and Similkameen rivers; the Okanagan Valley; and southeastern Vancouver Island. Typically orchards and vineyards are associated with the Coastal Douglas-fir, Interior Douglas-fir, Ponderosa Pine, and Bunchgrass biogeoclimatic zones.	
OW	Shallow Open Water	A shallow open water wetland class that typically is comprised of permanent shallow open water and that lacks extensive emergent plant cover; water is usually less than 2 m in depth, with submerged and floating aquatic plants present. Generally found throughout the province at elevations below 1000 m.	
PB	Lodgepole/Shore Pine Bog	A bog wetland class characterized by a sparse cover of stunted shore pine and poorly drained coastal soils. Shrubs and sphagnum moss dominate the understorey. Typically found along eastern Vancouver Island south of Kelsey Bay, throughout the Lower Mainland and up the Mainland Coast, including the western slopes of the Coast Mountains, Hecate Lowland, Outer Fiordland, Georgia Lowland, and the southern Gulf Islands, as well as the islands of Queen Charlotte Strait and the Strait of Georgia. The elevational limits of this unit range between sea level and 700 m.	*CWHds1 CWHds2 CDFmm1 CWHms1 CWHms2 CWHxm*
PO	Lodgepole Pine Outcrop	Typically a sparse to open lodgepole pine forest, with understories dominated by moss, lichens, and grasses, growing on shallow, rocky sites. Limited to areas with shallow soils over bedrock, within the Pacific Ranges.	*CWHxm CWHdm MSxv SBPSxc*
PP	Ponderosa Pine	Typically a sparse to open coniferous forest with shrub- or perennial grass-dominated understories, which occurs along the grassland/forest borders, leading to a ponderosa pine and Douglas-fir climax. Occurs at low elevations in the major valleys of the Thompson/ Okanagan Plateau, including the Thompson and Okanagan basins. It also occurs in the East Kootenay Trench and in the Fraser Valley from north of Lillooet to just south of Lytton. Generally found below 500 m in elevation.	*BGxh1 BGxh2 BGxw1 IDFxh1 PPdh1 PPdh2 PPxh1 PPxh2*

Code	Name[1]	Description	BEC units
PR	White Spruce – Balsam Poplar Riparian	Typically a dense, deciduous, mixed or coniferous forest, with thick shrub understories, found on or in association with fluvial sites; includes plant communities that succeed through deciduous forests to a white (or hybrid white) spruce climax. This unit occurs between 300 and 1200 m in the northern portions of the province, throughout the major river valleys of the Northern Boreal Mountains, Boreal and Taiga Plains, as well as in the Southern Omineca and Central Canadian Rocky mountains.	*BWBSdk1 BWBSdk2 BWBSmw1 BWBSmw2 BWBSwk1 BWBSwk2 SWBdk SWBmk SWBvk*
RB	Western Redcedar – Paper Birch	Typically a dense coniferous forest with shrub-dominated understories, which includes plant communities that succeed through deciduous seral stages or through Douglas-fir, lodgepole pine, and western larch (sometimes) to a climax of western redcedar and hybrid spruce. Commonly found in valley bottoms and lower slopes between 800 and 1400 m. Distributed throughout the Shuswap, Quesnel, and Okanagan highlands, as well as the North Thompson Upland, Southern Fraser Plateau, Southern Rocky Mountain Trench, and the leeside of the Cascade Mountains.	*ICHdk ICHmk2 ICHmk3 ICHmw3 IDFdk2*
RD	Western Redcedar – Douglas-fir	Typically a dense coniferous forest with shrub-dominated understories, which includes plant communities that succeed through Douglas-fir, lodgepole pine, and western larch (sometimes) to a climax of western redcedar. Found at low elevations (300–1200 m) in the Shuswap, Quesnel, and Okanagan Highlands and the southern Fraser Plateau. It also occurs in the southern Rocky Mountain Trench and the southern Monashee and Purcell mountains, as well as in the leeward Pacific range and the southern Chilcotin range.	*ICHdk ICHmk1 ICHmk3 ICHmm ICHmw2 ICHwk4 IDFmw1 IDFmw2 IDFww IDFxh2*
RE	Reservoir	Typically a fresh, dammed, deepwater habitat that is permanently flooded, with variable water levels. Found all over the province, mainly at lower elevations.	
RM	Reclaimed Mine	Typically a mined area or mine tailings that have plant communities composed of a mixture of agronomic grasses, forbs, and native plants. Mining activity has taken place in all regions of the province, covering large and small areas, depending on the minerals that were desired and the terrain . Reclaimed mines usually contain a mixture of native and introduced plant species. The density and composition of these communities is related to the age and location of the site, as well as the amount of disturbance that resulted from the mining activities. In some areas of the province, the disturbances caused by mining activities may have provided the ideal conditions for particular native plant species, which have flourished since the operation ceased. However, in other heavily disturbed areas, agronomic species may have been seeded to stabilize the soils and have subsequently dominated these previously mined sites.	

Code	Name[1]	Description	BEC units
RO	Rock	Typically a mixture of gentle to steep, non-alpine bedrock escarpments and outcroppings with little soil development and relatively low vegetative cover. Found anywhere exposed bedrock is located in non-alpine regions of the province. Occurs extensively in mountainous areas.	
RR	Western Redcedar – Black Cottonwood Riparian	Typically a dense coniferous forest with shrub-dominated understories, which includes plant communities that may succeed either through deciduous seral species or directly to a climax of hybrid spruce, western redcedar, and western hemlock. Found extensively throughout valleys of the Southern Interior Mountains and portions of the Northern Thompson Upland and Northern Okanagan Highland, between approximately 400 and 1450 m elevation. It also occurs between 350 and 1100 m in the valleys of the Skeena Mountains, Nass Basin, and Nass Ranges.	*ESSFvc ESSFwc1 ESSFwc2 ICHdk ICHdw ICHmc1 ICHxw ICHmk1 ICHmk2 ICHmk3 ICHmm ICHmw1 ICHmw2 ICHmw3 ICHvk1 ICHwk1 ICHwk2 ICHwk3 ICHwk4 ICHvk2 IDFmw1 IDFmw2 IDFww*
RS	Western Redcedar Swamp	A swamp wetland class that typically is an open forested wetland composed of western redcedar and various conifers, with a skunk cabbage and fern understorey associated with very poorly drained sites. The redcedar swamp is limited in size but has an extensive distribution. It occurs between 400 and 1550 m on the more gentle slopes of the Southern Interior Mountains and portions of the Northern Thompson Upland and Northern Okanagan Highland. It occurs throughout the Coastal Douglas-fir (CDF) and Coastal Western Hemlock (CWH) biogeoclimatic zones of the Coast Mountains and Vancouver Island regions between sea level and approximately 1000 m.	*CDFmm CWHdm CWHds1 CWHds2 CWHmm1 CWHmm2 CWHms1 CWHms2 CWHvh1 CWHvh2 CWHvm1 CWHvm2 CWHwm CWHwh1 CWHwh2 CWHws1 CWHws2 CWHxm ICHmk1 ICHmk2 ICHmk3 ICHmw1 ICHmw2 ICHmw3 ICHvk1 ICHvk2 ICHwk1 ICHwk2 ICHwk3 IDFmw2 IDFww*
SA	Sub-boreal White Spruce – Trembling Aspen	Typically a dense mixed or coniferous sub-boreal forest with shrub- and herb-dominated understories, which includes plant communities that succeed through trembling aspen seral forests to a white spruce climax.	
SB	White Spruce – Paper Birch	Typically a dense, mixed sub-boreal forest with dense shrub-dominated understories, which includes plant communities that succeed through paper birch, trembling aspen, and Douglas-fir seral forests to a white spruce climax. Found on the lower valley slopes and valley bottoms between the elevations of 450 and 1225 m in the Rocky Mountain Trench, Fraser Basin, and northern Fraser Plateau.	*SBSmh*

