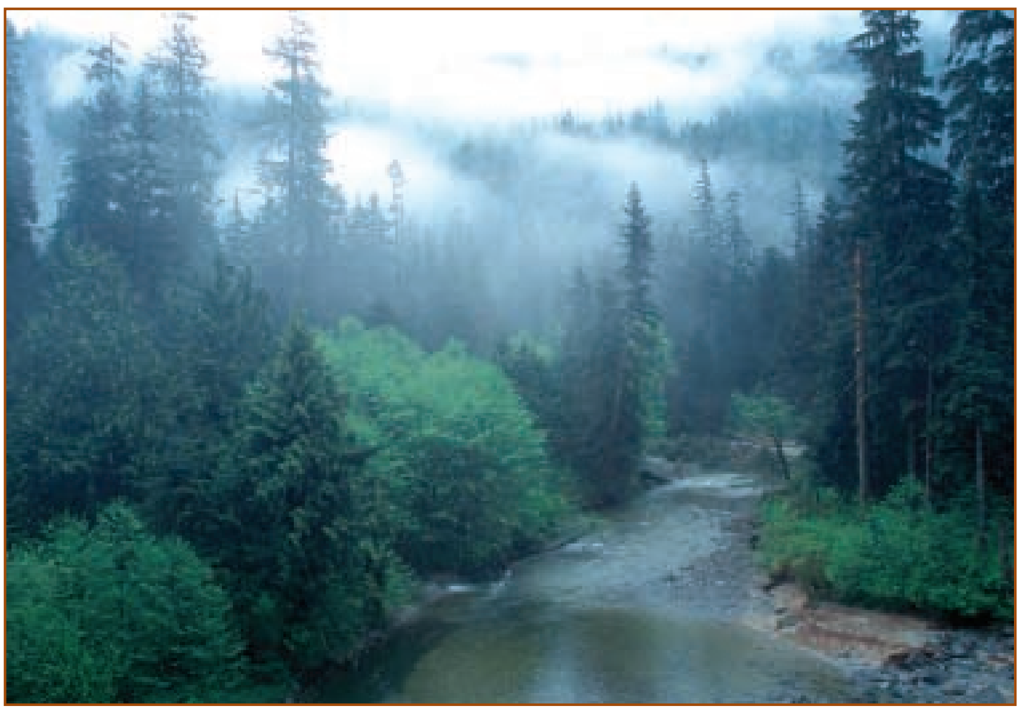
Identified Wildlife Management Strategy

Accounts and Measures for Managing Identified Wildlife

Coast Forest Region

Version 2004



BRITISH COLUMBIA
Ministry of Water, Land and Air Protection

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British Columbia
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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

Contents

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 Coast 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

Invertebrates

Johnson's Hairstreak

Loranthomitoura johnsoni

Original prepared by R.J. Cannings

Species Information

Taxonomy

The Johnson's Hairstreak is in the order Lepidoptera and the family Lycaenidae. *Loranthomitoura* is variously included in the genus *Mitoura* (e.g., Ferris 1989) or, with *Mitoura*, in *Callophrys* (e.g., Scott 1986; Layberry et al. 1998). Guppy and Shepard (2001) consider *Loranthomitoura* a valid genus containing four Nearctic species, two of which occur in British Columbia. There are no recognized subspecies of *L. johnsoni* (Guppy and Shepard 2001); however, the wing pattern of British Columbia specimens is quite different from specimens from California (C.S. Guppy, pers. comm.).

Description

A small butterfly (wingspan of 25–30 mm); dorsal surface of wings is chocolate brown (male) or reddish brown (female), and underside is brown with a thin white post-median band (Layberry et al. 1998).

Distribution

Global

Found in a narrow band from southwest British Columbia to west-central California (Layberry et al. 1998).

British Columbia

Formerly known from southeastern Vancouver Island and the lower Fraser Valley upstream to Yale; now known only from a few sites in the Vancouver area (Stanley Park, Pacific Spirit Regional Park, Lynn Canyon Park) and the UBC Haney Research Forest.

Forest regions and districts

Coast: Chilliwack

Ecoprovinces and ecosections

COM: NAL (historic)
GED: FRL, GEL (historic)

Biogeoclimatic units

CWH: dm, xm1

Broad ecosystem units

CW

Elevation

0–625 m

Life History

Diet and foraging behaviour

Larvae feed on all parts of conifer mistletoe, especially dwarf mistletoe, *Arceuthobium* spp., on western hemlock (*Tsuga heterophylla*) (Guppy and Shepard 2001). Adults feed on flower nectar (Opler et al. 1995).

Reproduction

Adults fly from late May to early July; eggs are laid on mistletoe. Larvae develop rapidly to pupal stage, which overwinters (Opler et al. 1995; Guppy and Shepard 2001).

Site fidelity

Found repeatedly at same sites from year to year.

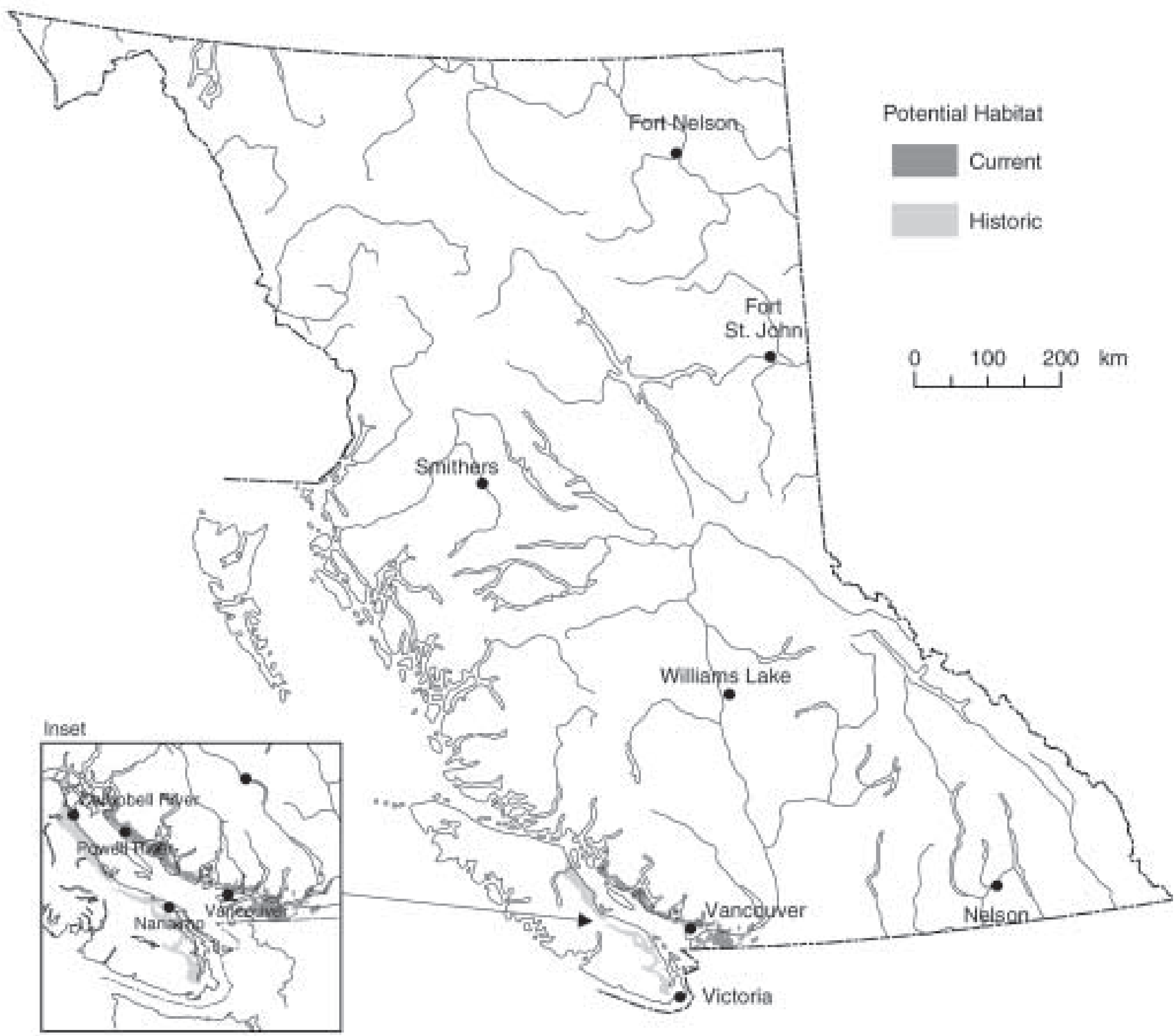
Home range

No data.

Dispersal and movements

No data.

Johnson's Hairstreak
(Loranthomitoura johnsoni)



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.

Habitat

Structural stage

6: mature forest
7: old forest

Important habitats and habitat features

Old-growth western hemlock forest with some infestation of western dwarf mistletoe is critical (Opler et al. 1995; Guppy and Kondla 2000).

Conservation and Management

Status

The Johnson's Hairstreak 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	OR	CA	WA	Canada	Global
S1S2	S2?	S3S4	S3?	N1N2	G2G3

Note: California has an incorrect and conflicting rank with the global rank. State ranks can not be more secure than the global rank.

Trends

Population trends

Population size at known sites is difficult to determine, but disappearance from historical sites on Vancouver Island and near Yale indicates a serious range contraction (Guppy and Kondla 2000). Considered very local and rare throughout its range (Opler et al. 1995; Layberry et al. 1998). Opler et al. (coordinators, 1995) considered it "threatened throughout its range" (<100 occurrences worldwide).

Habitat trends

Loss of old and mature forest from low elevation coastal areas has reduced the amount of habitat available to this species over the last century.

Threats

Population threats

The impacts of spraying *Bacillus thurengiensis kurstaki* (Btk) to control the introduced gypsy moth are not known. If spraying has a detrimental effect on this species, it could be substantial because all of the known extant populations in British Columbia are in the Greater Vancouver area where concern about gypsy moths (*Lymantria dispar*) has been high in the last decade (Guppy and Kondla 2000). However, the Btk-susceptible stage of this butterfly (the caterpillar) is not likely to be present until 2 months (early June) after the normal spray application "window" (early April), and therefore may not be affected.

Habitat threats

In forest harvest areas, removal of western hemlock (*T. heterophylla*) infected with western dwarf mistletoe (*Arceuthobium* spp.) constitutes another threat, since the mistletoe is the only food plant of this butterfly. However, dwarf mistletoe is widespread and common in western hemlock stands throughout the range of this butterfly so some other habitat factor may also be critical for Johnson's Hairstreak. Opler et al. (coordinators, 1995) mention loss of old-growth forest throughout the species' range as a concern, although the reasons for this apparent dependence are unclear. Forest openings with flowering plants are needed for adult nectar sources; this may be a critical limiting factor in younger forests (C.S. Guppy, pers. comm.). Mistletoe eradication and control programs are also likely to reduce the amount of suitable habitat (Guppy and Shepard 2001).

Legal Protection and Habitat Conservation

Butterflies are not protected under the provincial *Wildlife Act*. They are protected from collection in national and provincial parks.

Small populations are found in Stanley Park, Pacific Spirit Regional Park, and Lynn Canyon Park, as well as in the UBC Haney Research Forest. Despite this apparent habitat protection, the former three populations have all been sprayed by Btk as part of gypsy moth control programs during the 1990s. It is unknown what impact, if any, the spray programs had on these populations. Removal of mistletoe infested hemlock is also currently proposed for Lynn Canyon Park as part of park management.

Identified Wildlife Provisions

Wildlife habitat area

Goal

Maintain breeding habitat and larval forage species to prevent local extirpations.

Feature

Establish WHAs at known locations.

Size

Typically between 15 and 25 ha but size will ultimately depend on size of habitat patch.

Design

The WHA should be large enough to provide adequate breeding habitat (mature or old western hemlock with dwarf mistletoe and with openings for flowering plants) for the Johnson's Hairstreak population as well as ensure that the stand itself is windfirm and limit the exposure of surrounding new forest to mistletoe seed dispersal where this may be of concern. Incorporate nectar sources into WHA.

General wildlife measures

Goals

1. Retain western hemlock trees infected with dwarf mistletoe.
2. Prevent direct mortality.
3. Ensure stand is windfirm.

Measures

Access

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

Harvesting and silviculture

- Do not harvest. If approved, use partial harvesting methods to maintain representation of existing stand structure with no more than 50% basal area removal. Retain western hemlock with western dwarf mistletoe.

Pesticides

- Do not use pesticides.

Additional Management Considerations

Retention of suitable habitat is desirable, even where populations of Johnson's Hairstreak are presently unknown, to maintain some of the populations that are unknown due to lack of inventory and to provide opportunities for establishment of new populations.

Although retention of western hemlock infested by mistletoe is at odds with most forest health strategies, there may be situations in which patches of infested hemlock could be retained as wildlife tree retention areas or within riparian reserve zones where the riparian management zone is managed for non-host species.

Information Needs

1. Inventory of Johnson's Hairstreak in previously unsurveyed mistletoe-impacted hemlock stands in southwestern British Columbia north to Bella Coola.
2. Ecological needs (i.e., is Johnson's Hairstreak old-growth dependent?).
3. Long-term effects of Btk applied under current British Columbia gypsy moth program methodology. Are the caterpillars of this butterfly at risk?

Cross References

Spotted Owl

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Sonora Skipper

Polites sonora

Original prepared by R.J. Cannings

Species Information

Taxonomy

The Sonora Skipper is in the order Lepidoptera and the family Hesperiidae. The Sonora Skipper is one of six species in the genus *Polites* known from British Columbia; 16 species are known to occur in North America. Only one subspecies *P. sonora sonora*, occurs in British Columbia (Guppy and Shepard 2001). The taxonomy of this subspecies is currently under review. Layberry et al. (1998) assigned British Columbia specimens to *P. sonora siris*, but Guppy and Shepard (2001) show *P. sonora siris* as being restricted to western Washington State.

Description

A small orange (male) or orange-brown (female) skipper (wingspan 25–27 mm) with distinctive "crisp" crescent-shaped medial band of pale spots on the underside of the hindwing (Layberry et al. 1998; Guppy and Shepard 2001). The egg is round and light green; third instar larva is 5 mm long and grey green with many fine black scales (Guppy and Shepard 2001).

Distribution

Global

Found in southwestern British Columbia through Washington, Oregon, and California to Mexico; also in the American Rocky Mountains from Idaho and western Montana south to Colorado and northern Arizona (Opler et al. 1995).

British Columbia

This species is only confirmed from three locations in British Columbia: Crater Mountain, Manning Provincial Park, and Hope Mountain. This species may also occur near Merritt.

Forest region and districts

Southern Interior: Cascades, Okanagan Shuswap (Penticton)

Coast: Chilliwack

Ecoprovinces and ecosections

COM: EPR

SOI: OKR, STU

Biogeoclimatic units

BG: xh1

IDF: dk1, dk2, xh1

MH: mm

PP: xh1

Broad ecosystem units

BS, DF, DP, MF, PP

Elevation

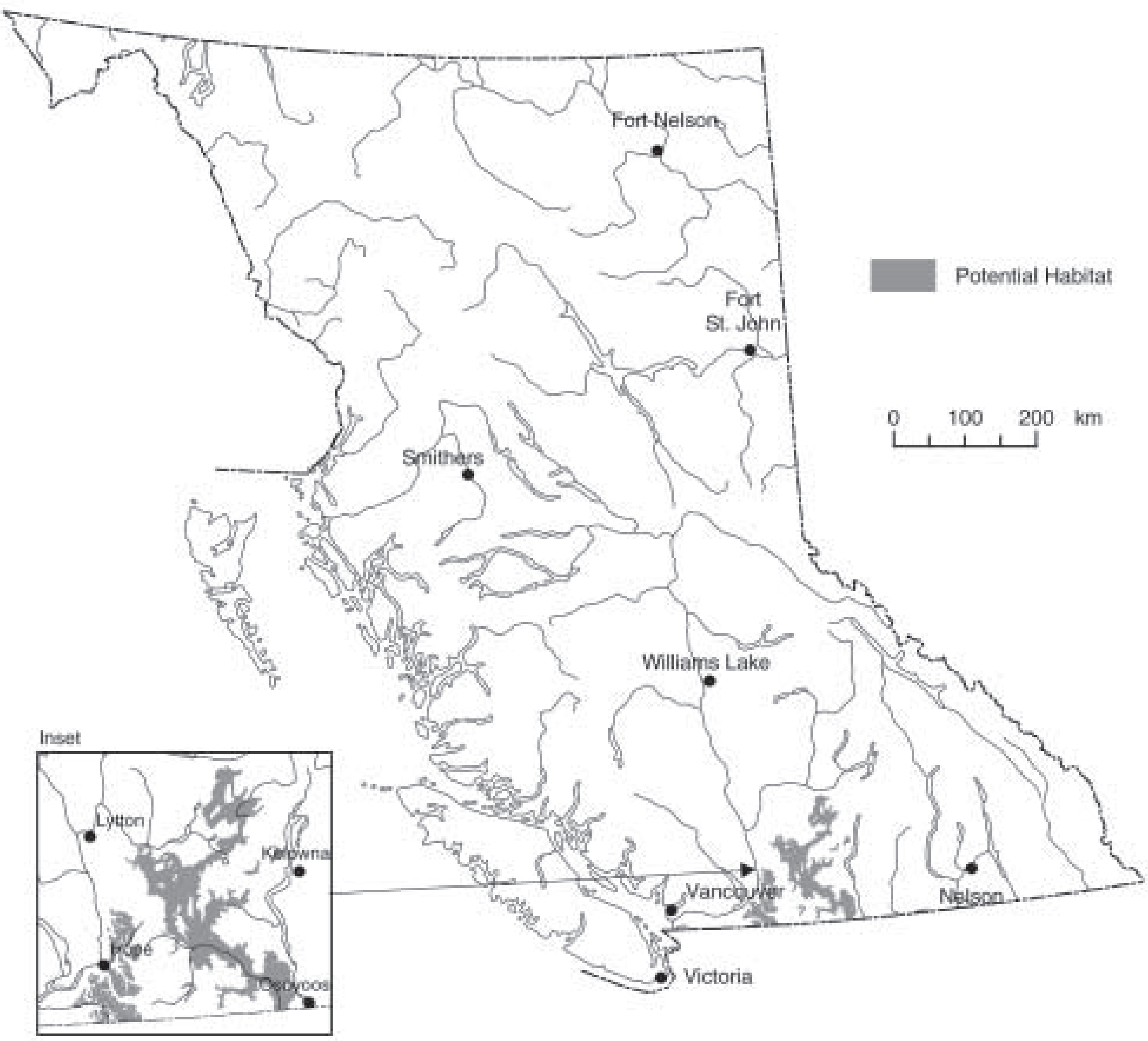
1160–1675 m

Life History

Diet and foraging behaviour

Larvae feed on grasses. Newcomer (1967) successfully reared this species on Idaho fescue, *Festuca idahoensis*. Adults nectar on a variety of flowers, including thistles (Opler et al. 1995).

Sonora Skipper
(Polites sonora)



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.

Reproduction

Eggs are laid in mid- to late June in central Washington and hatch about 8 days later. Larvae reach the third instar stage by the end of July (Newcomer 1967). Based on habits of closely related species and timing of larval development (Newcomer 1967), this species probably overwinters as pupae, at least at lower elevations. Populations at higher elevations (ca. 1500 m) may overwinter as third or fourth instar larvae, since adults do not fly at those altitudes until July (J.H. Shepard, pers. comm.).

Site fidelity

Sonora Skippers are found repeatedly in the same meadows year after year (C.S. Guppy, pers. comm.).

Home range

No data.

Dispersal and movements

No data.

Habitat

Structural stage

2: herb

Important habitats and habitat features

Small meadows and forest clearings (Dornfield 1980). Newcomer (1967) suspected that Idaho fescue was an important larval food plant.

Conservation and Management

Status

The Sonora Skipper 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	ID	MT	OR	WA	Canada	Global
S1	SU	S5	S?	S4	N1	G4

Trends

Population trends

Trend is not known. Only two sites are accurately recorded; Guppy and Kondla (2000) estimate that the species may occur in a total of five sites in British Columbia with a provincial population of no more than 3000 individuals.

Habitat trends

Grassland habitats in general are declining in quality and area due to urban and agricultural development, forest encroachment, and in-growth.

Threats

Population threats

This species has a very small range in British Columbia and is only confirmed from two locations. A restricted distribution and possible lack of genetic exchange increases the risk of extirpation.

Habitat threats

This species depends on grassy meadows; thus, the primary threats in British Columbia may include heavy livestock grazing, invasion of grasslands by invasive species, and fire suppression and resulting forest encroachment. Forest harvesting also poses a threat if it involves degradation of grass meadow habitat (Guppy and Kondla 2000).

Legal Protection and Habitat Conservation

Butterflies are not protected under the provincial *Wildlife Act*. They are protected from collection in national and provincial parks.

Manning Provincial Park provides some habitat protection for this species (Guppy and Kondla 2000). Cathedral Provincial Park and the newly announced Snowy Mountain Protected Area likely contain suitable habitat as well.

Under the results based code, range use plans may be used to address the habitat requirements of this species when mitigation measures are incorporated.

Identified Wildlife Provisions

Wildlife habitat area

Goal

Maintain breeding habitat and larval forage species (grasses) to prevent local extirpations.

Feature

Establish WHAs at known locations where species regularly occurs.

Size

Typically between 15–25 ha but will depend on area of suitable habitat.

Design

The WHA should include grassland and forest openings within the vicinity of the known site; adults are generally found near the oviposition sites (C.S. Guppy, pers. comm.). Where possible the WHA should encompass the meadow area or suitable habitat patch.

General wildlife measures

Goals

1. Maintain grassland at late seral to climax condition with healthy grass plants.
2. Maintain abundance and health of larval food plant (bunchgrasses, Idaho fescue).
3. Prevent or minimize introduction and spread of invasive species.
4. Prevent soil disturbance.
5. Control forest encroachment and in-growth.

Measures

Access

- Do not construct roads.

Harvesting and silviculture

- Minimize soil disturbance.

Pesticides

- Do not use pesticides.

Range

- Plan livestock grazing to maintain the desired plant community, desired stubble height and browse utilization. The desired plant community is that of the natural grassland at late seral to climax condition.
- Control livestock grazing (i.e., timing, distribution, and level of use) to minimize soil disturbance and the introduction of invasive species.
- Do not place livestock attractants within WHA.

Additional Management Considerations

Controlled prescribed burns and/or silvicultural treatments may be necessary to maintain suitable grassland habitats for Sonora Skippers.

Good range management practices should be sufficient to maintain corridors for dispersal and prevent introduction and spread of invasive species.

Information Needs

1. Inventory of appropriate habitat in the north Cascades of British Columbia.
2. Basic ecological information, such as flight period, larval food plants, and overwintering strategy
3. Access effects of livestock grazing, invasive species and forest encroachment.

Cross References

Bighorn Sheep, Flammulated Owl

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Shepard, J. 2001. Consultant, Pullman, Wash.

Quatsino Cave Amphipod

Stygobromus quatsinensis

Original prepared by Patrick Shaw

Species Information

Taxonomy

The Quatsino Cave Amphipod is in the order Amphipoda and the family Crangonyctidae. There are 151 recognized *Stygobromus* species in North America, with 50 additional species descriptions in preparation. *Stygobromus quatsinensis* is a member of the largely western *hubbsi* group (Holsinger 1974; Holsinger and Shaw 1987). There are no recognized subspecies.

Description

The Quatsino Cave Amphipod is a translucent, eyeless amphipod crustacean, which ranges from 5 to 7 mm in total body size.

Distribution

Global

Only known from subterranean karstic waters of coastal northwest North America from Vancouver Island to southeastern Alaska, where it was discovered in caves and springs on three offshore islands (Heceta, Dall, and Coronation).

British Columbia

In British Columbia, it is known only from limestone caves in the Quatsino Formation on Vancouver Island.

Forest region and districts

Coast: Campbell River, North Island, South Island

Ecoprovinces and ecosections

COM: LIM, NIM, WIM
GED: NAL, possibly SOG

Biogeoclimatic units

CWH

Broad ecosystem units

N/A (subsurface)

Elevation

100–800 m

Life History

The biology of this species is unstudied, but many aspects are expected to be similar to those of other members of the genus from elsewhere in North America.

Diet and foraging behaviour

Cave habitats tend to be of very low productivity, and potential food sources are sparse. *Stygobromus* amphipods are detritivores, feeding on bacteria, microfungi, organic particles on ingested sediments and possibly on animals (including small insects or other invertebrates) that wash into cave pools.