Code	Name[1]	Description	BEC units
SC	Shrub-Carr	A shrub-carr wetland class that typically is dominated by shrubs, found on poorly drained mineral soil sites. Occurs along stream edges, drainage ways, small depressions, and the perimeters of lakes, ponds, and sedge wetlands in most areas.	
SD	Spruce – Douglas-fir	Typically a dense coniferous forest with soopolallie- or pinegrass-dominated understories, which includes plant communities that progress though a mixture of lodgepole pine, Douglas-fir, and western larch to a white spruce and subalpine fir climax; sometimes with lodgepole pine or trembling aspen present. Located between 600 and 1600 m in the areas around the Nechako, Fraser, and Thompson plateaus, as well as in the Okanagan Highland. It is also located in the southern Rocky Mountains, southern Rocky Mountain Trench, southeastern Purcell and Monashee mountains, as well as the leeside of the Cascade Mountains.	*MSdk MSdm1 SBSdh SBSdk SBSdw1 SBSdw2 SBSdw3 SBSvk IDFdk1 IDFdk2 IDFdk3 IDFdm1 IDFdm2 IDFxh1 IDFxm IDFxw*
SF	White Spruce – Subalpine Fir	Typically a dense, coniferous sub-boreal forest with dense shrub- and moss-dominated understories, which includes communities that progress directly to a white spruce and subalpine fir climax, sometimes with lodgepole pine or trembling aspen. This unit is common throughout the lowland forests found on the Fraser Plateau, Fraser Basin, Nass Basin, Central Canadian Rocky Mountains, Omineca Mountains, Skeena Mountains, and Columbia Highlands. It also occurs to a limited extent in the Southern Rocky Mountain Trench and on the Thompson-Okanagan Plateau. In northerly areas it commonly occurs between 500 and 1200 m elevation, while more southerly locations occur at higher elevations between 1000 and 1650 m.	*ESSFmv3 SBSdh SBSdk SBSdw1 SBSdw2 SBSdw3 SBSmc1 SBSmc2 SBSmc3 SBSmh SBSmk1 SBSmk2 SBSmm SBSmw SBSvk SBSwk1 SBSwk2 SBSwk3 MSdc MSdm1 MSdm2 MSxk ICHdk ICHmk1 ICHmk3 ICHvc ICHwc ICHwk2 ICHwk4*
SG	Subalpine Grassland	Typically a high elevation, lush grassland habitat dominated by perennial grasses and forbs, on dry sites. This uncommon unit occurs on isolated, high elevation sites throughout the Northern Boreal Mountains, Omineca Mountains, Central Canadian Rockies, and Southern Interior Mountains. It is found at elevations ranging between 1000 and 1600 m in the north and approximately 1600 and 2000 m in the south.	*BWBSdk1 SWBmk ESSFdk ESSFmv ESSFxc ESSFxv*
SH	Shrub Fen	A fen wetland class that is typically dominated by shrubs, found on poorly drained organic sites. Common throughout the interior of the province, with the exception of the Bunchgrass (BG), Ponderosa Pine (PP), and Alpine Tundra (AT) zones. Limited to areas that are poorly drained, subhydric, and depressional or level.	

Code	Name[1]	Description	BEC units
SK	Spruce – Swamp	A swamp wetland class that typically is an open forested wetland of spruce with an understorey of skunk cabbage and sparse shrubs, found on very poorly drained sites. Located throughout the interior of the province, east of the Coast Mountains including the Northern Boreal Mountains; Taiga and Boreal plains; central, southern, and sub-boreal Interior; and the Southern Interior Mountains. Generally found at mid-elevations between 400 and 1400 m; more northerly locations may occur at lower elevations while more southerly areas may occur at higher elevations.	*IDFdk3 IDFdk4 SBPSdc SBPSmc SBPSmk SBPSxc BWBSdk1 SBSdw1 SBSmc2 SBSmh SBSvk ICHdk ICHmc2 ICHmk1 ICHmk2 ICHmw3 ICHwk4 ICHvc ICHwk1*
SL	Sub-boreal White Spruce – Lodgepole Pine	Typically a dense, sub-boreal coniferous forest that includes plant communities that succeed through lodgepole pine seral forests to a white spruce climax. This unit occurs extensively in the Southern Rocky Mountain Trench, Fraser Basin, Omineca Mountains, and northern portion of the Fraser Plateau; elevational limits range between 700 and 1400 m. It is also present at higher elevations between 1200 and 1650 m, and in portions of the southern Fraser and Thompson-Okanagan plateaus.	*SBSdk SBSdw1 SBSdw2 SBSdw3 SBSmc1 SBSmc2 SBSmc3 SBSmh SBSmk1 SBSmk2 SBSwk3 SBPSdc SBPSmc SBPSmk SBPSxc IDFdk3 IDFdk4 IDFdm2 MSxk MSxv*
SM	Subalpine Meadow	Typically a high elevation meadow community, dominated by moisture-loving herbaceous species, found on wetter sites in the subalpine forested areas. This unit occurs throughout the province at elevations ranging between 1000 and 1600 m in the north and 1600 and 2000 m in the south. It occurs in the Vancouver Island and Queen Charlotte Islands Ranges, Coast Mountains, Southern Interior Mountains, and Northern Boreal Mountains, as well as many of the high elevation plateaus found in the province.	*ESSFdc ESSFdk ESSFmc ESSFmk ESSFmm1 ESSFmv3 ESSFmv4 ESSFmw ESSFvc ESSFwc ESSFwk1 ESSFwk2 ESSFwm ESSFwv ESSFxc ESSFxv MHmm1 MHmm2 MHwh1 SWBdk SWBmk*
SP	Slow Perennial Stream	Typically a freshwater riverine habitat contained within a channel that has continuously slow-moving water, is bounded by banks or upland habitat, and has a low gradient; may include channels that form a connecting link between two bodies of standing water. Distributed throughout the province with a larger proportion of slow-moving streams found at lower altitudes where the gradient of the stream is reduced.	

Code	Name[1]	Description	BEC units
SR	Sitka Spruce – Black Cottonwood Riparian	Typically a dense coniferous forest with fern- or shrub-dominated understories, which may progress through plant communities with red alder, black cottonwood, or bigleaf maple to a coniferous mixture of Sitka spruce and western hemlock; found on or in association with fluvial sites. Occurs extensively throughout valley bottoms of the Coast and Mountains ecoprovince, ranging in elevation between sea level and 1000 m.	*CDFmm CWHdm CWHmm1 CWHds1 CWHds2 CWHvm1 CWHms1 CWHms2 CWHxm CWHvh1 CWHvh2 CWHwh1 CWHwm CWHws1 CWHws2 ICHvc CDFmm CWHdm CWHds1 CWHds2 CWHmm1 CWHms1 CWHms2 CWHvh1 CWHvh2 CWHvm1 CWHvm2 CWHwh1 CWHwm CWHws1 CWHws2 CWHxm ICHmc1 ICHmc2 ICHvc ICHwc*
SS	Big Sagebrush Shrub/Grassland	Typically an open to dense, dry shrubland, dominated by drought-tolerant shrubs and perennial grasses, and generally lacking trees. This unit occurs extensively throughout the lower to middle elevations of the Southern Interior and southern portion of the Fraser Plateau; including the Fraser River, Thompson and Okanagan basins, as well as the valleys around the Fraser River in the Pavillion Ranges, Nicola River, and the Similkameen River. More isolated ecosystems are also found in the Granby and Kettle River valleys of the Southern Okanagan Highland. Elevation ranges from 250 to 1300 m with a sagebrush variety change in the higher elevation subzone (MSxk: 1450 to 1650 m).	*BGxh1 BGxh2 BGxh3 BGxw1 BGxw2 ESSFxc MSxk IDFdk1 IDFdm1 IDFxh1 IDFxh2 PPxh1 PPxh2*
ST	Subtidal Marine	Typically a habitat that consists of open ocean overlying the continental shelf with salinities in excess of 18 ppt and a substrate that is continuously submerged. This unit occurs adjacent to the intertidal shores of all coastal islands and the mainland, including major inlets, fjords, bays, and the open ocean.	*CDFmm CWHdm CWHmm1 CWHms2 CWHvh1 CWHvh2 CWHvm1 CWHwh1 CWHwm CWHws1 CWHxm1 CWHxm2*

Code	Name[1]	Description	BEC units
SU	Subalpine Shrub/Grassland	Typically high elevation, northern habitat, characterized by dense shrubs and bunchgrasses, both inter-mixed and occasionally dominated by scrub birch, willows, and Altai fescue. Generally limited to the high elevation areas of the Northern Boreal Mountains and portions of the Omineca and Central Canadian Rocky Mountains. Elevational limits range between 1000 and 1600 m.	*SWBmk SWBun*
SW	Shrub Swamp	A swamp wetland class that typically is a tall shrub wetland, characterized by willows, a sparse cover of spruce and sedges, usually found along stream channels and composed of a mixture of mineral and organic material. Occurs at lower to middle elevations, in a limited extent along creeks and rivers throughout the province.	
TA	Talus	Typically sparsely vegetated, rubbly or blocky colluvial areas, at the base of rock outcroppings, cliffs, or escarpments. Found throughout the province in non-alpine areas, usually on steep slopes below rock outcrops or escarpments. The weathered bedrock sheds blocks of rubble, which accumulate in draws and across the base of steep slopes and cliffs.	
TB	Trembling Aspen – Balsam Poplar	Typically an open, deciduous subalpine forest found on warm aspects, often in association with shrub/grasslands. This important habitat occurs on steep, warm aspects in the Spruce–Willow–Birch biogeoclimatic zone. This unit is limited to elevations ranging between 1050 and 1500 m. It occurs throughout the subalpine areas of the Northern Boreal Mountains; small patches are also present in the Northern Omineca and Central Canadian Rocky mountains, as well as on the Muskwa Plateau.	*SWB*
TC	Transportation Corridor	Typically a linear-shaped land area dedicated to some form of above-ground system for carrying products from one point to another, including roads and railways. Commonly occurs in low to middle elevation biogeoclimatic units throughout the southern half of the province. In more northerly locations they are not as widespread. Transportation corridors tend to be associated with communities, linking one community to another and to resource-related activities.	
TF	Tamarack Wetland	A fen wetland class that typically is an open forested wetland, dominated by tamarack, scrub birch, sedges, and moss. Found between 300 and 1100 m elevation throughout the Boreal and Taiga Plains, as well as the Liard Basin.	*BWBSdk BWBSmw1 BWBSmw2*
TR	Transmission Corridor	Typically a linear-shaped land area dedicated to some form of above or below ground system for carrying products from one point to another, including transmission lines and pipeline. Commonly occurs in low to mid-elevation biogeoclimatic units throughout the southern half of the province. In more northerly locations they are not as widespread in occurrence. Transmission corridors tend to be concentrated around hydroelectric systems.	

Code	Name[1]	Description	BEC units
UR	Urban	Typically a mixture of human-influenced habitats that includes residential and urban areas, but excludes major agricultural lands. Urban development is not limited to specific regions or particular physical environments. However, most urban centres are situated at low elevations and near the coast, large rivers, or lakes.	
UV	Unvegetated	Typically non-alpine, unvegetated areas consisting of exposed soils and excluding unvegetated bedrock sites. Typically the total cover of vegetation, including trees, shrubs, herbs, and lichens, is less than 5% of the total surface area. This limited habitat occurs as a result of natural erosion, as well as human activities. Some typical sources of exposed soils include cutbanks along watercourses and roads, beaches, gravel pits, landings for sorting and loading logs, glacial moraines, mudflats in association with dried up lakes and ponds, and steep slopes where mudslides and debris torrents commonly occur.	
WB	Whitebark Pine Subalpine	Typically a subalpine habitat of open, whitebark pine forests, inter-mixed with lush bunchgrasses, other perennial grasses, and forbs, on droughty sites. Limited to south-facing slopes above the Engelmann Spruce – Subalpine Fir (ESSF) zone and below the Alpine Tundra (AT) zone, east of the leeward Coast Mountains into the Rocky Mountains. Occurs between 1650 and 2100 m elevation in more southerly areas and between 1000 and 1800 m in more northerly locations. Note, there is considerable range in the upper and lower elevational limits due to climatic variability and differing topography.	*ESSFdk ESSFdv ESSFmk ESSFxv*
WG	Hybrid White Spruce Bog Forest	A bog wetland class that is typically a sparse to open, treed organic wetland, composed of hybrid white spruce, with minor amounts of lodgepole pine and moss-dominated understorey. Occurs throughout the interior, east of the Coast Mountains; including the sub-boreal, central and southern interior of the province and into the Southern Interior Mountains. Elevational limits range between 400 and 1450 m. More northerly locations may occur at lower elevations while more southerly locations may occur at higher elevations.	*BWBS IDF MSdk MSxv SBPS SBS ICH*
WL	Wetland	Used for any wetland habitat class that cannot be recognized at small mapping scales.	
WP	Subalpine Fir – Mountain Hemlock Wet Parkland	Typically a high elevation mosaic of tree clumps and subalpine meadows or tundra, occurring above the closed forest and below the alpine. This unit occurs above the Engelmann Spruce – Subalpine Fir (ESSF) zone in the eastern Kitimat Ranges, south/central Hazelton Mountains, southeast Boundary Ranges, and northwest Skeena Mountains; elevation is approximately 1800 m. There is also a limited amount of this unit found on the leeward side of the Pacific Ranges, as well as in the western Monashee Mountains, at approximately 1675 m. Note, there is considerable range in the upper and lower elevational limits due to climatic variability and differing topography.	*ESSFmk ESSFmw ESSFvc ESSFwv*