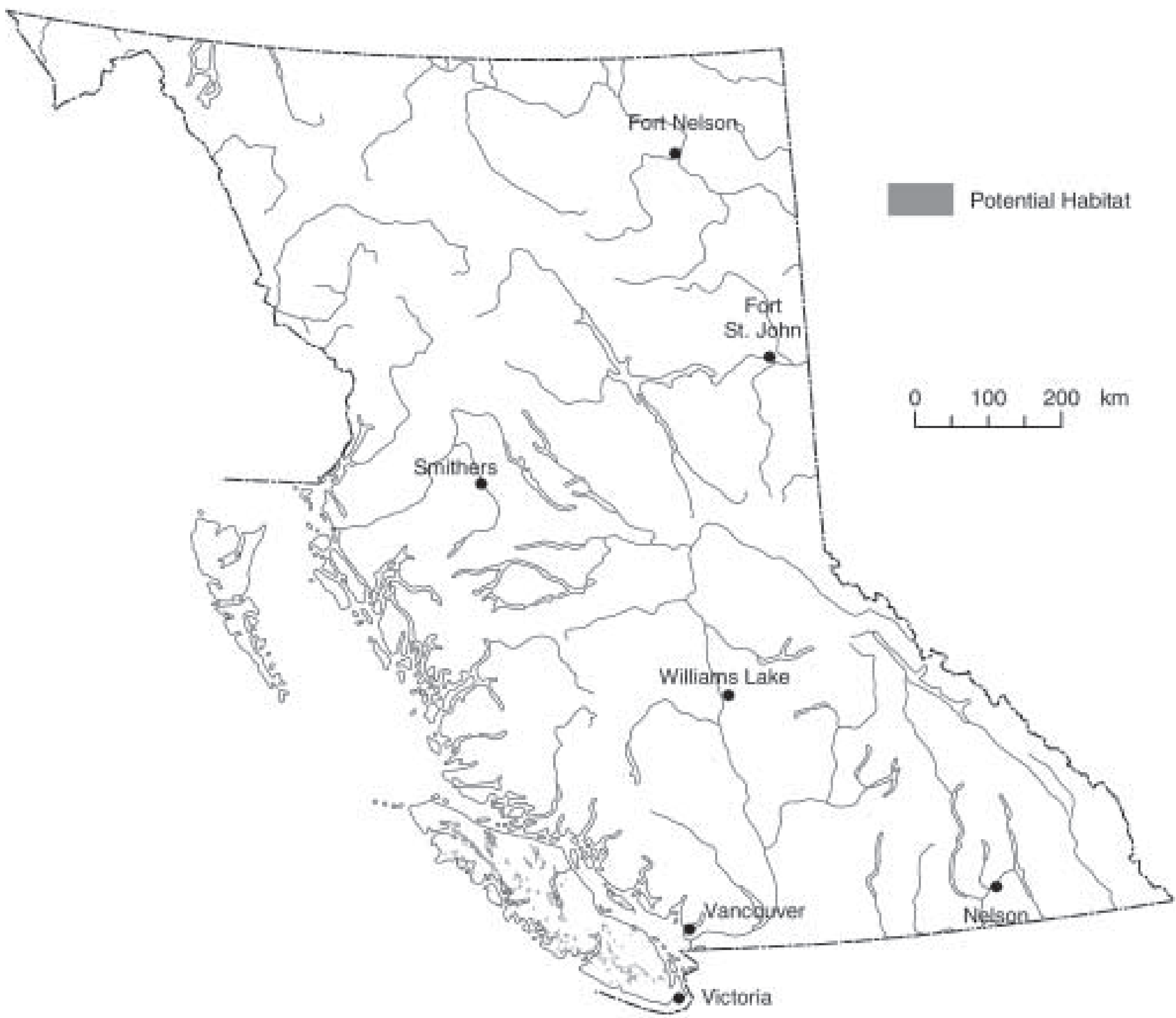
Reproduction

Breeding period or development time is unknown, although ovigerous females have been collected in October. Like all other amphipods, *Stygobromus* females lay a small number of eggs into a ventral brood pouch formed by lateral setose projections of the first segment of the first five of seven legs. Juveniles hatch as miniatures of the adults, and grow to maturity by direct development.

Site fidelity

Unknown.

Quatsino Cave Amphipod
(Stygobromus quatsinensis)



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

Home range

N/A

Dispersal and movements

Dispersal of subterranean aquatic species is through small, continuous water-filled cracks and fissures in suitable bedrock. Both because of the discontinuous nature of carbonate bedrock and the small size of these amphipods, present dispersal is probably limited. In the historical past (pre-glacial, or earlier), conditions must have existed that permitted colonization of widely disparate habitats from Vancouver Island to southeast Alaska.

Habitat

Structural stage

Unknown. Recorded below second-growth forest but highest densities have been found in caves beneath old and mature forest.

Important habitats and habitat features

Inhabits interstitial waters and caves in karst and is known only from coastal regions. Most commonly found in shallow, mud-bottom pools in caves. It has been collected from underground stream gravel. Possible distribution in hyporheic (water between the streambed and groundwater) habitats of surface streams requires further study.

Conservation and Management

Status

The Quatsino Cave Amphipod 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	AK	Canada	Global
S2S3	S?	N3	G3

Trends

Population trends

There are likely 10–20 known occurrences on Vancouver Island. The known occurrences in British Columbia have not been more than one or two individuals, although in one exceptional site, 11 were observed. No studies of population trends have been attempted.

From the known distribution, the present occurrences may represent relic populations that may have been stranded with the recession of continental ice sheets at the close of the Wisconsin Glaciation, approximately 10 000 years before present. Further study in karst of remote areas on mainland British Columbia, on the Queen Charlotte Islands, and at other island exposures of Quatsino Formation limestone may reveal other localities for the species.

Habitat trends

No data.

Threats

Population threats

Only small populations have been found in caves and springs in isolated carbonate karst areas on offshore islands in the Pacific Northwest. A restricted distribution and possible lack of genetic exchange may increase the risk of extirpation.

Habitat threats

This species is threatened by habitat alteration as it is vulnerable to changes in water quality related to surface activity. Forest harvesting and road construction can negatively impact karst areas through infilling from logging debris, changing surface hydrological conditions, increasing soil erosion, and, in some cases, shattering cave roofs (Harding and Ford 1993; Blackwell 1995).

Legal Protection and Habitat Conservation

Currently, this species has no legal protection. Several known localities are within provincial parks or protected areas (e.g., Weymer Creek Karst, Horne Lake Caves) and former forest recreational reserves. Most other known populations are found in the areas designated for "Enhanced Forestry," as described in the Vancouver Island Land Use Plan, including areas in the Tashish drainage, east of Nimpkish Lake, Cowichan Lake (the type locality), and areas surrounding Tahsis.

Adherence to the results based code best management practices for karst features, particularly recommendations for buffers around swallets and harvesting restrictions to minimize soil loss and infilling of epikarst, may provide sufficient protection at sites within the timber harvesting land base.

Identified Wildlife Provisions

Wildlife habitat area

Goal

Maintain long-term, stable habitat sites with good water quality.

Feature

Establish WHAs over swallets where populations have been found.

Size

Typically ≥3 ha but size will depend on site-specific factors.

Design

The WHA should be a minimum 100 m radius around the point where stream goes underground (swallet). Ensure upstream area is provided more protection.

General wildlife measures

Goals

1. Preserve groundwater quality.
2. Prevent habitat loss through infilling and smothering by suspended sediment.
3. Prevent elevated peak flows that would encourage wash out from shallow pools.
4. Minimize sediment and debris transport into swallet streams.
5. Ensure WHA is windfirm.

Measures

Access

- Do not construct roads unless there is no other practicable option and subsurface water quality will not be impacted.

Harvesting and silviculture

- Do not harvest.

Pesticides

- Do not use pesticides.

Recreation

- Do not develop recreation sites or trails.

Additional Management Considerations

Prevent flooding and washout which can remove the amphipods from small habitat pools.

Where populations are prone to wash out from flooding, swallet entrances should be fitted with traps to prevent transport and lodging of wood debris in narrow passages.

Design treatments to open the canopy of second-growth forest in order to increase the quantity and quality of understorey vegetation. This should be done with a minimum of site disturbance and is intended to control surface runoff and siltation.

Maintain riparian reserve zones on any streams entering WHA or directly entering caves and swallets.

Minimize recreational impacts.

Information Needs

1. Detailed distribution information. It is possible that the species is common outside of karst areas in deep gravel interstices and detailed collection in these habitats should be done. In addition, cave sites (such as karst areas on the Queen Charlotte Islands or mainland British Columbia) have not been searched in many areas.
2. Basic life history information. Population densities, site fidelity, and even basic information concerning reproductive periods are unknown.
3. Amongst the 151 *Stygobromus* species, this species is unique in its distribution, which crosses not only geologic but marine barriers. Careful morphological and/or genetic studies should be conducted to establish the relatedness and time of divergence of the disparate populations both in British Columbia and Alaska.

Cross References

Keen's Long-eared Myotis

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Fish

Vananda Creek Limnetic Stickleback

Gasterosteus species 16

Vananda Creek Benthic Stickleback

Gasterosteus species 17

Original prepared by Paul Wood, Joslyn Oosenbrug, and Sarah Young

Species Information

Taxonomy

The two Vananda Creek stickleback species occur *in situ* as a pair of closely-related species and therefore are described together in this account. They are known as the Vananda Creek Limnetic Stickleback (*Gasterosteus* species 16) and the Vananda Creek Benthic Stickleback (*Gasterosteus* species 17).[1]

The threespine sticklebacks (*Gasterosteus* spp.) are found only in the northern hemisphere. They are a species complex consisting of numerous reproductively isolated populations distributed along the coastal areas of the north Atlantic and north Pacific oceans, both in marine and adjacent freshwater environments (Bell and Foster 1994a). The amount of phenotypic variation among freshwater populations, and their rapid rate of evolution from marine forms have offered evolutionary biologists tremendous insight into the mechanisms of adaptive radiation and speciation. The recently evolved (post-Pleistocene) populations of North American freshwater sticklebacks have been of particular interest. Among these populations, Lavin and McPhail (1985) have documented a tendency: in large, deep lakes, limnetic plankton-feeding forms have evolved; and, in small, shallow lakes, littoral benthic-foraging forms have evolved (see also Hatfield and Schluter 1999).

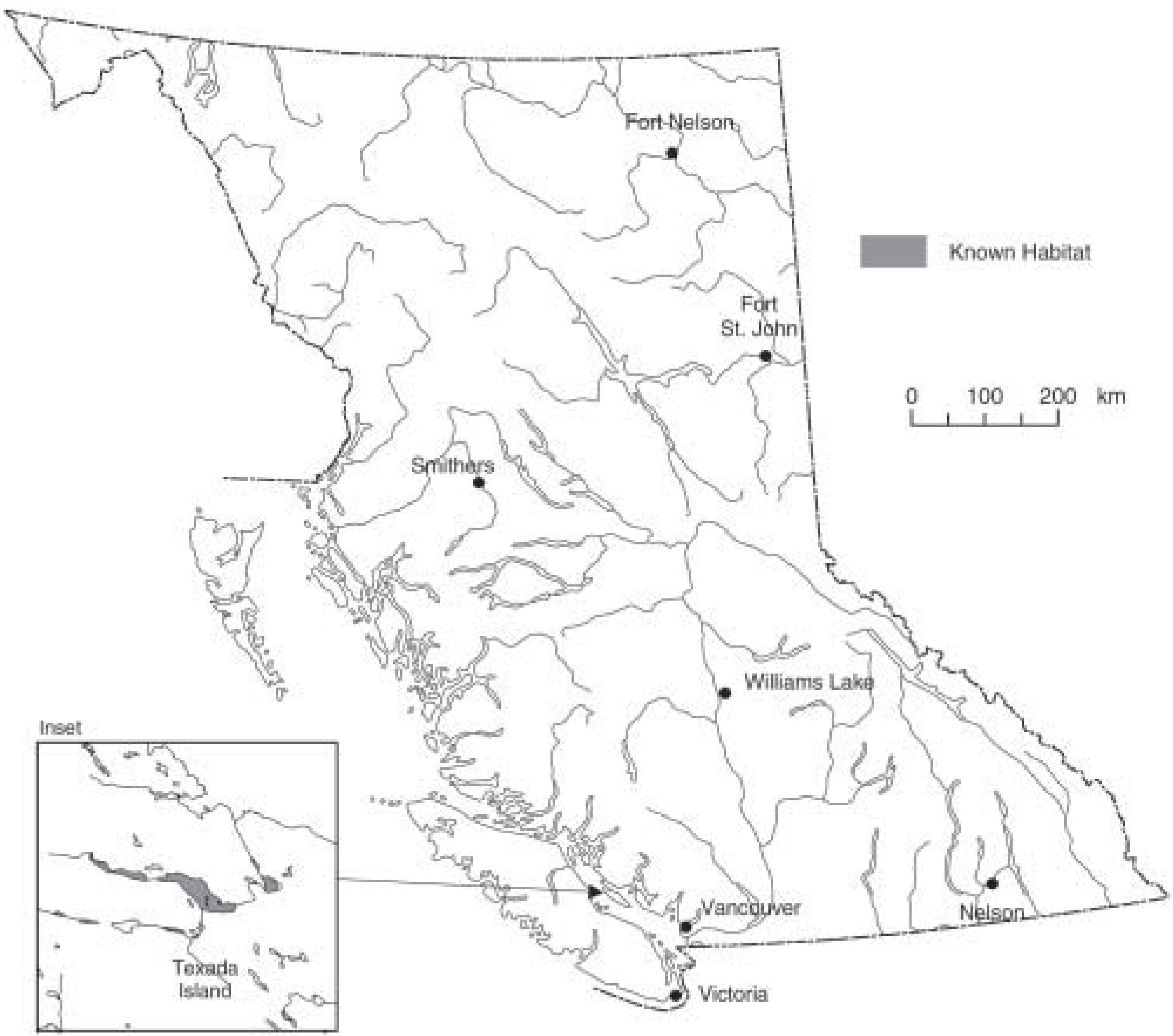
However, among all stickleback populations in the world, only in six small lakes in British Columbia have sympatric limnetic and benthic forms evolved (McPhail 1994, p. 418): the Enos Lake Limnetic and Benthic sticklebacks (McPhail 1984, 1989); the Paxton Lake Limnetic and Benthic sticklebacks (McPhail 1992); the Hadley Lake Limnetic and Benthic sticklebacks (McPhail 1994); and, in Emily, Priest, and Spectacle lakes on Van Anda Creek, what are now known as the Vananda Creek Limnetic and Benthic sticklebacks (McPhail 1994; Hatfield 2001b).

Even more surprising than the phenomenon of sympatric, reproductively isolated species is the realization that these four pairs of species evolved in parallel (Rundle et al. 2000; Schluter 2000). A recent review of the concept of evolutionarily significant units suggests that some gene flow between or among reproductively isolated populations within species complexes may be necessary for long-term viability (Crandall et al. 2000). However, there is little question among stickleback researchers that the pairs of sticklebacks in British Columbia are not simply evolutionary significant units (Foster et al. 2003), but are biological species in themselves (Hatfield 2001b, p. 586). They are also among the world's best examples of rapid adaptive radiation and parallel evolution (Bell and Foster 2003). Not surprisingly, therefore, these pairs of sticklebacks are the subject of intense interest and research among

1 The two species described in this account were named after Van Anda Creek. Until recently, the spelling for this creek was "Vananda" (i.e., one word) as was the town of the same name. The spellings of the town and the creek have now been changed to "Van Anda" (i.e., two words). The common names for the two stickleback species, however, still use the one-word spelling: Vananda.

Vananda Creek Limnetic and Benthic Sticklebacks

(Gasterosteus sp. 16 and 17)



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.

evolutionary biologists (cf. Schluter and McPhail 1992; Bell and Foster 1994b; Nagel and Schluter 1998; Rundle et al. 2000; Kraak et al. 2001).

The Hadley Lake pair is now extinct (Hatfield 2001a). This species account describes the Vananda Creek pair of sticklebacks.

Description

McPhail (1984, 1989, 1992, 1994), Hatfield (2001b), and Hatfield and Ptolemy (2001) have described the three remaining pairs of stickleback species in British Columbia. In general terms, they are small, silvery-green to black fish, <70 mm in length, with a laterally compressed body form. They have calcified lateral plates and retractable dorsal and pelvic spines.

The limnetic sticklebacks are smaller but more thoroughly armoured than the benthic sticklebacks. They are pelagic, zooplankton-feeding fish, and their relatively high numbers of gill rakers are presumed to be a plankton-feeding adaptation (Bentzen and McPhail 1984).

By contrast, the benthic sticklebacks are bottom-foraging fish with a larger and relatively stockier or chunky body form. They have conspicuously wide, short jaws, which are also presumed to be a feeding adaptation (Bentzen and McPhail 1984).

There is genetic evidence that the Enos Lake, Paxton Lake, and Vananda Creek pairs represent separate gene pools (McPhail 1984, 1992; Taylor and McPhail 1999).

Distribution

Global

The Vananda Creek Stickleback species occur only on Texada Island, British Columbia.

British Columbia

In British Columbia, these two species occur only in Emily, Priest, and Spectacle lakes in the Van Anda Creek watershed on Texada Island. There is no evidence to suggest that any sticklebacks in the fourth lake in the Van Anda Creek watershed, Kirk Lake, have evolved into a species pair.

Forest region and district

Coast: Sunshine Coast

Ecoprovince and ecosection

GED: SOG

Biogeoclimatic unit

CWH: xm

Elevation

The surface elevation of Emily Lake is approximately 40 m, while that of both Priest and Spectacle lakes is approximately 80 m (Hatfield 1998).

Life History

Diet and foraging behaviour

The Vananda Creek limnetics form loose schools in the open-water portions of the lakes where they feed on zooplankton (e.g., copepods and insect larvae) (Hatfield 2001b).

Vananda Creek benthics forage near the shallower lake edges, or in somewhat deeper water, for prey such as clams, dragonfly nymphs, and snails. As benthics grow larger, they pursue larger prey (Hatfield 2001b).

Juvenile sticklebacks remain in the littoral regions of the lakes where they pick invertebrates off vegetation. While nesting in the littoral zone, the males of both species—limnetics and benthics—often prey on benthos (Hatfield 2001b).

Reproduction

The Vananda Creek limnetics mature after 1 year and rarely live beyond 2 years; whereas the benthics seem to mature older and live longer, possibly as long as seven years. Breeding season is from April to June in B.C. populations, and is initiated when the males develop reddish throats and fore-bellies, and construct tubular nests (Foster 1994). Although courtship is a complex ritual, mate selection by the females is largely influenced by visual cues, particularly the red colouration on the males (Bakker and Rowland 1995; Baube et al. 1995). Immediately after a female lays her eggs in a nest, the male fertilizes them.

Males may mate with several females over a 1–4 day period before switching to a parental-care phase. In this phase, the male protects the eggs and fry from predators and also fans them, thereby providing them with sufficient oxygen (Foster 1994).

Females, by contrast, do not tend the young and continue to produce multiple clutches. Typical fecundity for a limnetic female is between 30 and 40 eggs per clutch or approximately 50 or 60 eggs for a really large female. Limnetic females produce several clutches a year in quick succession if food availability is high. Benthic females often carry more than 150 eggs and can carry up to 200 eggs. They produce only one or two clutches a season, regardless of food availability.

Home range/Site fidelity

The two species are restricted to the three small lakes—Emily, Priest, and Spectacle—on the Van Anda Creek mainstem. The two species remain in the lacustrine environment year round.

The males will defend a territory during the nest construction, mating, and parental care phases of the breeding process. The size of the defended territory is usually related to the size of the individual male.

An individual male may repeat the cycle of phases several times during a single breeding season. As a nest is generally severely damaged during the release of the fry, a male repeating the cycle will of necessity build a new nest (T. Hatfield, pers. comm.).

Movement and dispersal

When sufficiently large, the juveniles disperse from the littoral zones along the shorelines to open-water (limnetics) or deeper-water (benthics) portions of the lakes. For the limnetics, dispersal occurs towards late summer, when they become larger and swift enough to escape predators and their spines are of sufficient size to act as a deterrent (B.C. MELP 1999). This distance can be a matter of a few tens of metres, or perhaps upwards of a few hundred metres. Benthics continue to forage along the shallow margins of the lake for larger and larger prey as they grow, then move to deeper water to overwinter.

Habitat

Important habitats and habitat features

Breeding

From April to June, both species move from the more open-water or deeper-water portions of the lakes to the shallower, vegetated littoral zones to breed. Males of both species construct their nests in these shallow, vegetated littoral zones (McPhail 1994; Vamosi and Schluter 1999). The specific habitats in which limnetics and benthics choose to build their nests differ slightly (McPhail 1994). Hatfield (2001b) has noted that limnetic males choose slightly more open nesting sites (i.e., those sites with less aquatic vegetation) on gravel or rock substrates, or on submerged logs, and at water depths of no more than 1 m. Benthic males, by contrast, choose sites with aquatic vegetation, and in slightly deeper water, but rarely deeper than 2 m. These breeding microhabitats are highly sensitive, as discussed under “Threats” below.

Foraging

As the names of the two species imply, one feeds in the open-water, limnetic portions of the lakes near the surface, while the other feeds along the shallow margins of the lake either on the bottom (benthos) or by picking invertebrates off plants. It is precisely this difference in behaviour that is believed to have led to the reproductive isolation of these species, despite the fact that they inhabit the same lakes (Schluter 1993, 1995).

Conservation and Management

Status

The Vananda Creek Limnetic and the Vananda Creek Benthic Stickleback are on the provincial *Red List* in British Columbia. In Canada, both species are designated as *Endangered* (COSEWIC 2002).

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

BC	Canada	Global
S1	N1	G1

Trends

Population trends

Total population sizes and trends are unknown. However, Hatfield (2001b) reported that the populations were abundant in all three lakes.

Habitat trends

The aquatic habitats of Priest, Spectacle, and possibly Emily lakes have been impacted for some time by the dam located at the outlet of Priest Lake (Priest and Spectacle by the impoundment and the regulation of water levels; Emily by any regulation of the flow regime downstream of the dam). Records indicate that the current dam is a concrete structure, 1.8 m in height. A review of the water licence data suggests that major changes to the associated waterworks occurred around 1956, and a significant change in the storage capacity of the reservoir occurred around 1973 (J.G. Norris, pers. comm.).

The aquatic habitats of the three lakes can be impacted by sedimentation derived from erosion events on the lands within the watershed surrounding the lakes. The lands in the Van Anda Creek drainage have a long history of disturbances including forest harvesting. The authors are not aware of any references that document the exact timing, extent, or type of logging in this drainage in the past. While it was a not uncommon practice in the late 1800's to log with what are now known as "high-grading" practices (i.e., removing only the biggest trees), "a majority of stands are second growth…with no mention of vets in the polygon label" on the forest cover maps. "Given the activity around Van Anda around the turn of the century, and the active underground mining in the area, a lot of timber would have been required" (B. Kukulies, pers. comm.). The amount of soil disturbance created at the time is not known.

Approximately 60% of the Priest Lake Community Watershed is on Crown land, which is under the administration of the Ministry of Forests. The Ministry of Forests has approved a forest development plan including provisions for forest harvesting (A20507 Blocks 701P, 702P, 703P, and 704P; and A20489 Block 904P) in the Priest Lake Community Watershed (B.C. MOF 2001).

Threats

Population threats

These species are found in Emily, Priest, and Spectacle lakes—all in the Van Anda Creek drainage, Texada Island—and nowhere else in the world. Van Anda Creek itself flows from Spectacle Lake at the upper end of the drainage basin directly into Priest Lake and then into Emily Lake. Van Anda Creek also flows from Emily Lake to tidewater.

An unauthorized introduction of catfish (*Ameiurus nebulosis*) into Hadley Lake, on Lasqueti Island, occurred in the 1990s, and the limnetic and benthic stickleback species that formerly lived in the lake have now been assessed by COSEWIC (2002) as being extinct. Direct predation by the catfish is strongly implicated. If catfish, or any other species that preys on sticklebacks, were to be introduced into Emily, Priest, or Spectacle lakes, the Vananda Creek pair of sticklebacks might easily be driven to extinction.