Code	Name[1]	Description	BEC units
WR	Hybrid White Spruce – Black Cottonwood Riparian	Typically a dense deciduous, mixed or coniferous forest with shrub-dominated understories, found on, or in association with fluvial sites; includes plant communities that succeed slowly through black cottonwood to potential hybrid white spruce climax. Occurs throughout the interior, east of the Coast Mountains; including the sub-boreal, central, and southern interior and into the Southern Interior Mountains. Elevational limits range between 400 and 1450 m. More northerly locations may occur at lower elevations while more southerly locations may occur at higher elevations.	*ICHdk ICHmc1 ICHmc2 ICHwk1 IDFdk1 IDFdk2 IDFdk3 IDFdk4 IDFdm1 IDFdm2 IDFxm IDFxw IDFxh1 IDFxh2 SBPSdc SBPSmc SBPSmk SBPSxc SBSdh1 SBSdh2 SBSdk SBSdw1 SBSdw2 SBSmc1 SBSmc2 SBSmc3 SBSmh SBSmk1 SBSmk2 SBSmm SBSmw SBSvk SBSwk1 SBSwk2 SBSwk3 MSdk MSxv PPdh2 PPxh1*
YB	Yellow-cedar Bog Forest	Typically an open forest with shrubby yellow-cedar, mountain hemlock, and western hemlock; found on poorly drained sites. This unit is found on the western slopes of the Coast Mountains, north of the Fraser River through to the Alaskan border and throughout the Hecate Lowlands. It also occurs on the islands along the coast, including the Queen Charlotte Islands and Vancouver Island. It is restricted to the windward portion of southern Vancouver Island and expands to cover all of northern Vancouver Island, north of Kelsey Bay. Typically, the elevational limits of this unit range between sea level and approximately 1800 m.	*CWHmm2 CWHvh1 CWHvh2 CWHvm1 CWHvm2 CWHwh1 CWHwh2 MHmm1 MHmm2 MHwh*
YM	Yellow-cedar – Mountain Hemlock Forest	Typically an open scrubby forest with a well-developed understorey; mountain hemlock and yellow-cedar are the dominant climax species. Occurs at high elevations on the Queen Charlotte Islands and in hypermaritime areas of the coast, including major coastal islands north of Smith Inlet; typically found at elevations ranging from 500 to 1100 m.	*MHmm1 MHmm2 MHwh*
YS	Yellow-cedar Skunk Cabbage Swamp Forest	Typically an open forested wetland of yellow-cedar with an understorey of skunk cabbage and sparse shrubs found on poorly drained mineral sites. Occurs at higher elevations, ranging between 500 and 1600 m, on the Queen Charlotte Islands, Vancouver Island, and the Mainland Coast, expanding east into the Coast Mountains and north to the Alaskan border.	*MHmm1 MHmm2 MHwh*

Appendix 7. Structural stages and codes[1]

From *Standards for Terrestrial Ecosystems Mapping in British Columbia*. 1998. Ecosystems Working Group of the Terrestrial Ecosystems Task Force, Resources Inventory Committee.

Structural stage	Description
	Post-disturbance stages or environmentally induced structural development
1 Sparse/bryoid[a]	Initial stages of primary and secondary succession; bryophytes and lichens often dominant, can be up to 100%; time since disturbance <20 years for normal forest succession, may be prolonged (50–100+ years) where there is little or no soil development (bedrock, boulder fields); total shrub and herb cover <20%; total tree layer cover <10%.
Substages	
1a Sparse[a]	<10% vegetation cover
1b Bryoid[a]	Bryophyte- and lichen-dominated communities (>½ of total vegetation cover).
	Stand initiation stages or environmentally induced structural development
2 Herb[a]	Early successional stage or herbaceous communities maintained by environmental conditions or disturbance (e.g., snow fields, avalanche tracks, wetlands, grasslands, **flooding**, intensive grazing, intense fire damage); dominated by herbs (forbs, graminoids, ferns); some invading or residual shrubs and trees may be present; tree layer cover <10%, shrub layer cover <or equal to 20% or <1/3 of total cover, herb-layer cover >20%, or >or equal to 1/3 of total cover; time since disturbance <20 years for normal forest succession; many herbaceous communities are perpetually maintained in this stage.
Substages	
2a Forb -dominated[a]	Herbaceous communities dominated (>½ of the total herb cover) by non-graminoid herbs, including ferns.
2b Graminoid -dominated[a]	Herbaceous communities dominated (>½ of the total herb cover) by grasses, sedges, reeds, and rushes.
2c Aquatic[a]	Herbaceous communities dominated (>½ of the total herb cover) by floating or submerged aquatic plants; does not include sedges growing in marshes with standing water (which are classed as 2b).
2d Dwarf shrub[a]	Communities dominated (>½ of the total herb cover) by dwarf woody species such as *Phyllodoce empetriformis, Cassiope mertensiana, Cassiope tetragona, Arctostaphylos arctica, Salix reticulata,* and *Rhododendron lapponicum*. (See list of dwarf shrubs assigned to the herb layer in the *Field Manual for Describing Terrestrial Ecosystems.)*
3 Shrub/Herb[b]	Early successional stage or shrub communities maintained by environmental conditions or disturbance (e.g., snow fields, avalanche tracks, wetlands, grasslands, **flooding**, intensive grazing, intense fire damage); dominated by shrubby vegetation; seedlings and advance regeneration may be abundant; tree layer cover <10%, shrub layer cover >20% or >or equal to 1/3 of total cover.
Substages	
3a Low shrub[b]	Communities dominated by shrub layer vegetation <2 m tall; may be perpetuated indefinitely by environmental conditions or repeated disturbance; seedlings and advance regeneration may be abundant; time since disturbance <20 years for normal forest succession.

1 In the assessment of structural stage, structural features and age criteria should be considered together. Broadleaf stands will generally be younger than coniferous stands belonging to the same structural stage.