Signal crayfish (*Pacifastacus leniusculus*) have been introduced into Garden Bay Lake on the Sechelt Peninsula with "devastating" effects on the allopatric stickleback population in that lake (S.A. Foster, pers. comm.). These crayfish, also introduced into Enos Lake on Vancouver Island, appear to have disrupted the habitat of that lake's pair of stickleback species. Although crayfish may directly prey upon stickleback eggs (S.A. Foster, pers. comm.), the major impacts appear to be through habitat-disruptive mechanisms, three of which have been hypothesized (D. Schluter, pers. comm.). First, the crayfish stir up bottom sediments, creating turbid water. In Enos Lake, the crayfish are so numerous that their collective ability to create turbid water conditions is real. Second, the crayfish consume large quantities of vegetative matter in the littoral zone of Enos Lake. A lack of vegetative matter could interfere with the breeding microhabitat requirements of the two stickleback species, thereby leading to a breakdown in assortative mating. Finally, the comparatively large male benthics in Enos Lake might not be growing to their former large size due to a lack of suitable benthos to feed upon, or due to a lack of suitable benthic feeding sites, given the heavy macrophytic feeding habits of the introduced crayfish. Because size of the male sticklebacks is one of the visual cues that female sticklebacks use in their selection of mates, the recently-smaller benthic males could now be confused for limnetic males in the assortative mating process. This too might lead to hybridization and a subsequent collapse of the species pair.

An introduction of crayfish into the Van Anda Creek watershed is therefore considered to be a threat to the Vananda Creek species pair, given the similarity of habitats, especially the breeding microhabitats, between Enos Lake and Emily, Priest, and Spectacle lakes.

Coastal cutthroat trout (*Oncorhynchus clarki*) feed on sticklebacks, and they do reside in Emily, Priest, and Spectacle lakes. So far, they seem to coexist with the sticklebacks, at least at current population levels. However, any increase in the number of cutthroat trout in the lakes, for example through a stocking program, could upset the current balance between the stickleback and trout populations.

Habitat threats

The Vananda stickleback species pairs are potentially more sensitive to changes in habitat and water quality than normal populations of sitcklebacks. Relatively minor changes in environmental conditions could result in the limnetic and benthic species hybridized and collapsing into a hybrid swarm. The limnetic and benthic species are maintained as true species with limited gene flow by reproductive isolating mechanisms including strong assortative mating, low hybrid survival relative to the parent species, and relatively high growth and survival of the limnetic and benthic morphologies in their respective habitats. Changes in water quality that affect transparency (e.g., increases in turbidity or dissolved organic carbon) may interfere with females discriminating between males of either species, and an increase in hybridization frequency by as little as 3% (D. Schluter, pers. comm.) is sufficient to cause the two species to collapse into a hybrid swarm. Changes in the relative productivity of benthic relative to limnetic prey (zooplankton) associated with changes in water quality (nutrients or suspended solids) may also affect relative growth rates of either species or their hybrids. A decrease in benthic invertebrate production associated with environmental disturbances may lead to decreased growth (and therefore fitness) of benthic juveniles relative to hybrids, thereby selecting against the benthic species rather than hybrids. Decreased growth of benthics could also prevent them from growing large enough to be discriminated as benthic males by breeding limnetic females.

Recent changes in water and/or microhabitat characteristics in Enos Lake appear to have precipitated an increase in hybridization between this lake's limnetic and benthic species with a consequential loss of reproductive potential and the likelihood of collapse of both species (Kraak et al. 2001). Turbidity (very fine suspended solids) in the water is strongly implicated.

For a pair of cichlid species (family Cichlidae) in Lake Victoria in Africa, turbidity is the likely cause of the breakdown of assortative mating. In these species, as in the sympatric stickleback pairs in British Columbia, one of the assortative mating cues is the red colouration of the males; a slight difference in colour allows the females to distinguish between males of the two sympatric species. With turbidity, the females appear less able to distinguish between males of the two species (Seehausen et al. 1997).

In recent laboratory experiments using Enos Lake limnetic and benthic sticklebacks, Boughman (2001) observed that, in relatively clear water, blue and red are "high-contrast signal colours" (p. 944), meaning that females can use the slightly more red or slightly more blue colouration on the males to distinguish between limnetic and benthic males. In turbid water, this visual cue is masked or lost because the light that does penetrate the turbid water is "redshifted" (i.e., the ambient light in the water fails to illuminate the slight colour difference between the limnetic and benthic males). As a result, it has been suggested that females may mate with males of the other species (Kraak et al. 2001; D. Schluter, pers. comm.).

Thus, turbidity in the water would appear to be a significant threat to all sympatric stickleback pairs, including the Vananda Creek pair. Turbidity during the breeding season (April through June) would seem to cause a breakdown in the assortative mating between the two species, leading to the collapse of both species by way of hybridization. In addition, the risk to sympatric stickleback pairs, including the Vananda Creek pair, from sediment delivery is significantly higher because of the very short lifespan of the species. Due to the relatively fast turnover of generations, the degree of hybridization or recruitment failure that could occur in the first and/or second breeding period affected by a sediment event could seriously and irreversibly harm the species (T. Hatfield, pers. comm.). However, the degree and duration of the turbidity events that would precipitate such a collapse of these species is currently unknown.

Forest management practices have the potential to result in increased turbidity and sedimentation. Risks to sticklebacks from increased turbidity associated with suspension of very fine sediments is a serious concern, since this may potentially interfere with both mate recognition and zooplankton productivity. Changes in productivity of the benthos and zooplankton may affect viability of the species pairs and their hybrids (see above discussion). Very fine suspended solids are usually associated with erosion from soils with a high clay content, or runoff from logging roads.

Typically, release of suspended sediments into fish-bearing water bodies occurs as a result of altered hydrology or runoff over exposed soils or logging roads. Soils may be exposed during road building, forest harvest, and clearing for building sites. There is broad scientific literature indicating negative behavioural and physiological consequences from high deposition of sediment. The risk to species pairs from sedimentation is, at present, difficult to gauge, but remains a concern.

Forest management may result in other habitat disturbances or alterations. For example, riparian and littoral habitat can be affected by harvest and side-casting from roads. Riparian logging and littoral modifications are of minor intensity at present, but such impacts may increase in the future.

In addition, forestry may have cumulative effects on turbidity, water chemistry, or dissolved organic carbon that may influence water clarity or cause eutrophication.

An active placer mining operation near Priest Lake poses a threat of sediment delivery to one or more of Emily, Priest, and Spectacle lakes, but reports conflict about the amount of aggregate sorting now occurring at this mine. However, any soil disturbance, such as during forest road development or forest harvesting activities but also including natural disturbances, in the forested lands surrounding Emily, Priest, and Spectacle lakes could precipitate an erosion event, which could lead to subsequent sediment delivery into the lakes.

Water levels in Priest and Spectacle lakes are regulated by a dam at the outlet of Priest Lake. This has resulted in an increased surface elevation for Priest Lake and the back-flooding of the section of Van Anda Creek that joins Priest and Spectacle lakes. There are potential consequences resulting from the dam and water management decisions with regard to the regulation of flows and lake level:

- an elevated lake level may result in less suitable littoral habitats and erosion of riparian soils;
- the exposure of littoral areas during periods of drawdown may result in sediment generation during rainfall events;
- any changes in lake level elevation during spawning periods may affect reproductive success; and
- the dam may reduce the opportunity for gene flow with Emily Lake or may enhance gene flow between Priest and Spectacle lakes.

None of these potential issues have been evaluated in the Vananda Creek populations (T. Down, pers. comm.).

Legal Protection and Habitat Conservation

The two Vananda Creek sticklebacks are not legally recognized under the provincial *Wildlife Act*, but are protected by the provincial *Fish Protection Act*, and the habitat provisions of the federal *Fisheries Act*. 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*).

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).

There are no provincial or federal protected areas in the Van Anda Creek watershed.

Provisions enabled under the Forest Practices Code or its successor, the *Forest and Range Practices Act*, 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 and/or lake shoreline; community watersheds have the potential to protect an entire population of a stream and/or lake resident form.

A major portion of the Van Anda Creek drainage is designated as the Priest Lake Community Watershed, with Priest Lake being the water source for the community of Van Anda. The Code and FRPA do allow forest harvesting in a community watershed, provided that a watershed assessment has been conducted and that the recommendations from the assessment are being followed. A Coastal Watershed Assessment Procedure (CWAP) has been completed for the Priest Lake Community Watershed (Clarke and BaBakaiff 2000; Clarke and Gemeinhardt 2001).

Recovery planning for these species is underway.

Identified Wildlife Provisions

Wildlife habitat area

Goal

Prevent site-specific or cumulative forestry impacts to aquatic habitat or water quality that may lead to hybridization and introgression of stickleback species pairs or population decline in occupied lakes.

Feature

Establish a WHA at known sites (Spectacle Lake, Priest Lake, Emily Lake).

Size

The WHA should include the Crown land portion of the height-of-land watershed upstream of the outlet of Emily Lake, which would include the Crown land portion of the Priest Lake Community Watershed (which includes Priest and Spectacle lakes). This is necessary at least as an interim measure until a recovery strategy and action plans for the Threespine Stickleback species pairs are completed. Work on the recovery strategy is underway and scheduled for completion in 2003.

As the Priest Lake Community Watershed measures 1131 ha (Clarke and Babakaiff 2000), it is estimated that the overall Emily Lake height-of-land watershed would be approximately 1250 ha. With the Crown land portion of the Community Watershed estimated at 60% (B. Kukulies, pers. comm.), and assuming a similar land ownership for the area surrounding Emily Lake, the overall WHA would be expected to be approximately 750 ha. However, the overall height-of-land watershed includes the surface areas of the four lakes (Emily 7.1 ha; Priest 43.7 ha; Spectacle 10.6 ha; and Kirk ±8 ha), the surface areas of the stream channels joining the lakes, and other areas not contributing to the harvestable forest land base (e.g., marshes).

Design

The WHA should include a core area and management zone. The core area should be established around the three occupied lakes and all streams flowing into these lakes. The size of the core area will vary depending on the risk of sedimentation to the lakes but may be between 30–90 m (both sides of streams). The management zone should include the Crown forest lands that drain into these lakes, up to the height of land. It is recognized that these recommendations are more conservative than standard riparian management practices. However, given the international significance of these species and the consequences of an error in judgement (global and irreversible extirpation), it is reasonable to argue for more conservative riparian setbacks and harvesting practices to reduce the risk of potential impacts.

General wildlife measures

Goals

1. Minimize soil disturbance and prevent erosion and sediment delivery to the lakes.
2. Minimize road access.

Measures

Access

- Do not develop new roads in core areas. Construction and maintenance of existing roads must be done in a manner, and at times, that prevent or preclude sediment delivery to any water feature.

Harvesting and silviculture

- Do not harvest or salvage in the core area.
- Plan harvesting of management zone to meet goals of the general wildlife measure
- Conduct silvicultural activities in a manner that prevents or precludes sediment delivery to any water feature.

Pesticides

- Do not use pesticides.

Recreation

- Do not develop trails, recreation sites, facilities, or structures in the core area. In the management zone, restrict recreational developments to those designed to mitigate impacts from recreational activities.

Additional Management Considerations

The management of water levels within Priest and Spectacle lakes should consider the life history requirements of sticklebacks. In particular, significant changes, up or down, in the surface level elevations of the lakes during the breeding season may affect reproductive success. Further, to prevent erosion and sediment delivery to the lakes, riparian soils should not be flooded. In addition, the exposure of littoral habitat should be minimized at all times of the year, but especially during the typical rainy season.

Measures must be taken to prevent the introduction into these lakes of any exotic species that might prey on the sticklebacks, or otherwise disrupt their life history and habitat requirements. Similarly, no measures should be taken that might enhance the "native" cutthroat trout population.

Information Needs

1. The exact extent to which existing and potential sources of soil erosion could result in sediment delivery to one or more of the three lakes. Existing sources include private forest lands surrounding the three lakes, private residential lands surrounding the three lakes, and an active placer mining operation near Priest Lake.
2. The relationship between degrees of turbidity in the species' resident lakes and the resulting rates of hybridization.
3. The effects of crayfish on the breeding and foraging habitats of threespine sticklebacks.

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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).

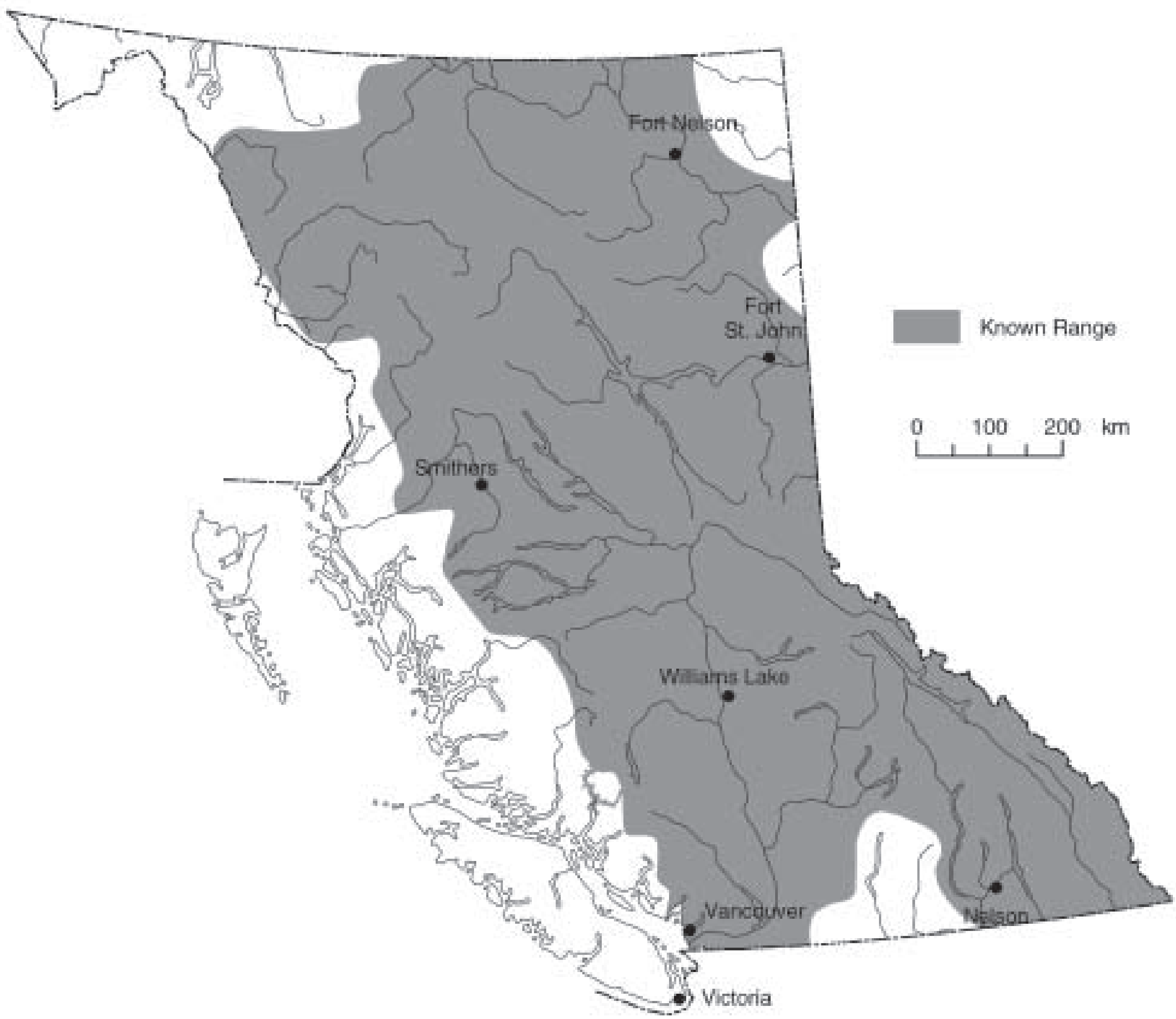
The taxonomic history is also complicated by records of hybridization between Bull Trout and Dolly Varden, where these species occur in sympatry (McPhail and Taylor 1995; Baxter et al. 1997). However, Hagen (2000) undertook a detailed study in the Thutade watershed, where Bull Trout and Dolly Varden 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 north-eastern 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).

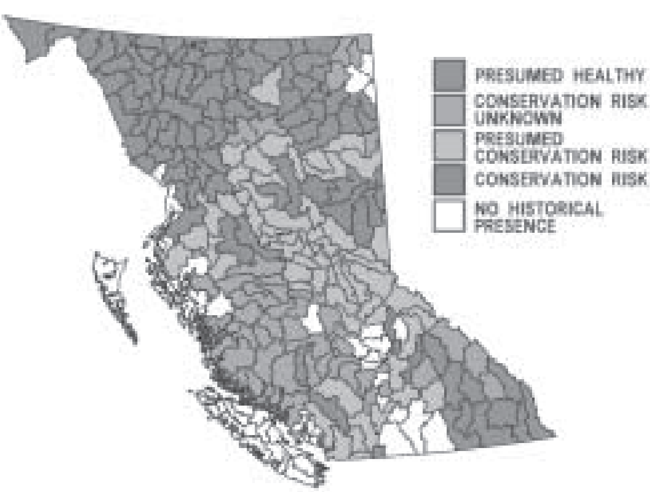


Figure 1. Status of Bull Trout in British Columbia by watershed group. Conservation risk means that the population is known to be in decline (B.C. MWLAP 2002).

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 Giant Salamander

Dicamptodon tenebrosus

Original prepared by Barbara E. Johnston

Species Information

Taxonomy

The Coastal Giant Salamander belongs to the Dicamptodontidae family (Good 1989). This group was originally considered to be a subfamily of Ambystomatidae. However, taxonomic analysis by Edwards (1976) and Estes (1981) found *Dicamptodon* to have several unique morphological and neurological traits that warrant distinct family status. Dicamptodontidae is an ancient lineage (Peabody 1954) that first appears in the fossil record of the lower Pliocene.

Within the subfamily Dicamptodontinae, Good (1989) recognized four distinct species on the basis of allozymes: *Dicamptodon aterrimus, D. copei, D. ensatus, and D. tenebrosus.* Prior to this analysis, *D. tenebrosus* and *D. ensatus* were considered to be one species called *D. ensatus*. These two species are similar in appearance and life history, but geographically disjunct. There are no recognized subspecies of *D. tenebrosus*.

Description

Coastal Giant Salamander larvae are ~33–35 mm in total length at hatching (Nussbaum and Clothier 1973). They are dark dorsally with light underbellies, have shovel-shaped heads, gills, and tail fins. If larvae transform into terrestrial adults, they usually do so between the sizes of 92 and 166 mm total length (Nussbaum et al. 1983). Some adults do not transform and remain obligate streams dwellers. These neotenes can grow up to 351 mm total length (Nussbaum et al. 1983). Terrestrial adults are heavy bodied and broad headed. They are dark brown to black dorsally and usually marbled with tan or copper (Farr 1989). Larger adults are noticeably less marbled than small individuals, suggesting these markings fade with age (B. Johnston, pers. obs.). Coastal Giant Salamanders are the only salamanders capable of true vocalization, with adults emitting bark-like cries when disturbed (Nussbaum et al. 1983).

Distribution

Global

The range of the Coastal Giant Salamander extends along the western coast of North America from southwestern British Columbia, through the Cascade and Coast Ranges, to northwestern California (Nussbaum and Clothier 1973; Nussbaum et al. 1983).

British Columbia

In British Columbia, the Coastal Giant Salamander is restricted to the Chilliwack River Valley and a few small nearby tributaries of the Fraser River. In this region, larvae have been recorded in ~60 headwater streams (Farr 1989; Haycock 1991; Richardson and Neill 1995, 1998). Their range appears to be continuous, extending from the west side of Vedder Mountain to the slopes east of Chilliwack Lake (Richardson and Neill 1995). The population on the west side of Vedder Mountain may now be isolated because of modifications to the drainage system of this area (Farr 1989).

Forest region and district

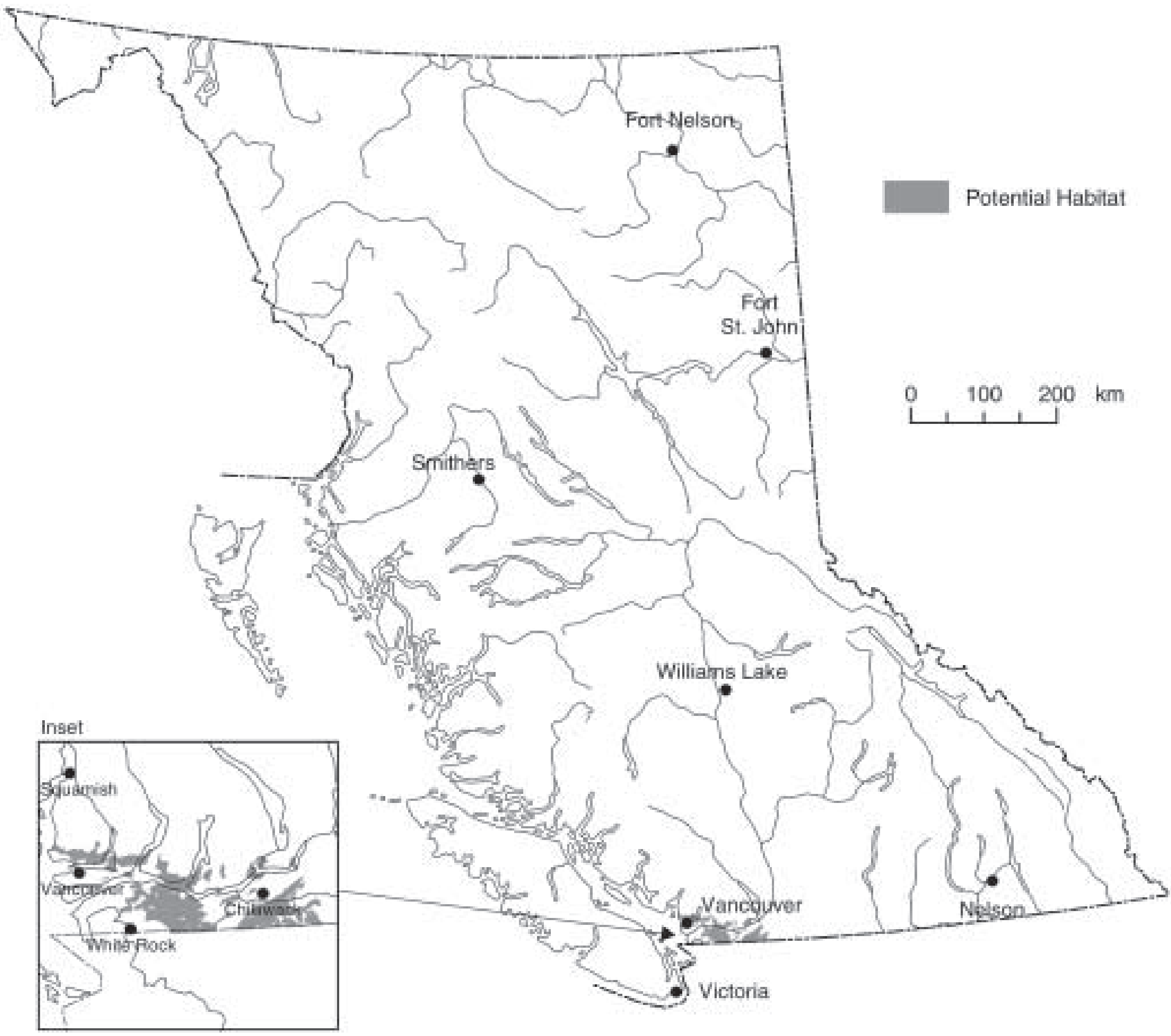
Coast: Chilliwack

Ecoprovinces and ecosections

COM: NWC, SPR

GED: FRL, GEL

Coastal Giant Salamander
(Dicamptodon tenebrosus)



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

CWH: dm, ds1, ms1, vm2, xm1

MH: mm1, mm2

Broad ecosystem units

CR, CW, FR, LL, LS, MF

Elevation

Sea level to 2160 m

Life History

Diet and foraging behaviour

Both larval and adult Coastal Giant Salamanders are opportunistic feeders. The aquatic larvae feed nocturnally on aquatic insects (i.e., caddisflies, stoneflies, dipterans, and beetles), benthos, small fish, and Tailed Frog larvae (Antonelli et al. 1972; Nussbaum et al. 1983; Parker 1994). Terrestrial adults feed on land snails, slugs, beetles, caddisfly larvae, moths, flies, small mammals such as shrews, and other amphibians (Stebbins 1951). Other unusual items such as lizards, garter snakes, and feathers have been found in the stomach contents of adults (Bury 1972; Nussbaum et al. 1983). Cannibalism has been noted in both larval and adult life stages of this species (Anderson 1960; Nussbaum et al. 1983).

Reproduction

Coastal Giant Salamanders are believed to breed once every 2 years (Nussbaum 1976). In California and Oregon, breeding can occur in either spring or fall (Nussbaum et al. 1983). Preliminary evidence from British Columbia suggests the timing of breeding is variable and may occur throughout the May to October active season (Haycock 1991; Ferguson 1998). Age at first reproduction remains unknown.