Structural stage	Description
3b Tall shrub[b]	Communities dominated by shrub layer vegetation that are 2–10 m tall; may be perpetuated indefinitely by environmental conditions or repeated disturbance; seedlings and advance regeneration may be abundant; time since disturbance less than 40 years for normal forest succession.
	Stem exclusion stages
4 Pole/Sapling[c]	Trees >10 m tall, typically densely stocked, have overtopped shrub and herb layers; younger stands are vigorous (usually >10–15 years old); older stagnated stands (up to 100 years old) are also included; self-thinning and vertical structure not yet evident in the canopy – this often occurs by age 30 in vigorous broadleaf stands, which are generally younger than coniferous stands at the same structural stage; time since disturbance is usually <40 years for normal forest succession; up to 100+ years for dense (5000–15 000+ stems per hectare) stagnant stands.
5 Young Forest[c]	Self-thinning has become evident and the forest canopy has begun differentiation into distinct layers (dominant, main canopy, and overtopped); vigorous growth and a more open stand than in the pole/sapling stage; time since disturbance is generally 40–80 years but may begin as early as age 30, depending on tree species and ecological conditions.
	Understorey reinitiation stage
6 Mature Forest[c]	Trees established after the last disturbance have matured; a second cycle of shade tolerant trees may have become established; understories become well developed as the canopy opens up; time since disturbance is generally 80–140 years for biogeoclimatic group A[d] and 80–250 years for group B.[e]
	Old-growth stage
7 Old Forest[c]	Old, structurally complex stands composed mainly of shade-tolerant and regenerating tree species, although older seral and long-lived trees from a disturbance such as fire may still dominate the upper canopy; snags and **coarse woody debris** in all stages of decomposition typical, as are patchy understories; understories may include tree species uncommon in the canopy, due to inherent limitations of these species under the given conditions; time since disturbance generally >140 years for biogeoclimatic group A[d] and >250 years for group B.[e]

a Substages 1a, 1b, and 2a–d should be used if photo interpretation is possible, otherwise, stages 1 and 2 should be used.

b Substages 3a and 3b may, for example, include very old krummholz less than 2 m tall and very old, low productivity stands (e.g., bog woodlands) <10 m tall, respectively. Stage 3, without additional substages, should be used for regenerating forest communities that are herb- or shrub-dominated, including shrub layers consisting of only 10–20% tree species, and undergoing normal succession toward climax forest (e.g., recent cut-over areas or burned areas).

c Structural stages 4–7 will typically be estimated from a combination of attributes based on forest inventory maps and aerial photography. In addition to structural stage designation, actual age for forested units can be estimated and included as an attribute in the database, if required.

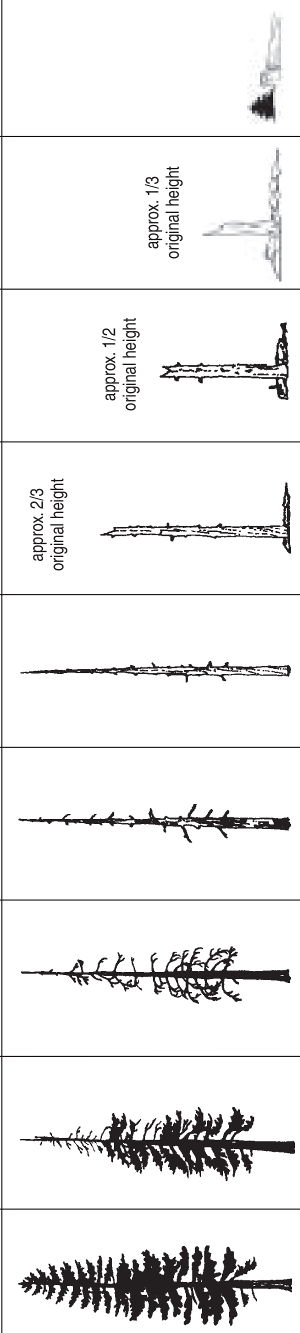
d Biogeoclimatic Group A includes BWBSdk, BWBSmw, BWBSwk, BWBSvk, ESSFdc, ESSFdk, ESSFdv, ESSFxc, ICHdk, ICHdw, ICHmk1, ICHmk2, ICHmw3, MS (all subzones), SBPS (all subzones), SBSdh, SBSdk, SBSdw, SBSmc, SBSmh, SBSmk, SBSmm, SBSmw, SBSwk1 (on plateau), and SBSwk3.

e Biogeoclimatic Group B includes all other biogeoclimatic units (see Appendix C).

Appendix 8. Wildlife tree classification for coniferous trees

From: *Vegetation Resource Inventory Ground Sampling Procedures*. 2002. B.C. Ministry of Sustainable Resource Management, Terrestrial Information Branch for the Resource Inventory Committee. See http://srmwww.gov.bc.ca/tib/veginv/publications.htm.

	LIVE		DEAD					DEAD FALLEN	
			Hard			Spongy	Soft		
Tree class	1	2	3	4	5	6	7	8	9
						approx. 2/3 original height	approx. 1/2 original height	approx. 1/3 original height	
Description	**Live/healthy**; no decay; tree has valuable habitat characteristics such as large, clustered or gnarled branches, or horizontal, thickly moss-covered branches.*	**Live/unhealthy**; internal decay or growth deformities (including insect damage, broken tops); dying tree.*	**Dead**; needles or twigs may be present; roots sound.	**Dead**; no needles/twigs; 50% of branches lost; loose bark; top usually broken; roots stable.	**Dead**; most branches/bark absent; some internal decay; roots of larger trees stable.	**Dead**; no branches or bark; sapwood/heartwood sloughing from upper bole; decay more advanced; lateral roots of larger trees softening; smaller ones unstable.	**Dead**; extensive internal decay; outer shell may be hard; lateral roots completely decomposed; hollow or nearly hollow shells.		**Debris**; downed trees or stumps.
Uses and users	Nesting (e.g., Bald Eagle, Great Blue Heron colonies, Marbled Murrelet); feeding; roosting; perching.	Nesting/roosting[1]—strong PCEs[2] (woodpeckers); SCUs[3]; large-limb and platform nests (Ospreys); insect feeders.	Nesting/roosting—strong PCEs; SCUs; bats.	Nesting/roosting—PCEs; SCUs; insect feeders.	Nesting/roosting—weak PCEs (nuthatches, chickadees); SCUs; bats; insect feeders.	Weaker PCEs; SCUs; insect feeders; salamanders; small mammals; hunting perches.	Insect feeders; salamanders; small mammals; hunting perches; occasionally used by weak cavity excavators such as chickadees.		Insect feeders; salamanders; small mammals; drumming logs for grouse; flicker foraging; nutrient source.



[1] Large witches' brooms provide nesting/denning habitat for some species (e.g., fisher, squirrels).