Montane streams are implied as breeding habitat for this species based on the observation of very small larvae in this habitat type (Haycock 1991; Nussbaum 1969; Henry and Twitty 1940). Only four known nest sites have been described from the field, all within the United States (Jones et al. 1990). The nests were located (1) in a stable talus and earth bank adjacent to a stream (Nussbaum 1969), (2) within a rock pile at the base of a waterfall (Nussbaum 1969), (3) on a submerged piece of lumber from a bridge crossing a fast flowing stream (Henry and Twitty 1940) and (4) on a partly rotted log in a riffle at the edge of a small stream (Jones et al. 1990).

On the basis of a few field and aquaria observations, Nussbaum et al. (1983) suggested that courtship occurs in hidden, water-filled nest chambers beneath logs and stones.

Males deposit up to 16 spermatophores. Females pick up one or two spermatophores with their cloacae and deposit a clutch of 135–200 eggs in the nest chamber (Nussbaum et al. 1983). Eggs are usually attached singly on the chamber roof.

In the field, adult salamanders have been observed near a developing clutch. This observation has been interpreted as females tending their own eggs (Farr 1989). Nussbaum et al. (1983) state a female will stay in the nest until the eggs hatch and the young abandon the nest chamber, a period of up to 200 days.

Coastal Giant Salamanders take approximately 35 days to develop to tail bud stage (Nussbaum 1969) and a further 5 months until hatching (Henry and Twitty 1940). Newly hatched larvae remain buried in the substrate and attached to their yolk sac for a further 3–4 months before appearing in streams at 45–51 mm in total length (Nussbaum and Clothier 1973). The larval period is believed to last between 2 and 6 years, averaging 3–4 years (Duellman and Trueb 1986; Ferguson 1998). Larval survivorship until adulthood is estimated at ~1–4% (Ferguson 1998), with predation and desiccation acting as the chief agents of mortality (Nussbaum and Clothier 1973).

At the end of the larval period, Coastal Giant Salamanders either transform into terrestrial salamanders or remain in their natal habitat as neotenes. The frequency of neoteny varies between populations and it is unclear whether this phenomenon is genetically or environmentally determined. The lifespan of this species is unknown. Studies of similarly sized aquatic salamanders suggest they may live up to 25 years (Duellman and Trueb 1986).

Home range

In aquaria, Coastal Giant Salamanders are reported to exhibit territorial behavior (Nussbaum et al. 1983). Terrestrial Coastal Giant Salamanders do not appear to occupy a home range. Over the course of one active season (June to September), individuals rarely returned to previously visited locations (Johnston 1998).

Site fidelity, movement, and dispersal

Coastal Giant Salamanders are highly sedentary, generally spending their entire life cycle in one creek (Farr 1989). Two mark-recapture studies conducted on larvae in the Chilliwack Valley found, respectively, that 73% of larvae remained within 10 m of their initial location of capture over 3 years (Neill 1998), and that only 10% of larvae moved farther than 20 m over 2 years (Ferguson 1998).

Terrestrial adults travel farther than larvae (commonly moving 10–50 m over a short time), but rarely move between streams (Johnston 1998). A radio-telemetry study in the Chilliwack Valley found that terrestrial adults are primarily active at night, with 70% of all movements occurring between dusk and dawn. The animals moved more frequently when it was raining. During dry periods, their movements were restricted to times of low temperatures (Johnston 1998). Based on the frequency and distance of movements, Johnston (1998) estimated that the probability of a terrestrial adult dispersing to an adjacent stream 0.5 km away was well below 1 in 1000 over the yearly active period. A genetic study conducted in the Chilliwack Valley found subpopulations to be moderately linked, indicating at least some dispersal between adjacent streams (Curtis and Taylor 2003).

The movement and dispersal patterns of juvenile Coastal Giant Salamanders (individuals recently transformed from aquatic to terrestrial phase) have not been studied. It is possible that juveniles are responsible for most of the dispersal, as is the case in many other species including some amphibians (Horn 1983; Duellman and Trueb 1986).

Habitat

Structural stage

4: pole/sapling
5: young forest
6: mature forest
7: old forest

Usually associated with structural stages 6 and 7, but have been recorded in stages 4–7. Habitat use may be more associated with specific habitat features than with structural stage.

Important habitats and habitat features

Aquatic

Suitable habitat for aquatic Coastal Giant Salamanders is generally found in clear, cool, fast-flowing and well-oxygenated streams with step-pool morphology and sufficient hiding cover (i.e., rocks, debris, and overhanging stream banks). Investigations into habitat use suggest that larvae predominantly use pocket pools (pools of small size) (Haycock 1991; Mallory 1996; Hatziantoniou 1999). Both stream depth and stream width are good predictors of larval salamander abundance, with abundance frequently decreasing with increasing wetted width (Richardson and Neill 1995) and with increasing depth (Southerland 1986; Tumlinson et al. 1990). Larval abundance has also been positively correlated with the number of substrate crevices and cover objects available (Hall et al. 1978; Murphy and Hall 1981; Conner et al. 1988; Parker 1991).

Terrestrial

Suitable terrestrial habitat is generally found in moist forested areas with ample hiding cover and in close proximity to streams. Eighty-four percent ($n = 19$) of the terrestrial adults captured using time-constrained searches in unmanaged forests in Oregon were found within 10 m of a stream (Vesely 1996). Johnston (1998) radio-tracked 18 terrestrial Coastal Giant Salamanders in old-growth and second-growth habitat in the Chilliwack and Nooksack River valleys. On average, 67% of each animal's recorded locations were within 5 m of the water's edge. The most common refuge locations used by terrestrial adults in this study were in/under coarse woody debris (38% of recorded refuges), underground (likely in small mammal burrows and root channels) (31%), and under rocks (26%). Any structure that provides a moist microsite appears to make a suitable resting site. When using coarse woody debris, terrestrial Coastal Giant Salamanders appear to select older wood in advanced stages of decay (classes 3–5) over newly fallen wood (Johnston 1998). Overwintering habitat does not appear to be a limiting factor for terrestrial adults. They tend to overwinter in the same types of refuges used throughout the active season, most commonly in underground burrows and seeps (B. Johnston, pers. obs.).

Suitable nesting sites may be the most critical habitat attribute for Coastal Giant Salamanders (Farr 1989). Only four nest sites have been described from the field (Henry and Twitty 1940; Nussbaum 1969; Jones et al. 1990). Each was located in a secure area (under rocks or wood) in or adjacent to a stream.

Conservation and Management

Status

The Coastal Giant Salamander is on the provincial *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)

BC	CA	OR	WA	Canada	Global
S2	S?	S4	S5	N2	G5

Trends

Population trends

Population estimates for Coastal Giant Salamanders are very difficult to determine. The terrestrial life stage is primarily fossorial (only above ground and visible about 1% of the time; Neill 1998) and aquatic individuals are remarkably discrete within streams. Roughly estimated, the population of Coastal Giant Salamanders in British Columbia is ~13 000 terrestrial adults and 4500–9000 neotenic adults (Ferguson and Johnston 2000). Coastal Giant Salamanders have been found in 15 of 20 stream systems in the Chilliwack Valley and associated areas, for a total of 75 occupied streams.

No long-term study of Coastal Giant Salamanders has been conducted to monitor the population's stability in the Chilliwack area. The Sumas Lake and the Vedder River areas may have historically supported populations of this species. In the 1920s, these populations were likely lost when Sumas Lake was drained for agricultural purposes and Vedder Creek was channeled north, becoming the VedderCanal.

Habitat trends

Suitable habitat is declining in British Columbia. The Lower Mainland is the most populated area of the province. Since 1827, the area of coniferous forest declined from 71 to 54% in the lower Fraser Basin ecosystem, while urban and agriculture use increased by 26% (Boyle et al. 1997).

Headwater streams receive little or no protection during timber harvesting. Timber harvesting is occurring throughout the Chilliwack River Valley. In the past 15 years (since ~1985), ~2500 ha have been logged (either clearcut or partial cut) within the known range of the Coastal Giant Salamander (MOF, Chilliwack Forest District). Following an 80-year harvest rotation, much of the remaining mature second growth will likely undergo second rotation cutting beginning around 2013. Urban development also continues to progress east up the Chilliwack Valley and into surrounding hillsides. Increasing habitat fragmentation (forest and stream habitats) is further reducing the quality of the remaining habitat.

Threats

Population threats

Like all amphibians, Coastal Giant Salamanders are highly dependent on moisture for dermal respiration. Transformed adults receive ~66% of their oxygen through the skin (Clothier 1971) and are thus sensitive to a loss of shading and cover objects. This water dependence limits the habitats they can exploit.

Studies conducted in the Chilliwack Valley suggest that both larval and terrestrial Coastal Giant Salamanders have limited dispersal tendencies. From 1996 to 1998, W.E. Neill (unpubl. data) found that fewer than 2% of marked larvae (*n* >2500) traveled >50 m annually. Mean annual movements were estimated at <2 m from the site of first capture. Similarly, Ferguson (1998) found that 90% of marked larvae moved <20 m (cumulative distance) over 1 year. In 1996 and 1997; Ferguson (2000) experimentally depleted 25–40 m reaches of four streams in the Chilliwack Valley to assess recolonization rates. One year after depletion, only 4–5% of the marked larvae from neighbouring reaches had colonized the depleted area. Ferguson (2000) estimated that full recolonization of a 400 m disturbed reach would require 8–55 years. Terrestrial Coastal Giant Salamanders also appear to have limited dispersal. Using a dispersal probability model developed from radio-telemetry data, Johnston (1998) concluded that the probability of a terrestrial adult dispersing between streams in the Chilliwack Valley was far less than 1 in 1000 over the yearly active period.

Dispersal or recolonization limitation in this species is supported by survey work conducted by Richardson and Neill (1995) in the Chilliwack Valley, where Coastal Giant Salamanders were detected in only 22 of 59 (37%) seemingly habitable streams. Results of a transplant experiment conducted in 1996 in the Chilliwack Valley, in which 53 larvae were introduced into an unoccupied stream, suggest that at least some of these uninhabited streams are able to sustain populations of aquatic giant salamanders (W.E. Neill, unpubl. data). Larval survival and growth estimates in the 2 years following introduction were indistinguishable from those at naturally occupied streams.

Several fish species have been shown to prey on giant salamander larvae, and it has been suggested that fish stocking in the Chilliwack River may inflict significant mortality on this species (Orchard 1984).

Coastal Giant Salamanders reach the northern extent of their range 19.5 km north of the Canada–U.S. border. Populations found in the Chilliwack region may therefore be particularly vulnerable. Populations on the periphery often have lower population densities, slower growth rates, and lower fecundity than those in the centre of a species' range (Hengeveld 1990; Lawton 1993). This lower viability is presumably due to climatic, competitive, or predation gradients, which increase towards range margins and, ultimately, limit species expansion. Larval densities and growth rates in British Columbia (Ferguson 1998; W.E. Neill, unpubl. data) appear to be lower than reported in Oregon (Nussbaum and Clothier 1973), the centre of the species range. The larval phase tends to be prolonged in Canadian populations (2–3 times longer than in Oregon; Ferguson 1998). If the annual survival rate of larval Coastal Giant Salamanders is relatively consistent across the species' geographic range, the fact that Canadian salamanders take longer to reach adulthood (reproductive age) means that the average survival rate to reproductive age is lower in British Columbia than in areas farther south.

Little is known of the effects of pesticides on Coastal Giant Salamanders. A common herbicide used in the Chilliwack Valley is glyphosate. This chemical is thought to hve low toxicity; however, some authors have suggested that adverse affects my be subtle (Ferguson and Johnston 2000). Ouellet et al. (1997) found a high prevalence of hindlimb deformities in some frog (*Rana* spp.) and toads (*Bufo americanu*s) from agricultural sites exposed to pesticide runoff.

Habitat threats

Forest management and urban development are the main threats to the habitats of Coastal Giant Salamanders. There are several possible causes for declines in amphibian populations following forest harvesting. Some direct mortality occurs during logging operations. This has been observed at three sites in the Chilliwack Valley (K. Mallory, pers. comm.). Canopy removal results in microclimatic changes (Chen et al. 1993, 1995; Brosofske et al. 1997) that may increase physiological stress on terrestrial amphibians, leading to reduced fitness or death. Logging and associated road building degrades stream habitat by increasing sedimentation and causing increases in summer stream temperatures (Newbold et al. 1980; Beschta et al. 1987; Hartman and Scrivener 1990). These changes may influence the growth rate of aquatic amphibians, as well as their ability to respire, find food, and take refuge from predators. Streams may become ephemeral after logging or dry up altogether. Given that many amphibian species, including Coastal Giant Salamanders, are obligate stream dwellers for a portion of their life, these changes constitute critical habitat loss.

Most studies of aquatic Coastal Giant Salamanders in the coastal Northwest have inferred logging effects by correlating larval density to the age of the surrounding forest. Results of these studies have been mixed, with some finding reduced density in logged stands (Bury 1983; Bury and Corn 1988; Connor et al. 1988; Corn and Bury 1989; Cole et al. 1997), others finding no effect (Hawkins et al. 1983; Kelsey 1995), and still others finding increased density in logged areas (Murphy et al. 1981; Murphy and Hall 1981). In their recent study conducted in Oregon, Biek et al. (2002) compared the abundance of larvae on the interface of recent clearcuts and mature forest. They found the abundance of larvae in headwater streams to be markedly lower in clearcuts than in downstream mature forest stands. Without examining demographic rates, it is difficult to interpret why abundance varies after logging, increasing at some sites and decreasing at others. Studies conducted on aquatic Coastal Giant Salamanders in the Chilliwack Valley have yielded inconsistent results (Ferguson 1998; Richardson and Neill 1998; Hatziantoniou 1999; W.E. Neill, unpubl. data).

Radio-telemetry studies of Coastal Giant Salamanders in Chilliwack and northwestern Washington suggest that the terrestrial phase of this species may be adversely affected by logging (Johnston 1998; Johnston and Frid 2003). Catch per unit effort was lower in clearcut habitat than in forested habitat, and salamanders in clearcuts altered their behaviour in ways consistent with a water stress hypothesis. In comparison with salamanders at forested sites, animals in clearcuts remained closer to the stream, spent more time in subterranean refuges, had a more restricted range, and were more dependent on precipitation for their movement during the driest field season. These changes in behaviour could reduce the fitness of animals in clearcuts by influencing their ability to find food and mates (Johnston 1998). These findings are consistent with results of a study in Oregon, where Vesely (1996) found terrestrial Coastal Giant Salamanders at fewer logged sites (1 of 13 sites, 7%) than sites with forest cover (5 of 12 sites with riparian buffer strips, 42%).

Curtis and Taylor (2003) also found that Coastal Giant Salamander populations at eight sample streams found had lower levels of genetic variation and heterozygosity in recent clearcut sites than in second-growth or old-forest sites. These results suggest that clearcut logging is associated with low population densities or population bottlenecks.

Logging roads constructed to gain access to timber may act as dispersal barriers to aquatic Coastal Giant Salamanders. Culverts are installed to enable uninterrupted stream flow below the roads. Most culverts, however, extend beyond the road edge, creating a considerable drop to the stream below (>1 m in many instances). Waterfalls created by the culverts likely prevent upstream movements of aquatic salamanders and the effect of the downstream drop is not known.

Farr (1989) cited housing development on the north side of Vedder Mountain as a potential threat to Coastal Giant Salamanders. Urbanization continues throughout the Chilliwack Valley, including in the Vedder Mountain area. The population of the City of Chilliwack has nearly doubled in the past 10 years, and the growth rate is expected to increase as the Vancouver metropolitan area extends up the Fraser Valley. With 20% of the region's population living in rural areas, housing developments are encroaching up mountainsides and into Coastal Giant Salamander habitat.

Legal Protection and Habitat Conservation

The Coastal Giant Salamander is protected in that it cannot be killed, collected, or held in captivity without a permit, under the provincial *Wildlife Act*. In areas where salmonid habitat exists downstream, some protection may be provided by the *Canadian Fisheries Act*.

Some areas of the Chilliwack River Valley receive some level of protection as parks, recreation areas, and ecological reserves. Coastal Giant Salamanders have been detected within Chilliwack Lake Provincial Park (9122 ha). This park is contiguous with a large park (North Cascades National Park) in Washington State. There are anecdotal observations for Cultus Lake Provincial Park (656 ha), Chilliwack River Provincial Park, and Liumchen Ecological Reserve (948 ha). Numbers present are not known (M. Turner, pers. comm.).

The vast majority of this species' habitat falls on Crown land managed for forestry. The results based code may ensure habitat protection through the establishment of old growth management areas, provided these areas overlap sites inhabited by Coastal Giant Salamanders. Habitat is also protected by riparian management recommendations that recommend reserve zones along S1–S3 streams. As is the case with the *Fisheries Act*, however, this does not afford significant habitat protection because Coastal Giant Salamanders rarely occur in fish-bearing streams. Most of this species' habitat falls along small headwater streams (S5 and S6). Riparian management recommendations also recommend that forest practices in management zones adjacent to these streams be planned and implemented to meet riparian objectives such as wildlife, channel stability, and downstream water quality.

Protected areas or special resource management zones created for other species with overlapping ranges with the Coastal Giant Salamander (e.g., Spotted Owl, Pacific Water Shrew, tall bugbane) may afford additional protection.

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

- ❖ Establish old growth management areas to protect suitable riparian habitats (i.e., small streams within range of species) or increase forest retention on small streams (i.e., S4–S6) and on stream reaches adjacent to Coastal Giant Salamander WHAs.
- ❖ Maximize connectivity of riparian areas.
- ❖ Maintain stream flow characteristics and water quality.
- ❖ Fall and yard away from stream channels and minimize site disturbance during harvesting to reduce risks of water diversion and stream sedimentation.
- ❖ Minimize the use of chemical applications within suitable Coastal Giant Salamander habitat.

Wildlife habitat area

Goal

Maintain and link important aquatic and riparian habitats not addressed through strategic or landscape level planning.

Feature

Establish WHAs at streams characterized by (1) presence of Coastal Giant Salamander larvae, (2) year-round flow, (3) small size (<5 m channel width), (4) intermediate gradient, (5) step-pool morphology, (6) stable channel beds, and (7) forest cover. In choosing WHA sites, priority should be given to sites that have the highest density of larvae and low levels of historical harvest, and that are adjacent to mature or old forest, closest to the headwaters, and free of fish.

Size

Typically between 20 and 100 ha depending on site-specific factors such as the number and length of streams included and whether overland connectivity is required.

Design

Wherever possible, include more than one stream or stream reach that contains Coastal Giant Salamanders within the WHA. A 30 m core area and 20 m management zone should be maintained on either side of all stream reaches with the WHA. When a WHA contains upland areas needed to connect adjacent stream reaches, include the upland area as part of the management zone. Maximize connectivity of streams and consider overland dispersal requirements of terrestrial adults in the design of the WHA.

General wildlife measures

Goals

1. Preserve the structure, flow regime, water quality and temperature of within-stream habitat.
2. Maintain microclimatic conditions in adjacent forest areas.
3. Maintain important habitat features such as cover objects (e.g., coarse woody debris), clear cold water, ample food supply, understorey vegetation, and subterranean channels.
4. Maintain connectivity between streams.

Measures

Access

- Do not construct roads or crossings. Approved roads should be constructed with minimum road bed and right-of-way widths, and whenever possible, downslope of WHAs. If constructed upslope, implement sediment-control measures and prevent water diversion.
- Approved crossings should use open-bottom structures (i.e., bridges or open-bottom culverts).
- When no longer in use, roads should be deactivated using methods that minimize the risk of water diversion and stream sedimentation.

Harvesting and silviculture

- Do not harvest in the core area.
- Within all riparian areas in the management zone, use partial harvesting systems that maintain 70% basal area, ensure windfirmness, and maintain forest structure and cover by retention of multi-layered canopy and snags. Within all upland areas within the management zone, ensure harvesting maintains shade, microclimatic conditions, coarse woody debris, and ground structure (i.e., small mammal burrows, root channels) to facilitate dispersal between streams.
- Do not salvage timber.
- Fall and yard away from streams.
- Remove slash and debris that inadvertently enters the stream (unless this will destabilize the bank or channel).
- Use silviculture strategies and equipment that minimize ground disturbance.
- Retain wildlife trees, non-merchantable conifer trees, understorey deciduous trees, shrubs, herbaceous vegetation, and coarse woody debris.
- Avoid burning.

Pesticides

- Do not use pesticides.

Recreation

- Do not establish recreation sites.

Additional Management Considerations

Manage stream reaches adjacent to WHAs according to the best management practices outlined in the *Riparian Management Area Guidebook*.

At S5 and S6 streams containing Coastal Giant Salamanders, retain riparian vegetation to provide stream shading.

Minimize debris entering the stream channel from logging operations.

To maintain coarse woody debris, avoid piling or burning residue (leave it well distributed across the stand) and retain non-merchantable material on site.

Recommendations for urban and rural land development are available from the MWLAP lower mainland office.

Avoid introducing fish into waters supporting Coastal Giant Salamanders.

Information Needs

1. Demographic responses of Coastal Giant Salamanders to habitat change (i.e., reproductive success, age-class distribution).
2. Movement and dispersal patterns of juvenile (recently transformed from aquatic to terrestrial phase) Coastal Giant Salamanders.
3. Population trends (long-term monitoring at established sites in the Chilliwack Valley).

Cross References

Coastal Tailed Frog, Keen's Long-eared Myotis, Pacific Water Shrew, Red-legged Frog, Short-eared Owl, Spotted Owl, tall bugbane

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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 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

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.

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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Red-legged Frog

Rana aurora aurora

Original prepared by Katherine A. Maxcy

Species Information

Taxonomy

The Red-legged Frog belongs to the family Ranidae (true frogs). Two subspecies are recognized: "Northern" Red-legged Frog (*Rana aurora aurora*) and "California" Red-legged Frog (*Rana aurora draytoni*). The "Northern" Red-legged Frog is the only subspecies that occurs in British Columbia.

Description

The Red-legged Frog is a medium-size anuran, ranging from 30 to 100 mm in snout-vent length (SVL). Adult females reach a larger body size (up to ~ 100 mm SVL) than do males (up to ~ 70 mm SVL). Juvenile frogs range from 18 to 40 mm SVL.

Adults have gold-coloured eyes that are oriented outward rather than upward as in Spotted Frog *(Rana pretiosa)*, with which it can be confused (Corkran and Thoms 1996). The colour of the ventral surface ranges from light golden to dark brown, possibly with a reddish tinge. Irregularly shaped black spots may also be present. Red-legged frogs have conspicuous dorso-lateral folds extending down either sides of the back. The undersides of the hind legs and lower belly are translucent red. In contrast to adults, juveniles may have little red on the thighs and belly and chest patterning is absent. In addition, the snout is short and rounded with a light, short lip line that may be quite indistinct.

Hatchlings average 12.4 mm total length and tadpoles reach lengths of 28.7 mm at metamorphosis (Brown 1975). Tadpoles have a stubby appearance and the tail is usually no longer than 1.5 times the body length. The overall body shape is oval with the dorsal fin taller than the thickness of the tail trunk. The ventral surface of the tadpole is tan with gold or brassy blotches. The dorsal fin may have a fine golden tone with light and gold-coloured dots, or it may be colourless (Corkran and Thoms 1996).

Distribution

Global

The Red-legged Frog occurs in the coastal lowlands of southwestern British Columbia, Washington, Oregon, and northern California.

British Columbia

The Red-legged Frog is found in the southwestern part of the province, including Vancouver Island and the Gulf Islands. On the mainland, the species occurs west of the Coast Mountains in the Fraser Valley and adjacent to the Strait of Georgia. Its northern limit in British Columbia has not been verified but may occur at least as far north as Kingcome Inlet (Waye 1999).

Forest region and districts

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

Ecoprovinces and ecosections

COM: NIM, NWC, NWL, SPR, WIM (possibly EPR, HEL, OUF)

GED: FRL, GEL, LIM, NAL, SGI

Biogeoclimatic units

CDF: mm

CWH: dm, ds, mm, vh, vm, wh, xm

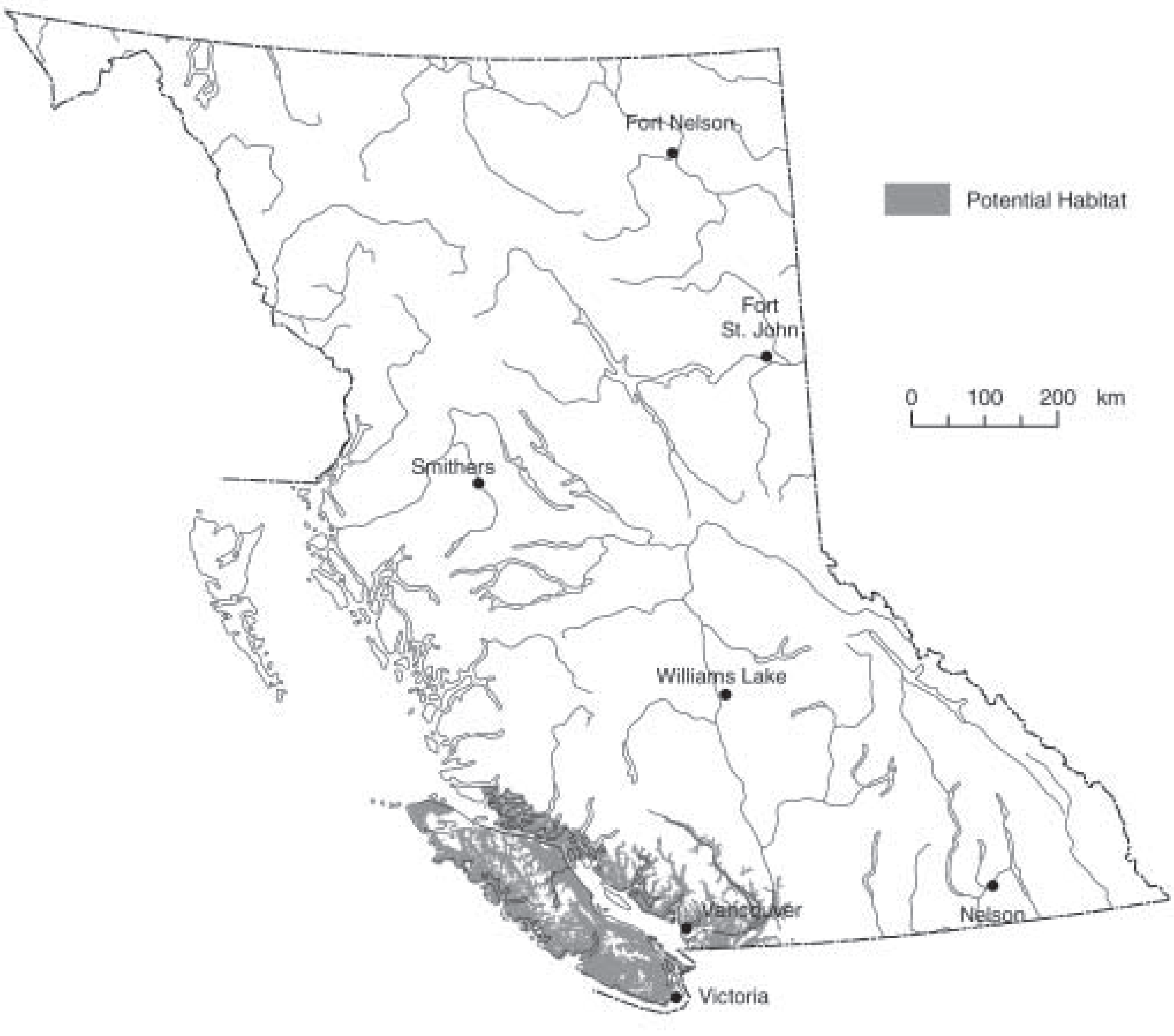
Broad ecosystem units

BG, CD, CG, CH, CP, CR, CW, DA, FE, FR, LS, ME, MR, OW, SP, SR, WL

Elevation

Generally at low elevations, mostly below 850 m.

Red-legged Frog
(Rana aurora)



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

Diet and foraging behaviour

Tadpoles are herbivorous and forage on filamentous algae in the water column, scraping algae off substrates, and possibly consuming decaying vegetation at the bottom of pools (Nussbaum et al. 1983).

Adult and juveniles are likely opportunistic foragers limited mainly by their gape in what they can eat (Licht 1986). The frogs feed mostly on land with dominant prey items including slugs, spiders, and many insects. The foraging behaviour of adult and juveniles is not easily observed. Newly metamorphosed individuals tend to remain near the water margins after emergence, stalking small prey in and out of the water (Licht 1986). During rainy periods, they may move several metres inland from the water's edge but return if substrates become dry. Metamorphosed frogs occasionally feed in aquatic habitats but are less efficient at capturing aquatic prey items than are the more aquatic Oregon Spotted Frog (Licht 1986).

Reproduction

Breeding occurs in a wide variety of wetlands including both temporary and permanent ponds, lakes, and slow-moving streams with emergent vegetation (Storm 1960; Brown 1975; Richter and Azous 1995; Beasley et al. 2000). Breeding activity is weather dependent. Frogs become active during rainy periods when daytime temperatures are >4–5°C (Storm 1960; Licht 1969, Calef 1973a) and begin moving to breeding sites. In southwestern British Columbia, breeding usually begins in late February to early March and lasts 2–4 weeks (Licht 1969; Brown 1975).

Males arrive at the breeding sites up to 1 week before females (Licht 1969). Males typically call underwater (Calef 1973b). Females are thought to reproduce every year (Licht 1969), laying an average of about 600 eggs per clutch with larger females producing more eggs. For egg-laying to occur, water temperatures must be at least 4°C (Licht 1969, 1971; Calef 1973b). The egg masses are attached to stalks of emergent vegetation (e.g., rushes and sedges) in quiet water of little or no flow (Storm 1960; Licht 1969; Briggs 1987; Richter and Azous 1995). Water depths range from 30 to 500 cm deep and are at least 60 cm from the shoreline (Briggs 1987). The placement of eggs below the surface of the water prevents the eggs from being stranded above the high watermark as water recedes. The egg masses are also protected from thermal extremes, as water temperature fluctuations are less than near the surface (Licht 1971).

The eggs hatch in approximately 5 weeks (Brown 1975) with some variation in development time depending on water temperature: the warmer the water, the faster development occurs. Normal egg development occurs at temperatures from 4 to 20°C (Licht 1971). The hatchlings take at least 3–4 months to metamorphose (Licht 1974; Brown 1975); young of the year begin to emerge in late July/early August and continue emerging through early October (Calef 1973a). Larval developmental and growth rate may be altered by both biotic (e.g., presence of predators) and abiotic (e.g., water temperature) factors.

Survival of embryos can be high; Licht (1974) observed a 90% survival rate to hatching. However, like other anurans, larval survival to metamorphosis appears to be much lower, estimated at 5% (Licht 1974). The main source of mortality of developing larvae is likely predation (Licht 1974; Adams 2000).

Site fidelity

Limited information exists on movement patterns and site fidelity of Red-legged Frogs. One study showed that males had a tendency to return to the same breeding site (a particular part of a lake; Calef 1973b), and individuals may well show fidelity to particular breeding sites from year to year. It is not known whether adult frogs return to the same terrestrial foraging area following breeding.

Home range

Unknown.

Movements and dispersal

One study on northern Vancouver Island examined movements of radio-tagged Red-legged Frogs within logged landscapes. While most (up to ~ 80%) tagged frogs moved <10 m within a 24-hour period, some made long movements, demonstrating potential to move relatively long distances over short periods (Chan-McCleod et al. 2000). Chan-McCleod et al. (2000) observed movements >300 m within 24 hours. However, these movements were recorded for frogs that were displaced from their original point of capture, so it is unlikely that these observations represent typical daily movements within the home range. Nothing is known about dispersal ability of the frogs and movements to and from aquatic breeding sites.

Habitat

Structural stage

2c: aquatic herbaceous	5: young forest
3b: tall shrub	6: mature forest
4: pole/sapling forest	7: old forest

Important habitat and habitat features

Aquatic

Although Red-legged Frogs require standing water to breed, they can use a diversity of waterbodies and wetlands. Breeding sites exhibit a wide variation in size, water depth, degree of permanency, and community structure (Richter and Azous 1995; Adams 1999; Beasley et al. 2000). Low water flow and complexity of microhabitat within the wetlands appear to be important. For example, although Red-legged Frogs were present in all types of wetlands sampled on western Vancouver Island (including shallow open water, marsh, swamp, fen, and bog), the highest proportion of occurrence was in bogs and fens (Beasley et al. 2000). Bogs and fens are characterized by humus substrate (as opposed to rock), greater herbaceous and emergent vegetation, and submerged down wood, all of which provide structural habitat for tadpoles. Adams (1999) also found that wetlands with emergent vegetation were more likely to be occupied by Red-legged Frogs than those with more open water (i.e., <50% of wetland surface had emergent vegetation). The Red-legged Frog selects sites with thin-stemmed, emergent plants (e.g., rushes and sedges) for breeding (Storm 1960; Licht 1969; Richter and Azous 1995); therefore, microhabitat of increasing complexity appears to be important for the frogs. Red-legged Frogs are also associated with wetlands having low water flow (Storm 1960; Licht 1969; Bury 1988; Richter and Azous 1995). Briggs (1987) recorded eggs in water depths from 30 to 500 cm deep and at least 60 cm from the shoreline.

The presence of Red-legged Frogs in aquatic-breeding habitat does not appear to be associated with forest age. Beasley et al. (2000) surveyed a variety of wetlands on the west coast of Vancouver Island for the presence of aquatic-breeding amphibians. Red-legged Frogs were present in 32% ($n = 11$) of wetlands that were in logged and/or roaded areas and 24% ($n = 27$) of wetlands that were undisturbed in old-growth forest (Beasley et al. 2000). Although Red-legged Frogs used wetlands disturbed by harvesting and intersected by roads, it is unknown whether these sites produced sufficient offspring to ensure population viability or whether they acted as reproductive sinks.

Terrestrial

Terrestrial habitat is where a significant portion of feeding and growth occurs (up to 90% of the time). Despite this, what constitutes high versus low quality terrestrial habitat remains unknown. Red-legged Frog abundance has been found to be positively and negatively associated with a variety of terrestrial habitat components. These relationships are difficult to interpret in a biologically meaningful way; however, some patterns are beginning to emerge. Red-legged Frogs are negatively associated with elevation (Aubry and Hall 1991; Bury et al. 1991; Aubry 2000; Beasley et al. 2000) and slope (Bury et al. 1991; Aubry and Hall 1991). Flatter sites at lower elevation (i.e., below 500 m) are areas associated with standing water (Aubry and Hall 1991). They also tend to be more abundant in riparian areas compared with upslope (McComb et al. 1993; Gomez and Anthony 1996; Cole et al. 1997). Chan-McCleod et al. (2000) found that frogs radio-tracked in clearcuts on northern Vancouver Island were usually associated with streams. Therefore, proximity to water appears to be an important determinant of their distribution, especially in disturbed landscapes. Two other habitat components that may be important to Red-legged Frogs include deciduous forest (in the United States) and abundance of coarse woody debris. Gomez and Anthony (1996) found the highest abundance of Red-legged Frogs in deciduous forest compared with a variety of conifer stand ages including old growth. Red-legged Frog presence was also correlated with high amounts of coarse woody debris indicating this habitat element may be important for cover (Aubry and Hall 1991).

At the stand level, as long as there is forest cover, the age of the forest does not appear to be important in determining the distribution of Red-legged Frogs. The Red-legged Frog has been found in a range of forest stand ages and although it can be associated with old growth (Walls et al. 1992; Blaustein et al. 1995), it is not considered an old growth dependent species in the United States (SAT 1993). The abundance of the frogs varies greatly among sites (Bury and Corn 1988; Bury et al. 1991; Cole et al. 1997; Maxcy 2000), making it difficult to establish clear relationships with specific variables such as forest age, structure, and composition. In Washington State, Red-legged Frogs were 1.25 more abundant in successional forests (30–76 yr) compared with clearcuts (Bury and Corn 1988). In Oregon, they were 5–10 times more abundant in rotation age stands (50–70 yr) compared with younger age classes including clearcut sites (Aubry 2000). In southwestern British Columbia, Maxcy (2000) captured 11 frogs in a 70-year-old second-growth stand before harvesting and only one frog one year post-harvesting.

The spatial distribution of Red-legged Frogs is likely related more to proximity of suitable breeding habitat rather than forest age *per se* (Welsh and Lind 1988; Bury et al. 1991; Corn and Bury 1991). Although Red-legged Frogs have no apparent association with stand age, they do appear to be negatively affected by clearcutting and very young successional forest.

Conservation and Management

Status

The Red-legged 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	WA	OR	CA	Canada	Global
S3S4	S5?	S3	S2?	N?	G4

Note: Washington has an incorrect and conflicting rank with the global rank. State ranks can not be more secure (i.e., S5) than the global rank (G4).

Trends

Population trends

There is currently no information on population trends for Red-legged Frog populations in British Columbia (Waye 1999). Most historical localities from the province have not been visited recently. Since the 1970s, populations in the Willamette Valley in Oregon have declined severely (Blaustein and Wake 1990). Populations of the California subspecies (*R. aurora draytoni*) have declined drastically through their range (Hayes and Jennings 1986; Fisher and Shaffer 1996).

Habitat trends

There has been a significant loss of Red-legged Frog habitat in parts of its range in British Columbia. The Lower Mainland is the most populated area of the province. Since 1827, wetland area has decreased from 10 to 1% in the lower Fraser Basin ecosystem (Boyle et al. 1997). Over this same period, the area of coniferous forest declined from 71 to 54%, while urban and agriculture use increased by 26% (Boyle et al. 1997). Southern and eastern Vancouver Island have also become extensively urbanized and developed. Much of the forest in the interior of the island and north of Vancouver has been fragmented by logging, but the effects of this fragmentation on the Red-legged Frog are unknown.

Threats

Population threats

The introduction of exotic species has been suggested as one reason for the decline of ranid frogs in western North America, including Red-legged Frogs. Bullfrogs (*Rana catesbieana*) in particular have been implicated in these declines (Nussbaum et al. 1983; Hayes and Jennings 1986; Kiesecker and Blaustein 1997). However, results from recent studies indicate Red-legged Frog responses to introduced predators including bullfrogs and fish are not predictable (Keisecker and Blaustein 1997; Adams 2000).

Under experimental conditions (e.g., pond enclosures or aquaria), the larvae of the Red-legged Frog are adversely affected by the presence of both bullfrog larvae and adults. Larval microhabitat use can change (Kiesecker and Blaustein 1998), growth rates are lower, and time to metamorphosis may be shorter (Adams 2000) or longer (Kiesecker and Blaustein 1998); all these factors have potentially negative consequences to survival. Due to the lower growth rates, metamorphosis occurs at a smaller size, which has implications for subsequent survival. Survival may also be directly reduced in the presence of bullfrog larvae (Lawlor et al. 1999); however, this is not a predictable response and depends on other factors as well. For example, Keisecker and Blaustein (1997) found the survival of Red-legged Frog tadpoles was unaffected by bullfrog presence if the tadpoles originated from a population that was sympatric with bullfrogs in its natural setting but not if the tadpoles were from a native population. Survival of Red-legged Frog tadpoles alone with bullfrog tadpoles was unaffected but was reduced when bullfrog larvae were present with adult bullfrogs and/or predatory fish (Kiesecker and Blaustein 1998). Adams (2000) observed low survival rates of Red-legged Frog tadpoles across a number of treatments, which included the presence and absence of predators in temporary and permanent wetlands. He suggests tadpole survival within enclosures was related to the abundance of tadpoles outside enclosures, indicating that some other factor other than the presence of exotic species was influencing survival rate of Red-legged Frog tadpoles such as predation by invertebrate predators and/or food limitation. Although Red-legged Frog tadpoles have variable survival in the presence of bullfrog larvae, metamorphosing frog survival was <5% in the presence of adult bullfrogs (Kiesecker and Blaustein 1998), indicating terrestrial mortality may have a considerable effect on the number of successful metamorphs leaving the wetland.

While the presence of bullfrogs and exotic fish has been shown to negatively affect Red-legged Frogs in a number of ways, other factors have been found more important in determining the distribution of Red-legged Frogs at the landscape scale. For example, Adams (1999) found the distribution of Red-legged Frogs was more closely associated with habitat structure and the presence of fish than to the presence of bullfrogs. Richter and Azous (1995) sampled 19 wetlands and found Red-legged Frogs in 70% of the wetlands. Lower species richness in these wetlands was not correlated with the presence of exotic fish or bullfrogs, but rather increasing water-level fluctuation and percentage of watershed urbanization. While bullfrogs and fish can significantly impact Red-legged Frog populations, other factors may be more important in determining their abundance and distribution.

Another factor implicated in the decline of amphibians in the Pacific Northwest is increased ultraviolet (UV) radiation. However, for Red-legged Frogs, UV does not appear to be an issue. There were no significant differences in survival of Red-legged Frog eggs (Blaustein et al. 1996; Ovaska et al. 1997) or larvae (Ovaska et al. 1997) between treatments shielded from UV-B compared with those exposed to ambient levels. Furthermore, the activity of photolyase (an enzyme important in repairing UV-damaged DNA) was higher in Red-legged Frogs compared with many amphibians (Blaustein et al. 1996), indicating UV-B radiation is an unlikely mechanism in the decline for this species at present. However, under experimentally enhanced UV-B levels, eggs and larvae of the Red-legged Frogs were more sensitive than those of the sympatric Pacific Treefrog (*Pseudacris regilla*) and experienced high mortality.

Roads can have both direct population impacts, particularly when they cross important dispersal or migration routes and are heavily used (Fahrig et al. 1995), as well as indirect impacts through habitat alteration. Road mortality has been documented for this species and may be common in urban environments (Waye 1999). The impact to populations is not known.

Although the effect of toxic pollutants on the Red-legged Frog is not specifically known, agricultural pollutants have been shown to have mutagenic effects on amphibians (Bonin et al. 1997). There have been no known instances where disease was determined to negatively impact populations of *R. a. draytoni* (USFWS 1996).

Habitat threats

Habitat loss and degradation have been suggested as the primary causes of ranid declines (Corn 1994; Blaustein 1994).

The loss of wetlands in the lower Fraser Valley and on southern Vancouver Island to urbanization and agriculture has significantly reduced available breeding habitat, fragmented habitats, and reduced the quality of breeding habitats.

On Crown land, forest harvesting and road construction are likely one of the primary threats to Red-legged Frog habitat. Forest harvesting has been shown to affect many functions of wetlands including productivity, hydrology, species assemblage, and habitat (Richardson 1994). However, the degree to which functions are altered depends on a number of other factors such as type of harvesting used (e.g., partial cutting, clearcut), use of a buffer around the wetland, and size of the wetland. In British Columbia, harvesting practices have likely altered wetlands but the importance of this to Red-legged Frog populations is unknown.

At the local scale (i.e., individual wetlands), removing forest canopy increases the rate of evaporative water loss. A shoreline that recedes too early in the spring potentially strands eggs that are laid in the shallow margins, directly increasing mortality of eggs. Developing larvae may also be stranded if the wetland dries up before the tadpoles have had a chance to metamorphose. Protection around wetlands is also critical to metamorphosing frogs that have a high risk of desiccation due to their timing of metamorphosis during the hottest, driest times of the year, and high surface area to volume ratio (they lose water more quickly than do adults). Without suitable microclimates, the risk of mortality due to desiccation is greatly increased (Semlitsch 1998; DeMaynadier and Hunter 1999).

At larger scales (e.g., watershed scale), the loss of small wetlands can affect metapopulation dynamics of pond-breeding amphibians and increase the probability of extinction of populations in the remaining wetlands (Gibbs 1993, 2000; Semlitsch 1998). Although small wetlands do not comprise a large area in the land base, they are often numerically dominant to large wetlands. For example, Semlitsch and Bodie (1998) observed 46% of wetlands in the southeastern Atlantic coastal plain were <1.2 ha. Over 97% of all wetlands surveyed on the west side of Vancouver Island were <0.1 ha (Beasley et al. 2000); Red-legged Frogs were present in 26% of these wetlands. The loss of unclassified wetlands not only decreases the number of aquatic-breeding sites, reducing the abundance or density of organisms, it also increases the nearest neighbour distance between sites, impeding source-sink processes (Gibbs 1993, 2000; Semlitsch 1998). For a number of species of ranid frogs, the occupancy of wetlands is related to the proximity of other breeding ponds (Laan and Verboon 1990; Gulve 1994; Pope et al. 2000). These results suggest nearby population sources are important in maintaining metapopulations of pond-breeding amphibians. Little is known about the metapopulation dynamics of Red-legged Frogs but studies on other ranids suggest they may be important.

Legal Protection and Habitat Conservation

Under the provincial *Wildlife Act*, the Red-legged Frog is protected in that it cannot be killed, collected, or held in captivity without special permits.

Several sites occur in protected areas including: Little Campbell River Regional Park, Miracle Beach Provincial Park, Morrell Nature Sanctuary, Garibaldi Provincial Park, Strathcona Provincial Park, Stanley Park, Rithet's Bog Nature Sanctuary, Spectacle Lake Provincial Park, and Trevlac Municipal Park (Waye 1999).

Habitat conservation needs may be partially addressed under the results based code, particularly the riparian management recommendations. Although retention of buffers on streams and wetlands is likely beneficial to Red-legged Frogs, the regulations associated with the riparian management for wetlands are not at an appropriate scale to manage for Red-legged Frog breeding habitat. Additional protection is required for wetlands <0.5 ha that currently receive no protection.

The most critical component for terrestrial habitat is likely sufficient cover and, on a larger scale, connectivity and distance between wetlands to maintain metapopulation dynamics in the landscape. Connectivity of habitats is not explicitly addressed under the results based code but may occur through landscape level planning.

Since the range of the species overlaps with urban areas, urban planning and municipal provisions may also provide some protection.

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

❖ Maximize connectivity of wetlands and riparian habitats considered to be of importance to this species (i.e., wetlands <850 m). Connectivity should be considered in terms of 1 km or less. A network of interconnected wetlands will increase connectivity and dispersal of juvenile frogs, possibly maintain metapopulation dynamics, and buffer against temporal variation in productivity of individual wetlands or stochastic events that may change a source population to a sink and vice versa.

Wildlife habitat area

Goal

Maintain aquatic and riparian breeding habitats not addressed by the *Riparian Management Area Guidebook* (e.g., non-classified wetlands <0.5 ha, ephemeral wetlands) or through landscape level planning. Over time, WHAs may need to be relocated to account for succession.

Feature

Establish WHAs at networks of small ephemeral or perennial wetlands (each <0.5 ha). A wetland network defined here is different from a wetland complex as defined in the riparian management recommendations. A wetland network is a general term that can include a wetland complex but also wetlands that are too small to be considered a complex (i.e., <5 ha total area) but are likely still important breeding habitat for Red-legged Frogs. A network should include at least three wetlands that are within 300 m of each other.

The priority for establishing WHAs should be those wetlands where Red-legged Frogs are known to occur regularly. Suitable sites are characterized by the following attributes: (1) high structural complexity within the wetland (i.e., high percent coverage of thin-stemmed emergent vegetation, coarse woody debris); (2) a humus substrate; (3) forest/vegetation cover surrounding wetland; (4) absence of vertebrate predators (fish and bullfrogs); (5) <850 m in elevation; (6) small size (<0.5 ha); and (7) capacity to hold water until the end of the summer (31 August).

Size

Generally, <10 ha but will depend on site-specific factors including the spatial arrangement of wetlands and size of wetlands.

Design

The WHA should include a core area that encompasses the wetland network plus a 30 m reserve of adjacent riparian habitat beyond the high watermark. The WHA should also include a 20 m management zone beyond the core area.

General wildlife measures

Goals

1. Prevent road mortality and mortality due to industrial activities during the breeding season (March–August).
2. Maintain as closely as possible the natural hydrological regime of wetlands.
3. Maintain the structural integrity of emergent vegetation to provide egg-laying sites and rearing habitat for developing tadpoles.
4. Maintain forest or vegetation cover adjacent to breeding sites to provide suitable microclimatic conditions for emerging juveniles and foraging adults.
5. Maintain important habitat features including natural levels of coarse woody debris, a deciduous component to stands where appropriate, and understorey vegetation surrounding wetlands.

Measures

Access

- Do not construct roads.

Harvesting and silviculture

- Do not harvest in the core area.
- In the management zone, use partial harvesting systems that maintain 70% basal area. Maintain forest structure and cover by retention of large diameter trees, multi-layered canopies, snags, and coarse woody debris. Retain as much understorey trees, shrubs, and herbaceous vegetation as is practicable.
- No salvage should be carried out.

Pesticides

- Do not use pesticides.

Additional Management Considerations

Consider installing culverts under roads with drift fences directed toward the culverts at selected locations on roads that have high traffic volume at night and where road mortality of Red-legged Frogs is high.