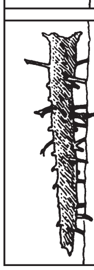
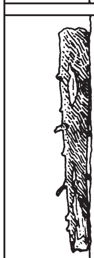
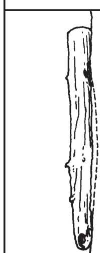
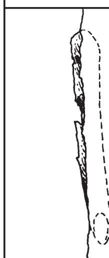
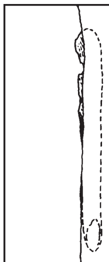
[2] PCE = primary cavity excavator

[3] SCU = secondary cavity user

* This classification system does not recognize root disease trees specifically. Such trees become unstable at or before death.

Appendix 9. Coarse woody debris classification

Adapted from: *Vegetation Resource Inventory Ground Sampling Procedures*. 2002. B.C. Ministry of Sustainable Resource Management, Terrestrial Information Branch for the Resource Inventory Committee. See http://srmwww.gov.bc.ca/risc/pubs/teveg/vri%20ground%20sampling2k2/vrigro%7e1.pdf.

	Decay Class				
Characteristics of fallen	 **Log class 1**	 **Log class 2**	 **Log class 3**	 **Log class 4**	 **Log class 5**
Bark	intact	intact	trace	absent	absent
Twigs	present	absent	absent	absent	absent
Texture	intact	intact to partly soft	hard, large pieces	small, soft blocky pieces	soft and powdery
Shape	round	round	round	round to oval	oval
Colour of wood	original colour	original colour	original colour to faded	light brown to reddish brown	red brown to dark brown
Portion of tree on ground	tree elevated on support points	tree elevated on support points but sagging slightly	tree sagging near ground	all of tree on ground	all of tree on ground
Invading roots	none	none	in sapwood	in heartwood	in heartwood

Appendix 10. Scientific names of commonly referred to tree and wildlife species

English name	Scientific name	Code
Alaska paper birch	*Betula neoalaskana*	Ea
alpine larch	*Larix lyallii*	La
amabilis fir	*Abies amabilis*	Ba
balsam poplar	*Populus balsamifera* ssp. *balsamifera*	Acb
bigleaf maple	*Acer macrophyllum*	Mb
black cottonwood	*Populus balsamifera* ssp. *trichocarpa*	Act
Douglas-fir	*Pseudotsuga menziesii*	Fd
Engelmann spruce	*Picea engelmannii*	Se
Garry oak	*Quercus garryana*	Qg
grand fir	*Abies grandis*	Bg
jack pine	*Pinus banksiana*	Pj
limber pine	*Pinus flexilis*	Pf
lodgepole pine	*Pinus contorta*	Pl
mountain hemlock	*Tsuga mertensiana*	Hm
Pacific dogwood	*Cornus nuttallii*	Gp
paper birch	*Betula papyrifera*	Ep
ponderosa pine	*Pinus ponderosa*	Py
poplar	*Populus balsamifera*	Ac
red alder	*Alnus rubra*	Dr
Sitka spruce	*Picea sitchensis*	Ss
subalpine fir	*Abies lasiocarpa*	Bl
tamarack	*Larix laricina*	Lt
trembling aspen	*Populus tremuloides*	At
vine maple	*Acer circinatum*	Mv
water birch	*Betula occidentalis*	Ew
western hemlock	*Tsuga heterophylla*	Hw
western larch	*Larix occidentalis*	Lw
western redcedar	*Thuja plicata*	Cw
western white pine	*Pinus monticola*	Pw
white spruce	*Picea glauca*	Sw
whitebark pine	*Pinus albicaulis*	Pa
yellow-cedar	*Chamaecyparis nootkatensis*	Yc
Pileated Woodpecker	*Dryocopus pileatus*	B-PIWO
Northern Flicker	*Colaptes auratus*	B-NOFL
Hairy Woodpecker	*Picoides villosus*	B-HAWO
Red-breasted Sapsucker	*Sphyrapicus rubber*	B-RBSA

Appendix 11. NatureServe status

NatureServe is a non-profit and independent organization that provides information on the conservation status of the world's plants, animals, and ecological communities. Formed in 1999 by the Nature Conservancy and the Natural Heritage Network, NatureServe uses standard criteria developed by NatureServe, the Nature Conservancy, and the Natural Heritage Network to assign conservation ranks. The ranking system is unique in three key respects: it is based on objective biological criteria; it is applicable at multiple geographic levels; and it includes ranks not just for species but for ecological communities. For more information on NatureServe, its methods, and its ranks, visit the NatureServe Web page at http://www.natureserve.org/explorer/aboutd.htm.

In short, each element is ranked at three geographic levels: global (G), national (N), and subnational (S). The global rank is based on the status of the element throughout its entire range whereas the subnational rank is based solely on its status within a state, province, or territory. Each element is assigned a rank between one and five unless considered extirpated, extinct, historical, or unranked (see descriptions below). The rank is based on the number of extant occurrences of the element, but other factors such as abundance, range, protection, and threats are also considered if the information is available. For information on ranking in British Columbia, visit http://wlapwww.gov.bc.ca/wld/documents/ranking.pdf.

Code	Rank	Definition
1	Critically Imperiled	*Extremely rare or some factor(s) makes it especially susceptible to extirpation or extinction. Typically ≤5 existing occurrences or very few remaining individuals.*
2	Imperiled	*Rare or some factor(s) makes it very susceptible to extirpation or extinction. Typically 6 to 20 existing occurrences or few remaining individuals.*
3	Vulnerable	*Rare and local, found only in a restricted range (even if abundant at some locations), or because of some other factor(s) making it susceptible to extirpation or extinction. Typically 21 to 100 existing occurrences.*
4	Apparently Secure	*Uncommon but not rare, and usually widespread in the province. Possible cause for long-term concern. Typically >100 existing occurrences.*
5	Secure	*Common to very common, typically widespread and abundant, and not susceptible to extirpation or extinction under present conditions.*
X	Extirpated or extinct	*Not located despite intensive searches and no expectation that it will be rediscovered; presumed to be extirpated or extinct.*
H	Historical	*Not located in the last 50 years, but some expectation that it may be rediscovered.*
?	Unranked	*Rank not yet assessed.*
U	Unrankable	*Due to current lack of available information.*

In addition to the above ranks, the following ranking modifiers are defined below.