Prevent fish introductions and the spread of bullfrogs.

Information Needs

1. Determine population/distribution trends and the northern extent of the Red-legged Frog. Trends should be determined separately for the Vancouver Island and mainland populations.
2. Information on movement patterns of newly metamorphosed Red-legged Frogs, home ranges of terrestrial adults, and metapopulation dynamics is needed to determine the appropriate scale of Red-legged Frog WHAs (i.e., network of wetlands).
3. More information is needed on the effects of forest management on Red-legged Frogs, particularly with respect to aquatic-breeding habitats. Experimental designs should focus on the breeding site in conjunction with the surrounding upland habitat as experimental units.

Cross References

Keen's Long-eared Myotis, Pacific Water Shrew

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Reptiles

Racer

Coluber constictor mormon

Original[1] prepared by Mike Sarell

Species Information

Taxonomy

Racers belong to the largest family of snakes, the Colubridae. The genus *Coluber* is represented by one species in British Columbia (Gregory and Gregory 1999). Eleven subspecies are described (Wilson 1978) but only *C. constictor mormon* occurs in British Columbia (Gregory and Gregory 1999). This subspecies may represent a distinct species (Fitch et al. 1981) but this is not widely accepted (Corn and Bury 1986).

Description

Racers have long, sleek bodies. Adults are a uniform olive to bluish grey dorsally, with a yellowish venter that often becomes whiter toward the throat and head (Brown et al. 1995). Young resemble Gopher Snakes (*Pituophis catenifer deserticola*), as there is a series of saddle-shaped markings along the back (Matsuda et al., in press). This pattern gradually fades from the tail toward the head during the first year. Racers seldom reach lengths >1 m (Matsuda et al., in press).

Distribution

Global

Racers are found throughout much of the United States, bordering parts of Canada and down into Central America. *Coluber constrictor mormon* occurs in the Pacific Northwest south to California (Brown et al. 1995).

British Columbia

In British Columbia, Racers generally occur in the south and central interior. Populations are known from the south Columbia, Kettle, Okanagan, Similkameen, Nicola, Thompson, and Fraser watersheds but there are two records from Anderson Lake (J. Hobbs pers. comm.) and Churn Creek.

Forest region and districts

Coast: Squamish

Southern Interior: 100 Mile House, Arrow Boundary, Cascades, Central Cariboo, Kamloops, Okanagan Shuswap

Ecoprovinces and ecosections

CEI: FRB

SIM: SFH

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

Biogeoclimatic units

BG: xh, xw

ICH: dw, mk1, xw

IDF: dm, mw, ww, xh, xm, xw

PP: dh, xh

Broad ecosystem units

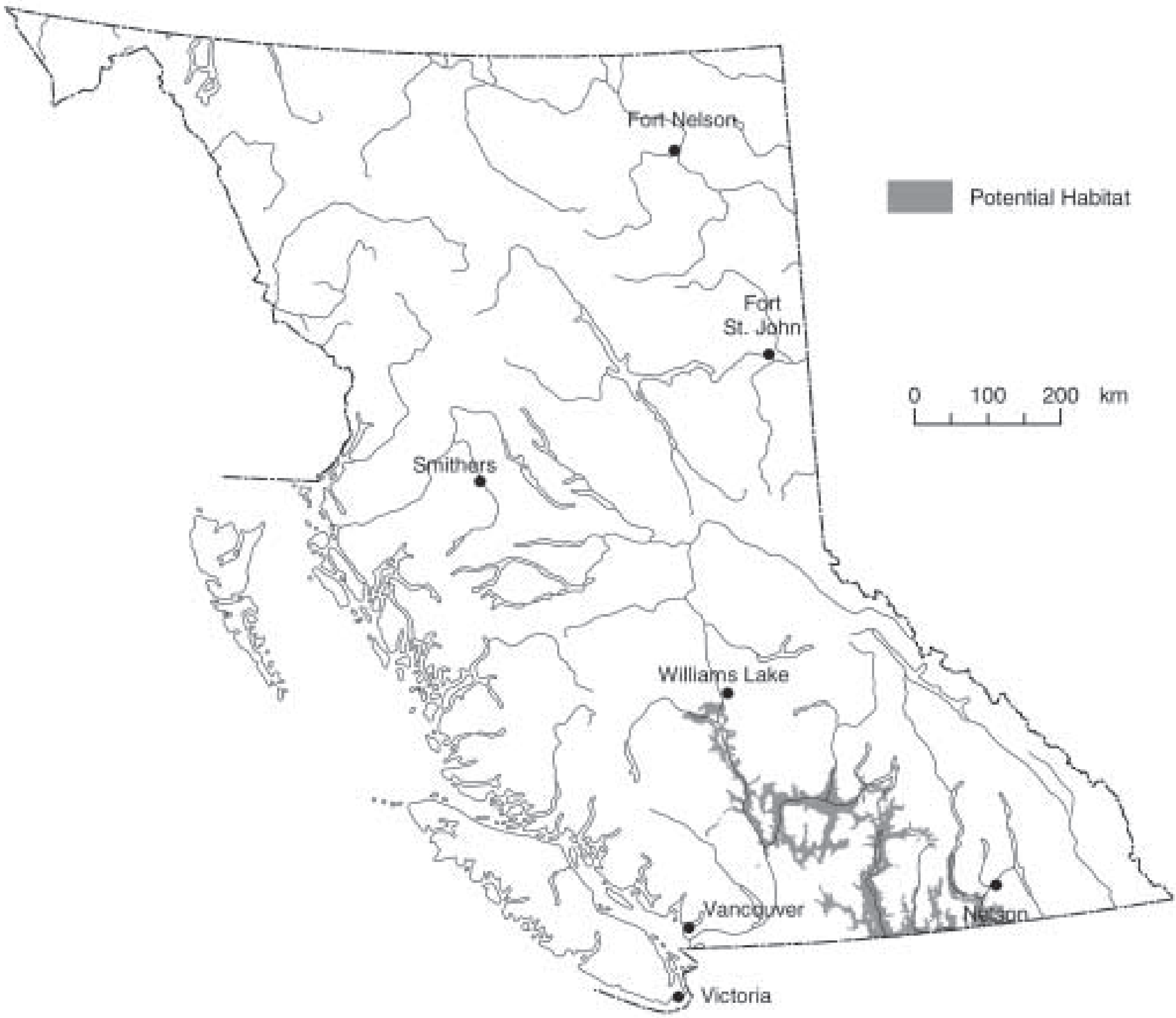
AB, BS, CF, CR, DF, DP, IH, LS, OV, PP, RO, SS

Elevation

Generally found at low to mid-elevations, up to almost 900 m in British Columbia (Sarell et al. 1997) and up to 1080 m in Washington State (Brown et al. 1995).

1 Volume 1 account prepared by C. Shewchuk.

Racer
(Coluber constrictor)



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

Diet and foraging behaviour

Racers are generalists, preying on small mammals, lizards, snakes, and insects (Brown et al. 1995). Racers are atypical of other British Columbia snake species, as they seem to demonstrate a greater dependency on vision when foraging and navigating. Prey are stealthily approached, ambushed, or chased. Unlike the scientific name implies, Racers do not constrict their prey but instead swallow their prey alive. Young Racers are suspected to feed predominantly on crickets and grasshoppers (Brown et al. 1995).

Reproduction

Racers mate shortly after emergence from winter dens. Between three to seven eggs are laid (June–July) in subterranean chambers on warm slopes. Racers will sometimes take advantage of other snake egg-laying sites and have been documented sharing egg-laying sites with Gopher Snakes (Shewchuk 1996). Eggs hatch almost 2 months after laying (August), although the development period is suspected to partially depend on incubation temperature (Shewchuk 1996).

Site fidelity

Racers are suspected to use the same den throughout their lives. Repeated use of summer home ranges is also suspected (Brown et al. 1995). The same egg-laying site may be used for several years.

Home range

Although these snakes are probably the most active of the snakes in British Columbia and are able to travel great distances over short periods, they tend to have discrete summer home ranges (Brown et al. 1995). Home ranges are usually located within 1 km of the den but one record shows a movement of almost 2 km (Brown et al. 1995). Daily movements of approximately 200 m have been documented within their home ranges during the summer foraging period (Shewchuk and Waye 1995).

Movements and dispersal

Snakes emerge in late March and April and travel from the den before mating in May. Racers have been reported to travel up to 1.8 km from the den to reach summer range (Brown et al. 1995). During the summer, daily movements are typically small (<100 m); however, gravid females may make larger journeys (>500 m) to reach egg-laying sites in July.

Habitat

Structural stage

Racers are most common in non-forested ecosystems. Where they do occur in forested habitats, they seem to prefer openings (Sarell et al. 1997; Sarell and Alcock 2000). Structural stage does not appear to be important, providing the canopy is not closed. It is not known whether Racers are impacted by grassland seral condition but it is possible that a reduction in cover may lead to greater predation. They can be found in all range conditions, however, they are more conspicuous in grazed grasslands.

Important habitats and habitat features

Denning

Racers hibernate during the winter (November through March). Dens may be used by solitary individuals but most often Racers share their den with other individuals and often den communally with other species of snakes (Brown and Parker 1976; Macartney 1985; Charland 1989; Radke 1989; Sarell 1993) such as Gopher Snakes and Western Rattlesnakes (*Crotalus oreganus*).

Dens are usually found on warm slopes in rock outcroppings or talus (Sarell 1993) in grasslands or open forest habitats. Den sites are suspected to be used in consecutive years, which may reflect a scarcity of special conditions required for suitable refuge from winter conditions. Den sites have also been found on warm slopes of unconsolidated material, usually glacio-fluvial deposits (Sarell and Alcock 2000). These dens house fewer individuals and are probably transitory due to gradual sloughing. Evidence from Washington State suggests that Racers are also able to den in small mammal burrows under the base of shrubs (Folliard and Larsen 1990).

Breeding

Eggs are laid in subterranean chambers on warm slopes. These chambers are sometimes excavated in soft, sandy banks although females will more typically use abandoned rodent burrows when available.

In the south Okanagan, egg-laying sites have been found near the crest of a sandy hill, with little surrounding vegetation (Shewchuk and Waye 1995; Shewchuk 1996).

Foraging

Foraging habitats are most often shrub-steppe and grasslands (Matsuda et al., in press), although open forests and riparian areas are also used.

Conservation and Management

Status

The Racer is on the provincial *Blue List* in British Columbia. It is designated as *Not at Risk* in Canada (COSEWIC 2002).

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

BC	CA	OR	ID	MT	WA	Canada	Global
S3S4	S5	S4?	S5	S5	S5	N4	G5

Trends

Population trends

Racers often appear to be the most abundant snake in arid ecosystems. Estimating their apparent relative abundance is misleading, as they are active during the day and are obvious when active, which increases the probability of detection. Populations seem to be most abundant in the south Okanagan and Lower Similkameen. Population studies have not been conducted but Racers are one of the most commonly killed snake species on roadways (M. Sarell, pers. obs.). It is suspected that population declines are widespread and significant (Campbell and Perrin 1990).

Habitat trends

The arid landscapes occupied by Racers probably remained suitable during the mining and ranching eras but intensive agricultural developments and rapid urbanization in recent years has significantly altered their habitats. In the late 1980s, it was calculated that about 10% of ecosystems in the south Okanagan remained relatively undisturbed (Redpath 1990).

Threats

Population threats

Populations are seasonally concentrated at den sites, causing this species to be susceptible to disturbance and local extirpation. Hibernating populations are vulnerable to mortality from earth-moving activities. During the summer, individuals are often killed by domestic cats and humans when they are encountered in agricultural areas. Road construction, urban developments, utility construction, and quarrying are the most likely activities to impact communal dens. Individual Racers are prone to mortality from vehicle traffic, intensive agricultural practices, and domestic pets.

Habitat threats

In British Columbia, the main threat to this species is habitat loss due to human development. This includes urbanization, agriculture, and the development of utility corridors. Road mortality is also of concern. Human population growth, roads, and volume of traffic have increased over the last few years in the south Okanagan and are expected to continue to increase. Road use statistics are available for a number of highways in the south Okanagan (B.C. Ministry of Highways 1999). In the summer, use of paved roads ranged from 2872 vehicles per summer day just north of the Canadian border at Osoyoos to 20 017 vehicles per summer day on the highway near Penticton.

Livestock grazing may be a concern in heavily or intensively grazed grasslands. Impacts from grazing may include trampling, reduced movements during critical foraging and mating periods, changes to habitat structure that may result in increased predation, and reduced prey abundance (Macartney and Weichel 1989; Didiuk and Macartney 1999). However, the impacts of livestock grazing have not been well studied and results are contradictory.

Legal Protection and Habitat Conservation

Under the provincial *Wildlife Act*, the Racer is protected in that it cannot be killed, collected or held in captivity without special permits.

A number of communal dens occur within protected areas including Okanagan Mountain Provincial Park, Kalamalka Provincial Park, Throne Ecological Reserve, White Lake Protected Area, Kobau Provincial Park, Churn Creek Protected Area, as well as other areas managed for conservation (e.g., Nature Trust of BC). However, many communal dens are isolated from protected areas and continuums of habitat are not protected.

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. Wildlife habitat features may be used to protect den sites.

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

❖ Maintain and maximize connectivity between hibernacula and foraging habitats.

Wildlife habitat area

Goal

Maintain and link denning habitat, foraging habitat, travel corridors, and egg-laying sites within and between adjacent populations.

Feature

Establish WHAs for communal dens, especially multi-species dens, and talus slopes, rock outcrops, or cliff habitats identified to be important for the conservation of this species.

Size

Approximately 200–300 ha but will depend on site-specific factors such as area of suitable habitat, nearness to foraging areas, and egg-laying sites.

Design

The boundaries of the WHA should be designed to include and connect den sites, travel corridors, egg-laying sites, and important foraging areas.

General wildlife measures

Goals

1. Minimize disturbance and mortality, particularly road mortality.
2. Maintain critical structural elements such as rock outcrops, talus slopes, friable soils, coarse woody debris, concentrations of boulders, or other unconsolidated materials and vegetative cover.
3. Maintain microclimatic conditions of hibernacula.
4. Maintain moderate to dense cover to conceal snakes and maintain foraging opportunities.
5. Maintain riparian areas in a properly functioning condition.

Measures

Access

- Place roads as far as practicable from hibernacula and known snake travel corridors. Avoid construction between April and October when snakes are active. When recommended by MWLAP, rehabilitate temporary access roads immediately after use or gate less temporary roads to reduce traffic.
- Where determined to be necessary by MWLAP, use snake drift fences and drainage culverts at intersections of roads and known travel corridors. Drift fences should be ≥75 cm high. Length will vary by site depending on area used by snakes. Consult MWLAP for more

information. Seasonal use restrictions may be appropriate for some roads.
- Do not remove or disturb rock or talus.

Range
- Plan livestock grazing (e.g., timing, distribution, and level of use) to prevent trampling and maintain suitable vegetative cover (i.e., >15 cm stubble height in upland; >10 cm in riparian areas).
- Do not concentrate livestock within 200 m of den during spring dispersal (March/April) and fall (September/October) aggregations.
- Do not place livestock attractants or corrals within 200 m of den site.
- Do not trail livestock within 200 m of den site during spring and fall aggregations.

Pesticides
- Do not use pesticides.

Recreation
- Do not establish recreation sites within WHA.

Additional Management Considerations

Where migration routes from denning locations to summer habitats have been transected by roadways, use methods such as drift fences, culverts, or seasonal road restrictions, to allow the safe passage of snakes.

Rock climbing should be considered a disturbance at sensitive sites.

Riparian areas adjacent to WHAs should be managed or restored to ensure range foraging habitat is maintained.

Avoid converting areas adjacent to WHAs to an early seral grassland condition. Early seral stages may have less cover for concealing Racers from predators and may experience greater threats from trampling due to higher livestock pressures.

Information Needs

1. Identification of hibernacula sites and characteristics.
2. Dispersal behaviour from dens.
3. Foraging habitats.

Cross References

Bighorn Sheep, "Great Basin" Gopher Snake, Lewis's Woodpecker, White-headed Woodpecker, water birch – red-osier dogwood

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Birds

"Queen Charlotte" Goshawk

Accipiter gentilis laingi

Original prepared by Erica McClaren

Species Information

Taxonomy

Two subspecies of goshawks are recognized in British Columbia: *Accipiter gentilis atricapillus* and *A. gentilis laingi* (AOU 1957; Palmer 1988). The subspecies *A. gentilis laingi*, referred to as the Queen Charlotte Goshawk, was described from a type-specimen from the Queen Charlotte Islands by Taverner (1940). Taverner (1940) described the subspecies as being faintly to distinctly darker than *A. gentilis atricapillus*. Adults were described as sootier grey ventrally with the black cap and nape extending over the shoulders and interscapulars, dorsally (Taverner 1940). He described juveniles as having breast streaks that were very broad and deeper in colour than *A. gentilis atricapillus* and as darker brown, dorsally (Taverner 1940). This subspecies was thought to inhabit islands of coastal British Columbia, primarily the Queen Charlotte Islands and Vancouver Island (Taverner 1940). Later, *A. gentilis laingi* was also described as having shorter wing lengths (based on wing curvature) (Johnson 1989; Whaley and White 1994) and smaller toes than *A. gentilis atricapillus* (Whaley and White 1994). Whaley and White (1994) speculated that the ecological significance of *A. gentilis laingi*'s smaller size was for increased manoeuvrability through the dense coastal forests and an increased component of avian prey relative to mammalian prey in its diet.

Gavin and May (1995) conducted a genetic analysis of goshawks throughout North America using allozymes, random amplified polymorphic DNA (RAPDs), restriction fragment length polymorphism (RFLPs) of monomorphic RAPD generated bands, and microsatellites in their analyses. They concluded that goshawks exhibited very little genetic variation throughout their range but acknowledged that they did not include genetic samples from the Queen Charlotte Islands or Vancouver Island thus were unable to address whether *A. gentilis laingi* was a genetically distinct subspecies. Currently, the debate over the subspecific designation of *A. gentilis laingi* continues while further genetic analyses are being conducted by Sandra Talbot in Alaska. These analyses include blood samples from Vancouver Island, southeast Alaska, and the central coast of British Columbia, but only one sample from the Queen Charlotte Islands. Preliminary analyses suggest that goshawk populations in southeast coastal Alaska and Vancouver Island are genetically differentiated from populations in interior Alaska and British Columbia (S. Talbot pers. comm.).

Description

Queen Charlotte Goshawks are raven-sized (53–66 cm length; NGS 1999) forest-dwelling raptors with short rounded wings and long tails. Adults (>2 years) have a conspicuous light grey supercilium flaring out behind the eye that separates their black crown from their blue-grey back. Underparts are white with dense grey barring that appears light grey from a distance. In general, females are darker brown above as adults than males and have coarser grey barring on their undersides. The tail has bands of alternating light and dark. Adults have white and grey flecked undertail coverts that flare out when individuals are agitated or when they are conducting aerial displays. Adult eye colour varies from yellow to dark red and generally becomes darker with age. Immature goshawks (<2 years) have a faint light grey supercilium and are brown above and buffy below with thick, dark brown streaks. The tail has

Northern Goshawk - subspecies *laingi*
(Accipiter gentilis laingi)

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.

alternating brown and black bands, with white edges. Immature undertail coverts are white with brown tear-shaped streaks. Tarsi and toes are greenish grey to pale yellow as immatures, becoming yellow as adults, while talons appear bluish-black to black (Squires and Reynolds 1997). Feathers continue approximately midway down the front of the tarsus (Squires and Reynolds 1997). Intermediate plumages between immature, subadult, and adult ages are described by Bond and Stabler (1941) and Squires and Reynolds (1997). These descriptions are based on those outlined by Squires and Reynolds (1997), NGS (1999), and Sibley (2000).

References to goshawks throughout the remainder of this account apply to *A. gentilis laingi* unless reported as Northern Goshawk (*A. gentilis atricapillus* or *A. gentilis gentilis*).

Distribution

Global

Queen Charlotte Goshawks occur along the Pacific Coast from Vancouver Island north to the Alexander Archipelago in southeast Alaska, coastal mainland Alaska and Lynn Canal (Webster 1988; Titus et al. 1994; Iverson et al. 1996; Ethier 1999).

British Columbia

British Columbia contains the majority of the Queen Charlotte Goshawk population worldwide. The Queen Charlotte Goshawk occurs on Vancouver Island, the Queen Charlotte Islands, and smaller coastal islands between Vancouver Island and mainland British Columbia. Their distribution throughout coastal mainland British Columbia is unknown, but radio-tagged individuals from Vancouver Island have moved to breed on adjacent coastal islands (McClaren 1997, 1999). As well, two goshawks from Vancouver Island have moved to adjacent coastal mainland during the winter (McClaren 2000, 2001). Most likely, Queen Charlotte Goshawks also inhabit forests on the west side of the Coast Mountains throughout coastal mainland British Columbia.

Forest region and districts

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

Ecoprovinces and ecosections

COM: NIM, NWL, QCL, SKP, WIM, WQC, (CBR, HEL, OUF, SBR – possible)

GED: LIM, NAL, SGI, SOG, (GEL – possible)

Biogeoclimatic units

CDF: mm

CWH: dm, mm, vh, vm, wh, xm

MH: mm, wh

Broad ecosystem units

CB, CD, CH, CR, CW, DA, FR, HL, HS, SR, YB

Elevation

Documented to breed between sea level and 900 m (Iverson et al. 1996; McClaren 2003) but may use higher elevations for foraging throughout the year (McClaren 1997, 1998, 1999; D. Doyle, pers. obs.).

Life History

Diet and foraging behaviour

Goshawks are considered opportunistic hunters, foraging on a variety of medium-sized birds and mammals throughout the year (Squires and Reynolds 1997). The majority of data on diet has been collected from goshawks during the breeding season (Vancouver Island: Ethier 1999; E.L. McClaren, unpubl. data; southeast Alaska: Iverson et al. 1996; Lewis 2001; Olympic Peninsula: Bloxton, in prep.). Most prey items include forest dwelling birds and mammals. Red Squirrels (*Tamiasciurus hudsonicus*), thrushes, jays, woodpeckers, Marbled Murrelet (*Brachyramphus marmoratus*), and grouse were the main prey in pellets found below active nest sites on Vancouver Island (Ethier 1999; E.L. McClaren, unpubl. data). Goshawk pellets from southeast Alaska contained similar prey species as those from Vancouver Island, but they had a higher component of members from the Alcidae family and Northwestern Crows (*Corvus caurinus*) (Iverson et al. 1996). Only anecdotal evidence is available to describe the prey items goshawks use during the winter. However, because fewer prey species are available to goshawks during the winter, certain species may be critical to goshawks during this time.

The rounded wings and long tail of goshawks make them well suited for manoeuvring through forested habitats while hunting. However, few data have been collected from radio-tagged birds while they are foraging or at kill sites. Therefore, our knowledge of Queen Charlotte Goshawk foraging habitat characteristics is limited (Squires and Reynolds 1997).

Reproduction

Queen Charlotte Goshawks typically do not breed until they are >2 years although, occasionally, they will breed in their second year (McClaren 2003). Individuals return to their breeding sites between early February and late March (ADFG 1996; E.L. McClaren, unpubl. data). Courtship consists of aerial displays, dawn vocalizations, nest building/repair, and frequent copulation, and occurs between February and early April, with peak activity occurring in March (Beebe 1974; Chytyk et al. 1997; A. Zeeman, unpubl. data). One to four eggs are laid mid- to late April and incubation (by the female primarily) occurs for 30–32 days (Beebe 1974; Iverson et al. 1996; E.L. McClaren, unpubl. data). During late courtship and early incubation, the female is primarily fed by the male (Cooper and Stevens 2000). Hatching occurs between late May and mid-June with typically one to three young fledging after 38–42 days in early to mid-July (ADFG 1996; McClaren and Pendergast 2002). Females assist males with hunting during the second half of the nestling phase; however, the timing varies and is influenced by brood size, food supply, and the male's hunting performance (Squires and Reynolds 1997; Dewey and Kennedy 2001). Fledglings remain near the nest (the post-fledging area [PFA]) for 40–60 days, after which they disperse and become independent of adults (Kenward et al. 1993; Kennedy et al. 1994; McClaren and Pendergast 2002). Dispersal occurs between early August to early September (Iverson et al. 1996; McClaren and Pendergast 2002).

Site fidelity

Nest site fidelity is the occupancy of the same nest area, by the same individual or pair of goshawks, in subsequent breeding seasons (Reynolds and Joy 1998). Nest site fidelity in goshawks is difficult to estimate because breeding goshawks can be secretive, making detection of alternative nest site locations and banded individuals laborious. Overall, site fidelity for the Queen Charlotte Goshawk appears to be greater for males than females, which concurs with studies on Northern Goshawks (California: Detrich and Woodbridge 1994; Arizona: Reynolds and Joy 1998). Studies in southeast Alaska have shown that radio-tagged males exhibit high site fidelity, whereas some females moved to new nest areas and mated with different males (Iverson et. al. 1996). All areas that females dispersed to included a portion of their winter home range (Iverson et al. 1996). On Vancouver Island, turnover rate of marked females was 78.9% (n = 57) with a maximum turnover rate of six consecutive years of occupancy by six different females within one nest area (McClaren 2003). It was not possible to calculate turnover rates for males because trapping success for males was less successful. Similar to southeast Alaska, breeding dispersal movements by radio-tagged males on Vancouver Island have not been observed (E.L. McClaren, unpubl. data). Between 1995–2002, goshawks on Vancouver Island used nest trees 1.6 years ($n = 72$), on average, similar to other studies in North America (Squires and Reynolds 1992; McClaren 2003).

Home range

The size of goshawk breeding home ranges varies according to the familiarity of individuals with their home range, differences in hunting efficiency, food requirements (brood size), and food availability (Kennedy et al. 1994). For example, in California, breeding home ranges averaged 1280 ha ($n = 5$) for Northern Goshawk females and 1880 ha ($n = 5$) for males (Keane and Morrison 1994) whereas in southeast Alaska, breeding home ranges for Queen Charlotte Goshawks averaged 19 215 ha ($n = 8$) for females and 5847 ha ($n = 8$) for males (Titus et al. 1994). In southeast Alaska, female breeding season home ranges were primarily <1000 ha; however, two females made large movements away from their breeding areas during the post-fledging period, dramatically increasing estimates of mean breeding season home range size (Titus et al. 1994). In southeast Alaska, goshawks travel among small islands to forage, thereby increasing travel distances to find food. Breeding home range size estimates for Queen Charlotte Goshawks in other parts of their range are not available. However, nesting density, the distance between adjacent active nests, may approximate breeding home range size. In the Nimpkish Valley and Gold River on Vancouver Island, mean nesting density for goshawks is 6.9 ± 0.7 ($n = 16$) (McClaren 2003).

Goshawk breeding home ranges appear to be composed of a nest area, PFA, and foraging area (Reynolds et al. 1992). The nest area often contains several alternative nest trees, roost trees, plucking posts, and is the centre of courtship behaviour and fledgling movements during the early post-fledging period (Reynolds et al. 1982; Kennedy et al. 1994; McClaren and Pendergast 2002). Goshawk nest areas may or may not be contained within the same forest stand (Reynolds et al. 1992; Squires and Reynolds 1992). Nest areas vary in size and shape depending on topography and the availability of suitable habitat (Reynolds 1983; Ethier 1999). On Vancouver Island, 95% of alternative nest trees within a nest area occur within 800 m of each other, suggesting that nest areas on Vancouver Island are approximately 200 ha (McClaren 2001). Although several nest trees occur <800 m from one another, the likelihood of locating nests farther is less. Therefore, 200 ha is a conservative estimate of the actual nest area. Because alternative nest spacing appears to be greater for the Queen Charlotte Goshawk than for the Northern Goshawk (Iverson et al. 1996; McClaren 2001; McClaren and Pendergast 2002), nest area size is more comparable to post-fledging size in this subspecies.

The PFA is the area used by fledglings before they become independent of adults and disperse (Kennedy et al. 1994). The PFA surrounds and includes the active nest area and corresponds roughly with the female core-use area (Kennedy et al. 1994). Post-fledging areas vary in size. Kennedy et al. (1994) reported a mean size of 170 ha for *A. gentilis atricapillus,* whereas estimates from the Kispiox and Lakes areas of British Columbia suggest PFA size is much smaller, averaging <20 ha (Doyle and Mahon 2000; Mahon and Doyle 2001). Both these PFA estimates for Northern Goshawks are smaller than the estimated nest area and PFA size for Queen Charlotte Goshawks. Preliminary data suggest that PFAs on Vancouver Island are similar in size to those originally proposed by Reynolds et al. (1992) and Kennedy et al. (1994) (McClaren and Pendergast 2002). Research on radio-tagged fledglings on Vancouver Island in 2001 and 2002 suggests PFA size for Queen Charlotte Goshawks is approximately equivalent to nest area size (McClaren and Pendergast 2002). Post-fledgling area size estimates from 12 fledglings on Vancouver Island was 58.6 ± 11 ha. Allowing for multiple PFAs around alternative nests and some buffering from edge suggests a nest area PFA size of 200 ha. Larger PFA estimates for Queen Charlotte Goshawks than for Northern Goshawks may result from lower prey densities and larger home ranges in coastal forests than interior forests.

Foraging areas make up most of an individual's breeding home range and they are comprised of the areas where adult male and female goshawks hunt. Foraging areas may include the nest area and PFA. It is believed adult males do not hunt directly within the nest area and PFA to maintain locally abundant food supplies for adult females and for fledglings when they are learning to hunt (Kennedy et al. 1994). Foraging areas vary in size among locales and among individual goshawks according to the experience of individuals within their breeding home range, differences in their hunting efficiency, food requirements (brood size), and the availability of food within their home ranges (Kennedy et al. 1994). Few studies have estimated the foraging area size for Queen Charlotte Goshawks because limited information is available on goshawk foraging activities. Most often, the size of the foraging area is based on breeding home size for goshawks with the assumption that goshawks forage widely throughout their home range. Research conducted on Northern Goshawks suggests that goshawks spend disproportionately more time foraging in mature forests within their home ranges (Bright-Smith and Mannan 1994; Good 1998; Stephens 2001).

Movements and dispersal

It appears that Queen Charlotte Goshawks do not undergo annual large-scale southward migrations (Iverson et al. 1996; McClaren 2003). Rather, males remain closer to nest areas than females and both sexes establish winter home ranges that may include part of their breeding home ranges (Iverson et al. 1996). On Vancouver Island, three females have moved between Vancouver Island, the islands off Vancouver Island's east coast, and the mainland coast (McClaren 2003). It is unknown whether Queen Charlotte Goshawks partake in cyclic massive invasions southward that have been reported for Northern Goshawks (Mueller and Berger 1967; Hofslund 1973; Mueller et al. 1977). Two radio-tagged females on Vancouver Island moved to nest in different nest areas in subsequent years (McClaren 2003). Breeding dispersal ranged from 4–12 km. Minimal information is available for goshawk juvenile dispersal. In southeast Alaska, radio-tagged juveniles (n = 23) were relocated between 11.2–161.6 km from natal areas 9–319 days after dispersal (Iverson et al. 1996). On Vancouver Island, fledglings could not be located from the ground or air within 1 week after dispersal (McClaren and Pendergast 2002). These results suggest that fledglings may move large distances from their natal territories immediately after dispersal.

Habitat

Structural stage

5: young forest (under certain conditions, may be used but is generally not preferred)
6: mature forest
7: old forest

A few nests occur in highly productive growing sites in forests in structural stage 5. Nests in these younger structural stages are typically in red alder (*Alnus rubra*) along creek beds within predominantly coniferous forests or in coniferous trees that have multiple leaders (McClaren 1998).

Important habitats and habitat features

Nesting

Queen Charlotte Goshawks appear to nest in a variety of forest types throughout their range and therefore their breeding habitat associations are difficult to characterize (Iverson et al. 1996; Ethier 1999; McClaren 2003). Although varied, the coastal forests goshawks breed in share common characteristics including: 1) >45 years (structural stages 5–7); 2) multi-layered canopies; 3) structurally diverse; 4) canopy closure >50%; 5) large diameter trees for the locale; 6) snags and coarse woody debris; 7) typically not along forest/non-forest edges; 8) not near urban areas; and 9) generally nests are on the lower 2/3 of slopes where slope gradient is <40° (Iverson et al. 1996; Daw et al. 1998; Ethier 1999).

Within these forest stands, goshawks build their nests in several tree species, and typically, nest trees include the largest trees in the stand (Reynolds et al. 1992; Iverson et al. 1996; Ethier 1999). Most often, goshawks breeding in coastal forests select western hemlock (*Tsuga heterophylla*), Douglas-fir (*Pseudotsuga menziesii*), Sitka spruce (*Picea sitchensis*), and red alder for nest trees at elevations <900 m (Iverson et al. 1996; Ethier 1999; McClaren 2003). On Vancouver Island, Ethier (1999) reported goshawk nest trees were immediately surrounded by forests with lower tree densities and larger dbh than forests outside the nest stands, whereas forest characteristics not immediately around nests but surrounding nests, were denser and had smaller dbh. He suggested goshawks might breed in forests with these characteristics to increase manoeuvrability within the nest stand while increasing their protection from predators with higher tree densities surrounding the nest stand.

Post-fledging

Post-fledging areas are considered important habitat for young goshawks because fledglings are learning to fly and hunt, making them extremely vulnerable to predation during this time (Reynolds et al. 1992; Kennedy et al. 1994; Daw and DeStefano 2001). Post-fledging areas are characterized by an abundance of the habitat attributes critical for goshawk prey (snags, coarse woody debris), and by extensive canopy cover (>50%) which provides protection to fledglings learning to fly and hunt (Reynolds et al. 1992; Kennedy et al. 1994; Daw and DeStefano 2001).

Foraging

Minimal information on the habitat of goshawk kill sites is available for Queen Charlotte Goshawks. Goshawks appear to be opportunistic in their hunting habitats as long as prey is available to them. In Arizona, Beier and Drennan (1997) reported that radio-tagged *A. gentilis atricapillus* were foraging in sites that had a higher canopy closure, greater tree density, and a greater density of large diameter trees than forests that were available to them. Importantly, the areas used by these goshawks for foraging did not have the highest abundance of prey species within their study area; foraging occurred in areas where prey were most available to goshawks because the forest structure was conducive for them to capture prey (Beier and Drennan 1997). It is unknown how important habitat edge zones, subalpine/alpine areas, and estuaries are as foraging habitat for the Queen Charlotte Goshawk. As well, it is unclear how patch size influences the suitability of forests for goshawk foraging habitat. In southeast Alaska, radio-tagged goshawks included beach/forest edge zones in their foraging habitat (Iverson et al. 1996). Although most locations of goshawks on Vancouver Island during the winter occurred in large patches of old-growth forests, some locations occurred in high-elevation forests, subalpine areas, and in estuaries (McClaren 1997, 1998, 1999).

Winter

Winter habitat requirements for the Queen Charlotte Goshawk are unclear. In southeast Alaska and on Vancouver Island, it appears that goshawks are partial migrants, remaining within 10–100 km of their nest. In some years satellite-tagged females on Vancouver Island moved to a separate winter area but in other years expanded their breeding home ranges to include their winter range (Iverson et al. 1996; McClaren 2003). Winter locations from a low-intensity radio telemetry study on Vancouver Island suggest goshawks spend disproportionate amounts of time in mature and old-growth forests throughout the winter (McClaren 1997, 1998, 1999). As well, several locations occurred in high elevation older forests, suggesting goshawks forage on grouse and ptarmigan during the winter. In southeast Alaska, 58% of combined breeding and non-breeding season goshawk habitat use was in very high to moderately productive old-growth forests and 30% of habitat use was in mature sawtimber, scrub forest, and low productivity old-growth forests (Iverson et al. 1996). Habitat use patterns did not significantly differ between the breeding and non-breeding seasons in southeast Alaska (Iverson et al. 1996).

Conservation and Management

Status

The Queen Charlotte Goshawk is on the provincial *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)

BC	AK	Canada	Global
S2B, SZN	S2	N2	G5T2

Trends

Population trends

Population trends are not known in Alaska and British Columbia (Iverson et al. 1996; Cooper and Stevens 2000). Most goshawk studies have focussed on describing goshawk habitat associations rather than on determining their demographic rates. Birth rates for the Queen Charlotte Goshawk, estimated by the number of young fledged/active nest (the number of young in the nest approximately 1 week prior to fledging; Steenhof 1987), was 1.6 ± 0.1 S.E. (n = 141 breeding events) on Vancouver Island (McClaren 2003). Mean nest productivity on Vancouver Island varied significantly among years within the same nest areas which suggests that prey and weather are important factors influencing goshawk reproduction (McClaren et al. 2002). Mean nest productivity values could not be calculated for goshawk nests in the Queen Charlotte Islands because sample sizes were too small, but for one to two active nests per year, nest productivity in the Queen Charlotte Islands ranged from 0 to 2 young (Chytyk and Dhanwant 1999). In southeast Alaska, a mean number of two young fledged per nest attempt (Flatten et al. 2001). Adult and juvenile survivorship information is scarce for *A. gentilis laingi*. In southeast Alaska, Iverson et al. (1996) estimated survivorship of radio-tagged adults (sexes combined) to be 0.72 (n = 39; 95% CI = 0.56–0.88) between July 1992 and August 1996. They used a staggered-entry Kaplan-Meier estimator (Pollock et al. 1989) for their data analysis (Iverson et al. 1996). The annual survival rate of juveniles has not been estimated for *A. gentilis laingi.* Radio telemetry data from Vancouver Island for adult goshawks suggest that adults have high overwinter mortality rates (McClaren 2003). However, survival estimates on Vancouver Island may be biased high due to the possibility of elevated mortality rates of birds induced by the extra weight from backpack radio transmitters. Although evidence for detrimental effects of backpack transmitters on goshawk survival throughout North America and Europe is lacking, it may be a concern for radio telemetry studies on smaller *A. gentilis laingi*.

Habitat trends

Typically, Queen Charlotte Goshawks breed in mature and old forests throughout their range (Titus et al. 1994; Chytyk et al. 1997; McClaren 2003), which are economically valuable to forest companies for timber harvest. Thus, with the continued harvest of potential goshawk breeding habitat, there will be a shift in forest age and structural stage class distribution, and increased exposure of interior forest areas to edge influences as the landscape becomes more fragmented and human intrusion expands into these forests through access roads. It is predicted that this will decrease the amount of suitable breeding habitat available to *A. gentilis laingi* throughout its range (Iverson et al. 1996; DeStefano 1998; Cooper and Stevens 2000). Reduced age of forest harvesting (i.e., decreased rotation periods) is expected to further reduce the availability of suitable breeding habitat because forests will be harvested before they obtain the structural attributes that characterize goshawk nest stands (DeStefano 1998). Furthermore, older forests may suffer from increased 'natural' disturbances (e.g., fire, wind-throw, snowpress), as they become more fragmented and vulnerable to the natural elements and to human-induced forest fires.

The influence of forest harvesting and natural disturbances on the suitability of foraging habitat for goshawks in the future is less clear. Goshawks may be forced to increase their breeding home range size in order to gather sufficient prey to raise young as landscapes become more fragmented around their nest sites. The influence of forest harvest practices on the abundance and availability of goshawk prey species is less clear because goshawks appear to be opportunistic hunters during the breeding season. However, because Queen Charlotte Goshawks typically do not forage within younger forests, access to most forest prey will be reduced as the overall distribution of forest age class across the landscape becomes younger and a shorter harvest rotation time is practiced. In southeast Alaska, Queen Charlotte Goshawks avoided young forests and clearcuts during radio telemetry studies (Iverson et al. 1996).

Because little information regarding the habitat needs of Queen Charlotte Goshawks in the winter is available, it is difficult to predict future trends for their winter foraging habitat. Regardless, the availability of suitable winter foraging habitat is likely essential for the persistence of Queen Charlotte Goshawk populations because they may be heavily reliant on important prey species during the winter when fewer prey species are available to them. Winter foraging success for goshawks determines the body condition that they enter the breeding season in and therefore, determines whether they initiate breeding within a given year.

Threats

Population threats

Since the early-mid 1900s, Queen Charlotte Goshawk populations do not appear to be threatened by shooting and trapping. Pesticides and other contaminants have not been examined in Queen Charlotte Goshawk populations but Snyder et al. (1973) reported pesticide levels in *A. gentilis atricapillus* populations to be low.

The influence of human disturbances on goshawk populations has not been studied in an experimental framework. However, human disturbances around nest sites appear to have caused *A. gentilis atricapillus* to abandon nests during courtship, incubation, and in the early nestling phase (Boal and Mannan 1994; Squires and Reynolds 1997; Toyne 1997), with fewer effects during the late nestling and fledgling-dependency phases (Toyne 1997). Furthermore, Bosakowski and Speiser (1994) and Bosakowski and Smith (1997) reported *A. gentilis atricapillus* avoided urban areas for nesting. The relationship between human disturbance and the ability for goshawks to nest successfully appears to vary according to an individual's tolerance level. Adults are more sensitive early in the breeding season than they are later on, when they have invested more energy in raising their young.

Habitat fragmentation may result in other raptors better suited to edge habitats such as Red-tailed Hawks (*Buteo jamaicensis*), Great Horned Owls (*Bubo virginianus*), and Barred Owls (*Strix varia*) outcompeting goshawks for nest sites. As well, predation rates on adults and young may increase as nest and roost sites become more accessible to edge dwelling predators such as Great Horned Owls, Raccoons (*Procyon lotor*), American Marten (*Martes americana*), and Fisher (*Martes pennanti*). In fragmented landscapes within Wisconsin, Erdman et al. (1998) documented increased competition by Red-tailed Hawks with *A. gentilis atricapillus* populations, and increased nest predation rates from Great Horned Owls and Fisher. On Vancouver Island, no other species have been observed using known goshawk nest sites, suggesting that competition for nest sites with other species is not high at this time. Iverson et al. (1996) reported nestling predation rates to be low in southeast Alaska. Predation on nestlings and fledglings has been observed on Vancouver Island. However, it is unclear how predation regulates goshawk populations (E.L. McClaren, unpubl. data; McClaren and Pendergast 2002). As well, predation rates on goshawks during their first years are unknown. On the Queen Charlotte Islands, one nest was depredated by a raccoon (P. Chytyk, pers. comm.).

Habitat threats

Breeding, roosting, foraging and winter habitat loss, fragmentation, and degradation from forest harvesting pose the greatest threats to Queen Charlotte Goshawk populations (Iverson et al. 1996; Cooper and Stevens 2000). Although the influence of habitat fragmentation on goshawk populations remains unclear, habitat loss through the conversion of older forests to early seral stages will likely affect goshawk reproduction and survival over time. Risks associated with forest fragmentation and the conversion of older forests to younger ones include: 1) a reduced number of suitable nest areas; 2) decreased prey species abundance and accessibility; 3) increased competition and predation from edge-adapted species; 4) reduced juvenile dispersal and gene flow; 5) increased human access and disturbance; and 6) altered microclimate conditions within interior forests. Altered microclimate conditions may expose adults to inclement weather and influence their thermoregulatory capabilities, reducing their survival directly or their ability to successfully incubate eggs and brood young. For example, North et al. (2000) demonstrated that reproduction in "California" Spotted Owls (*Strix occidentalis occidentalis*) was higher when nest site canopy cover was greater because canopy influenced nest site microclimate.

Legal Protection and Habitat Conservation

The Queen Charlotte Goshawk, its nests and eggs are protected under the provincial *Wildlife Act*. Capture of wild birds for falconry has been closed on Vancouver Island and on the Queen Charlotte Islands since 1994 (Cooper and Stevens 2000). Even prior to the 1994 closure, few Queen Charlotte Goshawks were captured for falconry in British Columbia, as most falconers preferred to take the larger, Northern Goshawk individuals (M. Chutter, pers. comm.).

On Vancouver Island, goshawk nests have been located in Walbran, Strathcona, and Gold/Muchalat Provincial Parks and the Nimpkish Island ecological reserve, and likely occur in several other provincial parks and ecological reserves on Vancouver Island. Several parks throughout the Queen Charlotte Goshawk range consist primarily of unsuitable habitat (i.e., >900 m that is steep open forest canopy or non-forested).

The provisions enabled under the *Forest and Range Practices Act* that may maintain suitable habitat for this species include ungulate winter ranges (UWRs), old growth management areas (OGMAs), wildlife tree retention areas, and riparian management areas. However, the ability of these areas to provide patches that are large enough to be suitable breeding habitat (i.e., 200 ha PFAs) is limited. Preliminary analysis of UWR size on Vancouver Island indicates that roughly <4% of current UWRs are of suitable size for a goshawk PFA (D. Doyle, unpubl. data). Although, these other mechanisms may be useful, particularly when used in conjunction with wildlife habitat areas (WHAs), their stand-alone utility to provide suitable goshawk breeding habitat is limited. They may be used to provide foraging habitat for goshawks around PFAs.

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

Because goshawks have large breeding and winter home ranges and often build multiple nests within breeding areas throughout their lifetime, it may be more effective to address the requirements of this species at the landscape level to ensure that suitable goshawk breeding, foraging, and wintering habitat exists throughout the landscape (i.e., outside of designated WHAs) in addition to maintaining known nest sites. Winter habitat, which is currently not considered in this document, may be equally as important to long-term goshawk persistence as protecting their breeding habitat. However, in the absence of winter habitat data for goshawks, it is difficult to make winter habitat recommendations at this time but should be revisited when data become available.

- ❖ Ensure that late structural staged forests (structural stages 5–7) <900 m asl are represented throughout the forested land base so that both established and dispersing goshawks will have an opportunity to breed and forage in favourable habitats.
- ❖ Ensure that late structural staged forests exist in large patch sizes equally as often as small patch sizes and that connectivity between late structural staged forest patches is maintained.
- ❖ Ensure that suitable breeding habitat for goshawks occurs every 6–8 km, the current goshawk nesting density observed within some areas on Vancouver Island.
- ❖ Maximize retention of and connectivity between suitable nesting, post-fledging and foraging habitats.
- ❖ Maintain suitable foraging habitat in close proximity to known nests, particularly within the immediate 2200 ha surrounding the PFA. Although foraging areas can be much larger than 2200 ha for goshawks (i.e., goshawks forage throughout their breeding home range), this represents the core foraging area in the breeding season since it is in closest proximity to the PFA.

- ❖ Utilize OGMAs, UWRs, and WTR areas to buffer goshawk 200 ha PFAs to protect their integrity and to provide foraging habitat around PFAs.
- ❖ Minimize the influence of harvesting adjacent to PFAs to maintain the stand's integrity (e.g., wind firmness).

Wildlife habitat area

Goal

Maintain breeding habitat at known goshawk nests to ensure that breeding pairs may successfully raise their young to dispersal.

Feature

Establish WHAs in areas with known goshawk nest trees. Typically, WHAs should be placed around nesting areas where occupancy and nest productivity patterns are known. Determining re-occupancy and breeding success of goshawk breeding areas is extremely difficult given their use of several alternative nest trees within their breeding area in successive years (Squires and Reynolds 1997). As well, goshawks can be very secretive and difficult to detect using existing survey techniques (McClaren 2001). Because goshawks do not breed every year, a nest area may be inactive one year but active in following years. Thus WHAs should only be removed if the habitat has changed since the establishment of the WHA and is now considered unsuitable goshawk breeding habitat.

Foraging areas within 2200 ha of the PFA should be maintained through coarse filter mechanisms such as UWR, OGMAs, WTR areas, riparian management areas, retention harvesting, and other landscape level planning strategies. When these other mechanism cannot address foraging habitat requirements within 2200 ha of goshawk PFAs, foraging areas (amount to be determined on a site specific basis), can be incorporated within the WHA. This may be required in areas such as the Queen Charlotte Islands where UWR areas are not in place.

Currently, information regarding habitat features that enhance goshawk overwinter survivorship is unavailable and therefore, they cannot be addressed in this document.

Size

Approximately 200 ha but will depend on site-specific factors such as the terrain, habitat distribution, the distribution of OGMAs and UWRs, whether foraging habitat is included within the WHA, and the predicted harvesting regime in future years.

Design

The WHA should include suitable post-fledging habitat (see "Important habitats and habitat features"). The size and shape of the WHA should be determined by the existing habitat and future habitat projections for the breeding habitat and surrounding area. The area around the active nest should be searched for alternative nest trees, plucking posts, and roost sites by a qualified biologist. Ideally, observations and vocalizations of juveniles and their sign during the post-fledgling period should also be used to determine WHA boundaries. Sign includes whitewash, plucking posts, down, and pellets. In addition, consider connectivity with larger stands to prevent stand isolation. Fragmentation may lead to higher predation rates and increased competition for nest sites by edge-adapted predators and competitors. Stand isolation may also threaten the WHA integrity through windthrow.

When sufficient foraging habitat cannot be maintained within the surrounding 2200 ha of the goshawk PFA through alternate mechanisms, it should be incorporated into the WHA. Habitat characteristics and prey transects should be used to determine the boundaries of foraging areas within the WHA.

Manage the PFA as the core area and foraging habitat (if included) as the management zone.