B	Associated rank refers to breeding occurrences of mobile animals
E	An exotic species or species introduced by humans to the province
N	Associated rank refers to non-breeding occurrences of mobile animals
Q	Taxonomic status is unclear or is in question
R	Reported from the province, but without persuasive documentation for either accepting or rejecting the report
T	A rank associated with a subspecies or variety
Z	Occurs in the province but as a diffuse, usually moving population; difficult or impossible to map static occurrences

Appendix 12. Determining wildlife tree dbh recommendations for cavity-nesters

Resource managers often apply minimum size recommendations (e.g., wildlife tree dbh) to achieve wildlife conservation objectives. The use of minimum dbh sizes for retention of wildlife trees may not be the best management practice for cavity-nesters. Larger diameter wildlife trees provide important features including larger diameter cavities and thicker insulation around the nest cavity. An alternative approach to minimum sizes is to use the mean plus one standard deviation. Since information is not always available for a specific species of cavity-nester, it may be possible to use information from a primary cavity-nester to approximate the characteristics of the trees that will be selected by the secondary cavity-nester. Both the Pileated Woodpecker (*Dryocopus pileatus*) and Northern Flicker (*Colaptes auratus*) are primary cavity nesters and provide nesting and roosting cavities for many secondary cavity users. A summary of the nesting requirements of these two species is provided in Tables 12-1 and 12-2.

Table 12-1. Characteristics (mean ± SD) (cm) of Pileated Woodpecker nest trees in coastal and interior ecosystems

Location	Forest type	N	Tree dbh (cm)	Tree height (m)	Nest height (m)	Citation
Coastal ecosystems						
Western Washington	Western hemlock, Pacific silver fir	27	100.5	39.7	35.2	Aubrey and Raley (1996)
Oregon Coast Ranges	Western hemlock	15	68.9 ± 25	26.5 ± 16	19.9 ± 11	Mellen (1987)
Oregon Coast Ranges	Western hemlock	6	67.0 ± 20.3	26.5 ± 14.7	16.7 ± 5.4	Nelson (1988)
South Cascades	Mixed conifer to Douglas-fir	2	88.0 ± 19.8	40.0 ± 4.2	19.0 ± 4.2	Lundquist (1988)
Southeast Vancouver Island	CWHxm, CDF	7	82 ± 42	22 ± 13.8	17.4 ± 9.3	Hartwig (1999)
North Vancouver Island	CWHxm, CWHvm, MHmm	2	84.2 ± 17.5	36.7 ± 9.1	16.1 ± 3.4	Deal and Setterington (2000)
Interior ecosystems						
Blue Mountains, Oregon	Coniferous	105	84	28	15	Bull (1987)
Okanogan National Forest	Coniferous	6	84.2 ± 17.5	36.7 ± 9.1	16.1 ± 3.4	Madsen (1985)
Northern Montana	Coniferous	89	73.4 ± 1.9	29.0 ± 1.0	15.9 ± 0.6	McClelland and McClelland (1999)
South-central B.C.	Deciduous (IDF)	20	40.5 ± 7.1	19.2 ± 6.3	9.2 ± 1.8	Harestad and Keisker (1989)
West-central Alberta and northern B.C.	Deciduous	98	44.0			Bonar (1997)

Table 12-2. Characteristics (mean ± SD) of Northern Flicker nest trees in coastal and interior ecosystems

Location	Forest type	N	Tree dbh (cm)	Tree height (m)	Nest height (m)	Citation
Coastal ecosystems						
Northern Vancouver Island	CWHxm, CWHvm, MHmm	85	73.1 ± 3.4	22.6 ± 1.1		Deal and Setterington (2000)
Oregon Coast Ranges	Western hemlock	9	95.8 ± 30.0	38.6 ± 9.6	35.6 ± 10.8	Nelson (1988)
South Cascades	Mixed conifer to Douglas-fir	3	127.7 ± 38.5	46.3 ± 15.0	38.7 ± 20.6	Lundquist (1988)
Interior ecosystems						
Okanogan National Forest	Coniferous	16	70.4 ± 27.2	20.8 ± 11.9	14.3 ± 9.7	Madsen (1985)
South-central B.C.	Deciduous	17	31.9 ± 9.9	14.7 ± 7.8	5.7 ± 3.7	Harestad and Keisker (1989)
Riske Creek, B.C.	Deciduous	159	33.87 ± 10.34		3.32 ± 2.82	Wiebe (2001)

Many secondary cavity-nesters depend on more than one primary cavity-excavator for suitable cavities. Thus several data sets can be combined by using a weighted mean, which will give proportional weight to studies according to their sample sizes. This method may be used to calculate an optimum recommended dbh tree size for retention in coastal and interior ecosystems (see Table 12-3 for examples or the Pileated Woodpecker and Northern Flicker).

1. Derive recommended mean from mean values from studies on appropriate species of cavity-nesters.
2. Standardize data from studies by converting standard errors to standard deviation. Standard deviation = standard error * √n (Zar 1996).
3. Include data from generally similar ecosystems (i.e., northwestern U.S. and southwestern Canada and separate interior from coastal studies when appropriate).
4. Give more weight to studies that have larger sample sizes by using a weighted mean. The recommended mean is a weighted mean that is being used here to combine the means from two or more studies while adjusting for differences between subgroup frequencies (weighted mean = $\sum x_i * n_i / \sum n_i$). A pooled standard deviation can be calculated from the studies. Pooled SD = $\sqrt{[\sum [SD_i^2 (n_i - 1)] / [\sum n_i - G]}$ where G is the number of groups or studies (R. Davidson, statistics professor, Univ. Victoria, BC, retired).

Table 12-3. Recommendations for optimum size dbh (mean + 1SD) (cm) for Northern Flicker and Pileated Woodpecker in British Columbia based on weighted mean and pooled standard deviation

	Northern Flicker		Pileated Woodpecker	
Location	**Coniferous**	**Deciduous**	**Coniferous**	**Deciduous**
Interior ecosystems	70–98[a] or larger	34–44 or larger	74–80 or larger	41–48 or larger
Coastal ecosystems	77–88 or larger		74–102 or larger	

a After Madsen (1985) only.

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Appendix 13. Northern Interior region Identified Wildlife forest district tables

Fort Nelson Forest District

Common Name	CAR	CLH	EMR	ETP	FNL	HYH	KEM	LIP	MAU	MUF	MUP	PEP	SBP	SIU	TLP
Fish															
Bull Trout	X		X	X	X	X	X	X	X	X	X		X		
Birds															
Bay-breasted Warbler				X	X	X		X							
Black-throated Green Warbler		X									X				
Cape May Warbler					X						X				
Connecticut Warbler		X			X										
Sandhill Crane		X		X	X			X	X		X	X			X
Short-eared Owl					X					X	X				X
Mammals															
Boreal Caribou		X		X	X				X		X	X			X
Fisher	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Grizzly Bear	X	*	X	X	X	X	X	X	X	X	X	X	X	X	X
Northern Caribou	X		X			X	X	X		X	X		X		
Wolverine	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

X = Present; T = Introduced; I = Irregular/incidental; P = Possible; H = Historic; * = Extirpated in parts

Fort St. James Forest District

Common Name	BAU	ESM	MAP	NEL	NOM	NSM	SBP	SOM	SSM
Fish									
Bull Trout	X	X	X	X	X	X	X	X	X
Birds									
American White Pelican	X								
Long-billed Curlew				P					
Mammals									
Fisher	X	X	X	X	X	X	X	X	X
Grizzly Bear	X	X	X	X	X	X	X	X	X
Northern Caribou	X	X	X				X	X	
Wolverine	X	X	X	X	X	X	X	X	X

X = Present; T = Introduced; I = Irregular/incidental; P = Possible; H = Historic; * = Extirpated in parts

Kalum Forest District

Common Name	BUR	CRU	ESM	KIM	KIR	MEM	NAB	NAM	NSM	SBR
Fish										
Bull Trout	X	X	X	X		P	X	X	X	P
Amphibians										
Coastal Tailed Frog				X	X			X		X
Birds										
Great Blue Heron				X	X	X	P	X	X	X
Marbled Murrelet		P		X	X	X	X	X		X
Sandhill Crane		X	X	X	X		X	X		
Mammals										
Fisher	X	X	X	X		X	X	X	X	
Grizzly Bear	X	X	X	X	X	X	X	X	X	X
Wolverine	X	X	X	X	X	X	X	X	X	X

X = Present; T = Introduced; I = Irregular/incidental; P = Possible; H = Historic; * = Extirpated in parts

Mackenzie Forest District

Common Name	BAU	CAR	EMR	ESM	KEM	MAP	MCP	MIR	NEL	NHR	NOM	PAT	PEF	SBP	SOM	WMR
Fish																
Bull Trout	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Birds																
Sandhill Crane	X			X		X	X		X	X		X				
Short-eared Owl									P							
Mammals																
Fisher	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Grizzly Bear	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Northern Caribou	X	X	X	X	X	X		X						X	X	X
Wolverine	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

X = Present; T = Introduced; I = Irregular/incidental; P = Possible; H = Historic; * = Extirpated in parts

Nadina Forest District

Common Name	BAU	BUB	BUR	KIM	KIR	MAP	NAM	NAU	NEU
Fish									
Bull Trout	X	X	X	X		X	X	X	X
Birds									
Great Blue Heron	X	X		X	X		X	X	X
Sandhill Crane	X	X		X	X	X	X	X	X
Mammals									
Fisher	X	X	X	X		X	X	X	X
Grizzly Bear	X	X	X	X	X	X	X	*	X
Northern Caribou	X	X	X		X	X	X	X	X
Wolverine	X	X	X	X	X	X	X	X	X

X = Present; T = Introduced; I = Irregular/incidental; P = Possible; H = Historic; * = Extirpated in parts

Peace Forest District

Common Name	CLH	EMR	FNL	FRR	HAF	HAP	KIP	MIR	MUF	MUP	NHR	PEF	PEL	SHR	WMR
Fish															
Bull Trout	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Westslope Cutthroat Trout														T	
Birds															
Bay-breasted Warbler			X			X	X						X		
Black-throated Green Warbler	X				X	X	X			X			X		
Cape May Warbler			X			X	X			X			X		
Connecticut Warbler	X		X			X	X						X		
Great Blue Heron						X							X		
Nelson's Sharp-tailed Sparrow							X						X		
Sandhill Crane	X					X	X			X	X		X	X	
Short-eared Owl			X				X		X	X			X		
Mammals															
Bighorn Sheep				X	X						X			X	
Boreal Caribou	X		X			X	X			X					
Fisher	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Grizzly Bear	*	X	X	X	X	*	*	X	X	X	X	X	H	X	X
Mountain Caribou											X			X	
Northern Caribou		X		X	X	X	X	X	X	X		X			X
Wolverine	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

X = Present; T = Introduced; I = Irregular/incidental; P = Possible; H = Historic; * = Extirpated in parts

Prince George Forest District

Common Name	BAU	BOV	CAM	FRR	MCP	NAU	NEL	NHR	NPK	QUL	SHR	UFT
Fish												
Bull Trout	X	X	X	X	X	X	X	X	X	X	X	X
Birds												
Great Blue Heron	X		X			X	X		X			X
Long-billed Curlew							X			X		X
Sandhill Crane	X		X		X	X	X	X		X	X	X
Short-eared Owl							X			X		
Mammals												
Bighorn Sheep				X				X	X		X	
Fisher	X	X	X	X	X	X	X	X	X	X	X	X
Grizzly Bear	X	X	X	X	X	*	X	X	X	*	X	X
Mountain Caribou		X	X						X			X
Northern Caribou	X			X		X						
Wolverine	X	X	X	X	X	X	X	X	X	X	X	X
Plant communities												
Hybrid White Spruce/Ostrich Fern							X			X		
Western Redcedar/ Devil's-club/Ostrich Fern		X	X		X						X	X

X = Present; T = Introduced; I = Irregular/incidental; P = Possible; H = Historic; * = Extirpated in parts

Skeena Stikine Forest District

Common Name	ALR	BAU	BUB	BUR	CAR	CBR	CRU	ESM	KEM	KLR	LIP	MAP	MEM	NAB	NAM
Fish															
Bull Trout		X	X	X	X	P	X	X	X		X	X	P	X	X
Amphibians															
Coastal Tailed Frog															X
Birds															
Great Blue Heron		X	X										X	P	X
Marbled Murrelet						X	P						X	X	X
Sandhill Crane		X	X				X	X			X	X		X	X
Short-eared Owl															
Mammals															
Fisher		X	X	X	X		X	X	X		X	X	X	X	X
Grizzly Bear	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Northern Caribou		X	X	X	X		X	X	X		X	X		X	X
Wolverine	X	X	X	X	X	X	X	X	X	X	X	X	X	X	

Skeena Stikine Forest District (continued)

Common Name	NBR	NSM	SBP	SBR	SSM	STH	STP	TAB	TAH	TEB	TEP	THH	TUR	WHU
Fish														
Bull Trout	X	X	X	X	X		X				X	X	X	
Amphibians														
Coastal Tailed Frog				X										
Birds														
Great Blue Heron		X		X	X									
Marbled Murrelet	X			X										
Sandhill Crane										X	X			
Short-eared Owl								X						
Mammals														
Fisher		X	X		X		X			X	X	X	X	
Grizzly Bear		X	X	X	X	X	X	X	X	X	X	X	X	X
Northern Caribou			X				X		X	X	X		X	
Wolverine		X	X	X	X	X	X	X	X	X	X	X	X	X

X = Present; T = Introduced; I = Irregular/incidental; P = Possible; H = Historic; * = Extirpated in parts

Vanderhoof Forest District

Common Name	BAU	BUB	NAU	NEL
Fish				
Bull Trout	X	X	X	X
Birds				
American White Pelican	X	X	X	
Columbian Sharp-tailed Grouse	X	X	X	X
Great Blue Heron	X	X	X	X
Long-billed Curlew				X
Sandhill Crane	X	X	X	X
Mammals				
Fisher	X	X	X	X
Grizzly Bear	X	X	*	X
Northern Caribou	X	X	X	
Wolverine	X	X	X	X

X = Present; T = Introduced; I = Irregular/incidental; P = Possible; H = Historic; * = Extirpated in parts