General wildlife measures

Goals

1. Prevent disturbance and abandonment of breeding goshawks.
2. Maintain important breeding and foraging habitat features within core area (PFA).
3. When foraging habitat is included within WHA, maintain suitable foraging habitat and habitat features.

Measures

Access

- Do not construct roads within core area.

Harvesting and silviculture

- Do not harvest or salvage (e.g., cedar) within core area.
- Develop a management plan for harvesting and road development within the management zone that is consistent with the general wildlife measure goals.
- Do not commercial thin within core area. Commercial thinning may occur within the management zone provided the activities promote the structural characteristics of forests for goshawk foraging (e.g., low density thinning of young seral stages to promote older structural attributes).

Pesticides

- Do not use pesticides.

Additional Management Considerations

Minimize disturbance when working adjacent to a WHA between 15 February and 1 September. In general, avoid blasting, road construction, helicopter activity or other prolonged disturbance.

Information Needs

1. Relationship between habitat components and goshawk reproduction and survival. These include the minimum patch size of PFAs and degree of surrounding landscape fragmentation that maintains successful (minimum one young fledged) occupancy by breeding goshawks and breeding over time.
2. Influence of forest harvest practices on goshawk prey species abundance/availability during the breeding and non-breeding seasons and ability of forest enhancement techniques (e.g., thinning) to improve younger forests for goshawk breeding and foraging areas.
3. Goshawk winter habitat associations and prey use.

Cross References

Great Blue Heron, Marbled Murrelet, "Queen Charlotte" Hairy Woodpecker, "Vancouver Island" Northern Saw-whet Owl

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"Queen Charlotte" Northern Saw-whet Owl

Aegolius acadicus brooksi

Original prepared by R.J. Cannings

Species Information

Taxonomy

The genus *Aegolius* is a New World taxon consisting of four species; two are resident in the neotropics, another is widespread across the boreal forests of the Northern Hemisphere, and the fourth, the Northern Saw-whet Owl, is restricted to temperate forests in North America. *Aegolius acadicus brooksi* is the only subspecies of the Northern Saw-whet Owl other than the nominate form that occurs throughout the remainder of the range. *A. acadicus brooksi* is separated from the nominate form on the basis of colouration—the white spotting on the dorsal feathers of the nominate form is replaced by rich buff spotting in *A. acadicus brooksi* (Flemming 1916; Cannings 1993; Sealy 1998). The vocalizations of the two forms are similar, but tend to be higher pitched in *A. acadicus brooksi* (R.J. Cannings, unpubl. data).

Description

A tiny owl (male 75 g; female 100 g), with small head and no ear tufts. Sexes alike. Upper parts greyish to reddish brown, finely spotted with buffy white especially top of head, scapulars, and wings; around back of neck a narrow half-collar of mixed black and white. Lower breast and abdomen, white striped with dark brown. Tail dark brown with six or seven white cross-bars. Yellow eyes.

Distribution

Global

The Northern Saw-whet Owl breeds throughout southern Canada and the northern United States, south at higher elevations to South Carolina in the Appalachians and Oaxaca in the western cordillera. *A. acadicus brooksi* is restricted to the Queen Charlotte Islands (Cannings 1993).

British Columbia

The Queen Charlotte subspecies is a non-migratory resident on the Queen Charlotte Islands. There are a few records of individuals of the mainland population (*A. acadicus acadicus*) migrating through the Queen Charlottes, but no records of *A. acadicus brooksi* from the mainland (Sealy 1998).

Forest region and district

Coast: Queen Charlotte Islands

Ecoprovinces and ecosections

COM: QCL, SKP, WQC

Biogeoclimatic units

CWH: vh1, wh1, wh2

Broad ecosystem units

Breeding: primarily HS, some CH
Foraging: CB, CH, HS, SR

Elevation – (breeding)

0–1220 m

Life History

Diet and foraging behaviour

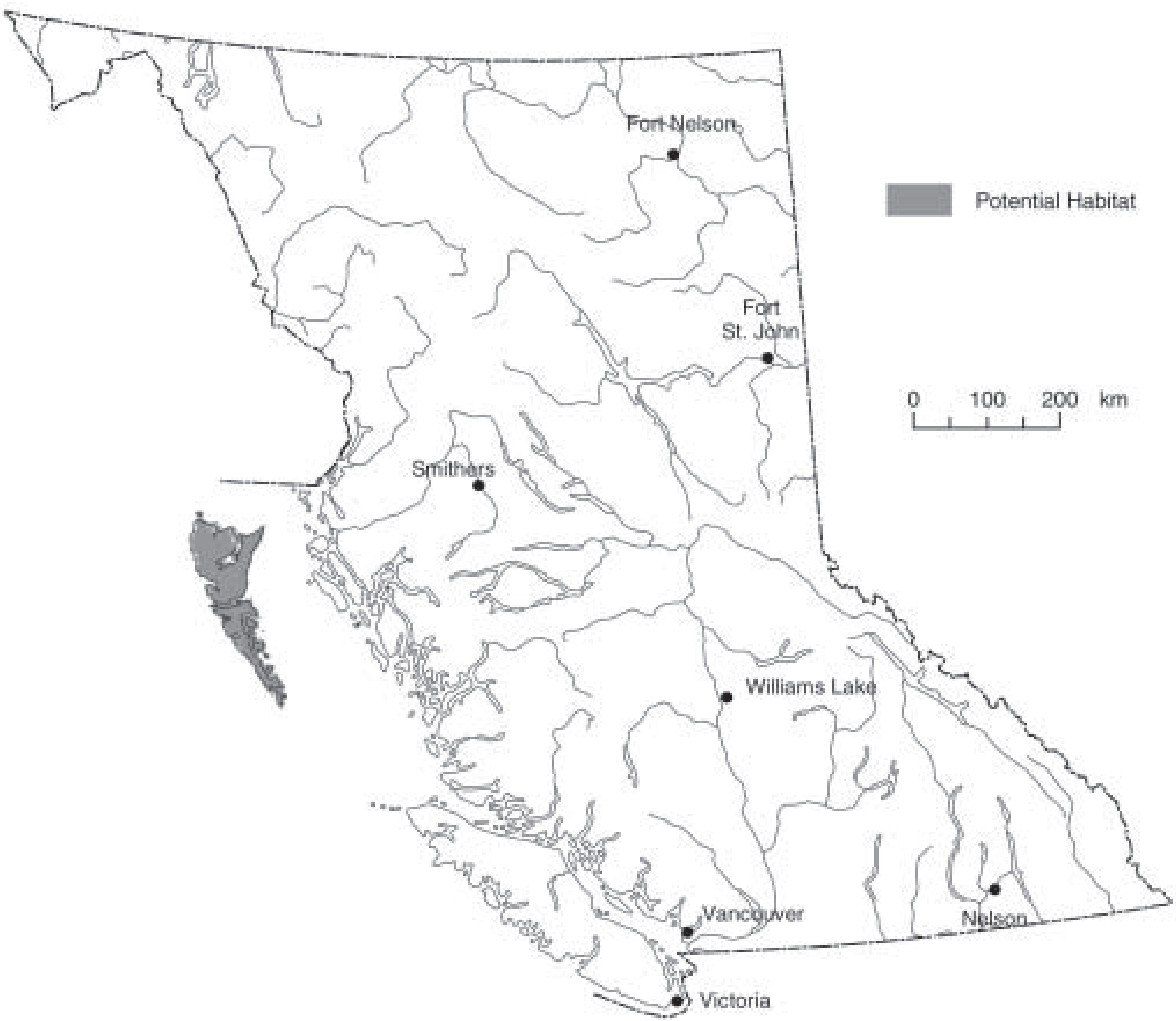
The Northern Saw-whet Owl feeds almost exclusively on small mammals such as deer mice (*Peromyscus*) and shrews (*Sorex* spp.) but will also eat small birds (e.g., Ancient Murrelet [*Synthliboramphus antiquus*] fledglings) and insects (Cannings 1993). On the Queen Charlotte Islands, some saw-whets feed extensively on intertidal invertebrates (Hobson and Sealy 1991). The species is highly nocturnal in all of its behaviours.

Reproduction

Northern Saw-whet Owls nest in tree cavities, and will use suitable nest boxes when available. Only two

Northern Saw-whet Owl - subspecies *brooksi*

(Aegolius acadicus brooksi)



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.

nests have ever been located and described for this subspecies in British Columbia. This species is a secondary cavity-nester (Cannings 1993). There is a strict division of labour in breeding, with the smaller male providing all the food while the female incubates the eggs and broods the young. Courtship begins in March; three to seven eggs are laid from late March to early April and are incubated for approximately 4 weeks; eggs usually hatch from mid-May to late June and fledge by mid-July (Campbell et al. 1990; Cannings 1993).

Site fidelity

It is not known whether this subspecies reuses nest sites. Surveys conducted in 2002 on the Queen Charlottes confirmed the continued presence of owls at nine sites at which owls had originally been detected druing surveys conducted by Gill and Cannings in 1996 (Hobbs and Holschuh 2002). The continued presence of owls at these sites suggests that these sites continue to be selected by this species over succesive generations (Hobbs and Holschuh 2002). There is further evidence from the mainland subspecies that suggests reuse of the same nesting area.

Home range

Home ranges for breeding males in the Okanagan Valley range from 125 to 150 ha (Cannings 1987). No studies have measured this on the Queen Charlottes but it is likely similar. Cannings (1993) felt that territories in high quality habitat were generally about 100 ha; territories along rivers with mature to old-growth forests in the Queen Charlotte Islands are likely similar (Gill and Cannings 1997; pers. obs.).

Dispersal and movements

The Queen Charlotte subspecies is not migratory. There are no data on juvenile dispersal.

Habitat

Structural stage

6: mature forest
7: old forest

Generally prefers stages 6 or 7 but will forage in 3 (shrub/herb). Generally avoids stages 4 and 5 (pole/sapling and young forest).

Important habitats and habitat features

Nesting

Highest densities occur in coniferous forests. Early seral and mature forest habitats are used within the home range. To date, only two studies have been conducted on the ecology of this subspecies. In 1996, Gill and Cannings surveyed 238 sites and found 61 owls; in 2002, Hobbs and Holschuh surveyed 287 sites and found 26 owls. The sites with owls were closer to riparian habitat and had more old forest (>120-year-old) and more young forest (10- to 30-year-old) than sites without owls. Singing trees (trees used by males advertising for mates) were in old forest stands and two were in mature forest stands. Singing trees were larger in height and diameter, and had less shrub cover around them than randomly selected trees in similar aged forests. Daytime roost sites were located in the upper third (canopy) of large western hemlock trees within old growth forest stands (Hobbs and Holschuh 2002)

Wildlife trees with cavities are required for nesting. The Northern Saw-whet Owl is a secondary cavity-nester that uses old woodpecker nest sites in either coniferous or deciduous wildlife trees. Heart rot decadence may be a critical feature. Of two nests found in British Columbia for this subspecies, one was in a cavity located on the bole of a western hemlock (*Tsuga heterophylla*) snag and the other in a cavity in a Sitka spruce (*Picea sitchensis*) snag (Hobbs and Holschuh 2002; Tarver, unpubl. data). Both nest trees were classified as decay class 5 and >100 cm dbh. Tree heights were 28 m and 15 m, respectively.

Availability of suitable cavities for nesting may be more limiting on the Queen Charlotte Islands than on the mainland, because Pileated Woodpecker are absent from the Queen Charlotte Islands. Northern Saw-whet Owls on the Queen Charlotte Islands may only be able to use natural cavities in old trees and snags, or cavities excavated by smaller woodpeckers (e.g., Red-breasted Sapsucker [*Sphyrapicus ruber*] and Hairy Woodpecker [*Picoides villosus*]) that have subsequently been enlarged by other cavity users. It is possible that Northern Flicker cavities are also suitable.

On northern Vancouver Island, 99% of the Red-breasted Sapsucker, Hairy Woodpecker, and Northern Flicker (n = 322) nests were in the CWHxm2 and CWHvm1 and 1% were in the MH biogeoclimatic zone (Deal and Gilmore 1998). Variables that best characterized these three woodpecker nest plots in the Nimpkish Valley included a greater dbh of amabilis fir (*Abies amabilis*), Douglas-fir (*Pseudotsuga menziessi*), western hemlock, and western white pine (*Pinus monticola*); a greater density of western hemlock and western white pine; and a greater volume of western hemlock in the nest plots (Deal and Setterington 2000). This same study found that 77% of the three species of woodpecker nests were found on slopes <20%.

The four most common tree species excavated by these woodpeckers for nesting on Vancouver Island were western hemlock, western white pine, Douglas-fir, and Pacific silver fir (*Alnus rubra*). Other tree species used for nesting included red alder (*Alnus rubra*), lodgepole pine, yellow-cedar, and western redcedar (*Thuja plicata*). Black cottonwood may also be used. Woodpecker nests were found more often than expected in western white pine, and less than expected in western redcedar and yellow-cedar. They appeared to avoid trees <30 cm and to select trees that were within 80–100 cm dbh. Red-breasted Sapsuckers nest trees (n = 155) had large diameter, (mean ± SD) 84.6 ± 2.0 SD cm, and tall height, 29.5 ± 0.8 trees. Hairy Woodpeckers nest trees (n = 78) had large diameter, (mean ± SD) 79.6 ± 3.1 cm, and tall height, 26.7 ± 1.3 trees. The majority of Red-breasted Sapsucker and Hairy Woodpecker nests were found in wildlife tree classes 2–7.

Foraging

Uneven-aged forest structure with openings is preferred. This species can probably hunt successfully in small clearcuts, but not in young (pole/sapling) forests. It requires edge habitat in forest openings for hunting. Also forages in intertidal areas on the Queen Charlotte Islands.

Conservation and Management

Status

The Queen Charlotte Northern Saw-whet Owl 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	Canada	Global
S3	N3	G5T3

Trends

Population trends

The only population information comes from Gill and Cannings (1997) and Hobbs and Holschuh (2002). Assuming the species is largely restricted to CWH habitats, an approximate population estimate would be 2775 males throughout the Queen Charlotte Islands (based on an area of 8500 km^2 of CWH in the Queen Charlotte Islands). This is probably a liberal estimate because it assumes that habitat coverage in both surveys was representative of the entire Queen Charlotte Islands, that all habitat is equal and habitat is saturated, and that they were detecting owls only within 500 m of their calling stations.

Habitat trends

Suitable habitat is likely declining. Under the current harvest rates within the range of the Queen Charlotte Northern Saw-whet Owl, the annual rate of decline of suitable habitat is estimated to be between 2–4% and probably tending towards the lower end of this range given the recent harvest rate adjustments and some incremental gains in suitable habitat due to improvement in habitat conditions in secong-growth stands (A. Cober, pers. comm.).

Threats

Population threats

The Queen Charlotte Northern Saw-whet Owl has a restricted range, occurs at low densities, and is an endemic non-migratory subspecies which may increase its risk of extinction.

Habitat threats

The primary threat to populations of Northern Saw-whet Owls in general, and *A. acadicus brooksi* in particular, is likely the loss and degradation of breeding and foraging habitat through forest harvest practices (Cannings 1993). This species requires tree cavities for nesting and forest openings for hunting; both these resources are reduced or eliminated by modern forest harvest practices. Cavities may be more of a limiting factor on the Queen Charlotte Islands than for mainland populations, because the Pileated Woodpecker are absent from the Queen Charlotte Islands.

Legal Protection and Habitat Conservation

The Northern Saw-whet Owl, its nests, and its eggs are protected from direct persecution by the provincial *Wildlife Act*.

Much of Gwaii Haanas National Park Reserve on the south end of Moresby Island (1470 km^2) is likely suitable habitat for this species, as is Naikoon Provincial Park on northeastern Graham Island (726 km^2).

Habitat conservation may be partially addressed by the old forest retention targets (old growth management areas), riparian reserves, and wildlife tree retention area recommendations in the results based code. However, standard riparian management will often be too narrow to provide sufficient habitat, but a well-designed old growth management area could provide adequate habitat for this species.

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

Since this species is largely dependent on woodpecker cavities for nest sites, management practices that benefit woodpeckers will also enhance habitat for this species.

- ❖ The objective for this species is to maintain wildlife trees >40 cm dbh and green recruitment trees for nesting across the breeding range and over time. Consider wildlife tree retention area, old growth management area, or riparian objectives for this species in the Queen Charlotte Islands Forest District.
- ❖ Blocks should be assessed to identify potentially suitable WTR areas. Suitable WTR areas for this species should be based on the information in Table 1.

Table 1. Preferred WTP characteristics for the Queen Charlotte Northern Saw-whet Owl

Attribute	Characteristics
Size (ha)	≥1 ha
Location	CWHwh, CWHvh; near riparian areas; slopes <20%
Tree features	visible woodpecker or natural cavities; evidence of heart rot
Tree species	coniferous and deciduous; particularly western hemlock, Sitka spruce, lodgepole pine, yellow-cedar, western redcedar, red alder
Tree size (dbh*)	83–85 cm or larger; in the absence of trees with the preferred dbh, trees ≥40 cm should be retained for recruitment
Wildlife tree class	3–5; mix of live and dead trees particularly those with an indication of heart rot

* Weighted mean and pooled standard deviation of trees selected by Red-breasted Sapsucker and Hairy Woodpecker (Deal and Setterington 2000).

❖ It is recommended that salvage 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 that should be maintained over the long term (>80 years).

Wildlife habitat area

Goal

Any nest sites and occupied breeding residences should be established as WHAs. Suitable habitat should be managed through the old forest and wildlife tree retention objectives.

Feature

Establish WHAs at known nest sites or occupied residences. Residency is indicated by detections made during the breeding season.

Size

Typically between 80 and 100 ha but size will depend on site-specific conditions.

Design

Design the WHA to minimize disturbance and maintain suitable foraging habitat. The WHA should include a 12 ha core area around the nest if known and a 300 m management zone. The management zone should encompass the remaining home range, which should be estimated based on suitable habitat. When the exact location of the nest site is not known, design core area to include highly suitable nest trees or known roost sites.

General wildlife measure

Goals

1. Maintain nest site or potential nest trees.
2. Minimize disturbance to nesting birds (1 March to 15 July).
3. Maintain suitable foraging habitat.
4. Maintain riparian corridors.
5. Ensure WHA is windfirm.
6. Maintain important habitat features (i.e., large diameter wildlife trees).

Measures

Access

- Do not construct roads within core area unless there is no other practicable option.
- Do not construct roads during critical breeding times (1 March to 15 July) within the management zone.

Harvesting and silviculture

- Do not harvest or salvage within the core area.
- Do not salvage within the management zone.
- In the management zone, use partial harvesting methods that retain 40% basal area. Retain wildlife trees as described in Table 1 or, where not available, retain largest diameter class to meet 40% retention and maintain for at least one full harvest rotation with no additional harvest entries.
- Do not harvest in the management zone during the breeding season (i.e., 1 March to 15 July).
- Retain a minimum 10 m reserve zone on all stream reaches.

Pesticides

- Do not use pesticides.

Additional Management Considerations

Queen Charlotte Northern Saw-whet Owls are associated with riparian habitats (Gill and Cannings 1997). To maintain suitable habitat for this species, large riparian buffers should be maintained.

Information Needs

1. Biology and habitat requirements of subspecies.
2. Inventory.
3. Impacts from forest harvesting.

Cross References

Ancient Murrelet, "Queen Charlotte" Goshawk, "Queen Charlotte" Hairy Woodpecker

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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

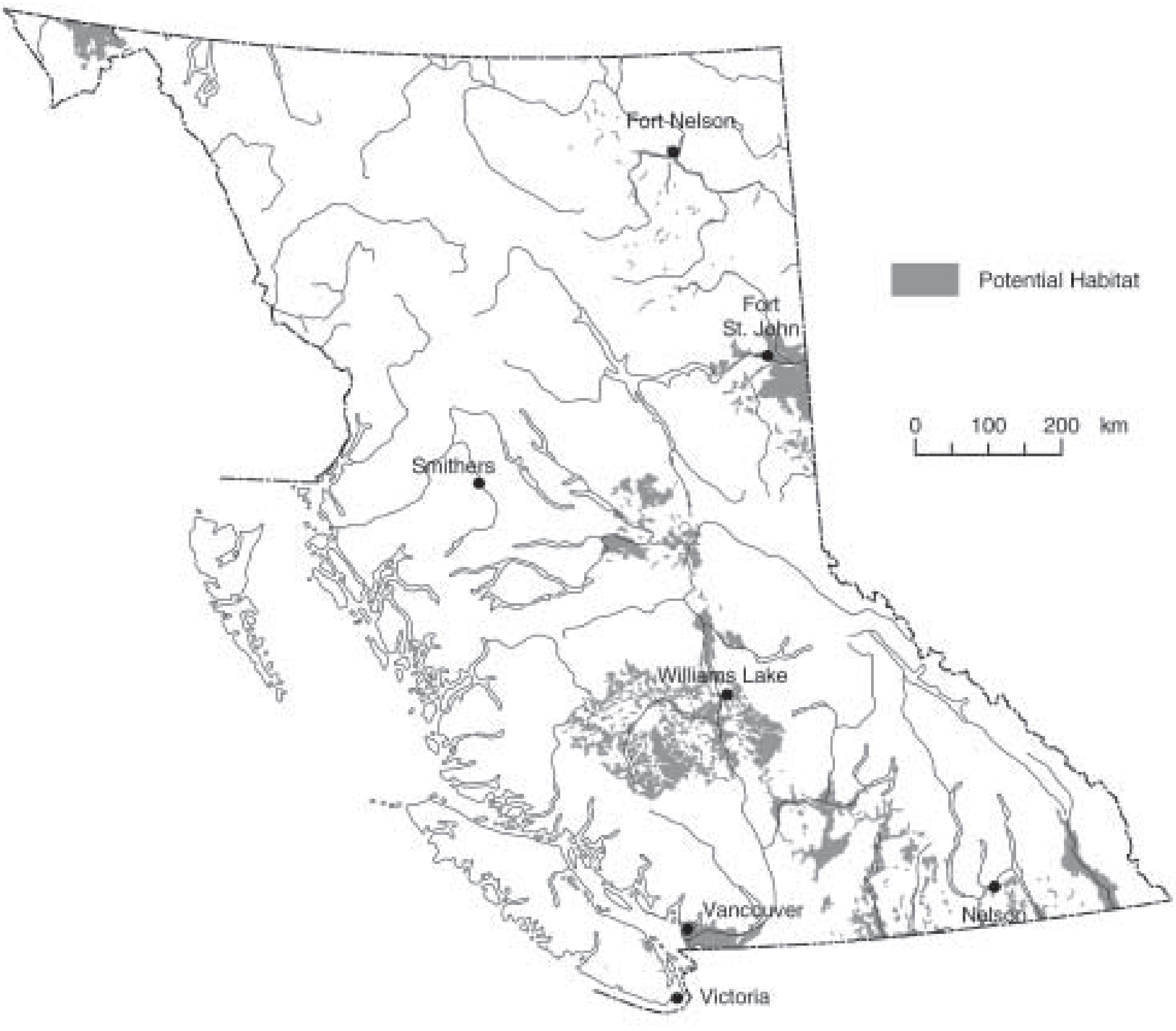
SBI: NEL

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.

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Sandhill Crane

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Spotted Owl

Strix occidentalis

Original by Ian Blackburn and Stephen Godwin

Species Information

Taxonomy

Three subspecies are recognized: Mexican Spotted Owl (*Strix occidentalis lucida*), California Spotted Owl (*S. occidentalis occidentalis*), and Northern Spotted Owl (*S. occidentalis caurina*) (Dawson et al. 1986; Wilcove 1987). Starch-gel electrophoresis was unable to detect variation between *S. occidentalis occidentalis* and *S. occidentalis caurina*; however, *S. occidentalis lucida* did show variation, suggesting the possibility of two distinct species (Barrowclough and Gutierrez 1990). In addition, two separate evolutionary histories have been demonstrated by the major allelic frequency difference between *occidentalis/caurina* and *lucida* (Barrowclough and Gutierrez 1990).

Description

The Spotted Owl is considered a medium-sized owl with an average height of about 45 cm, and average wingspan of about 90 cm. The plumage consists largely of dark brown body feathers with a regular pattern of round to elliptical white spots, white horizontal bars on the chest and tail, large dark brown eyes surrounded by tawny facial disk, and no ear tuffs. Male and female Spotted Owls have similar plumage. Females may be distinguished by their comparatively larger body size (females: $n = 65$, mean = 663 g, SD = 42.8 g; males: $n = 68$, mean = 579 g, SD = 34.9 g; Blakesley et al. 1990), and higher pitch of their vocalization (Forsman et al. 1984).

Distribution

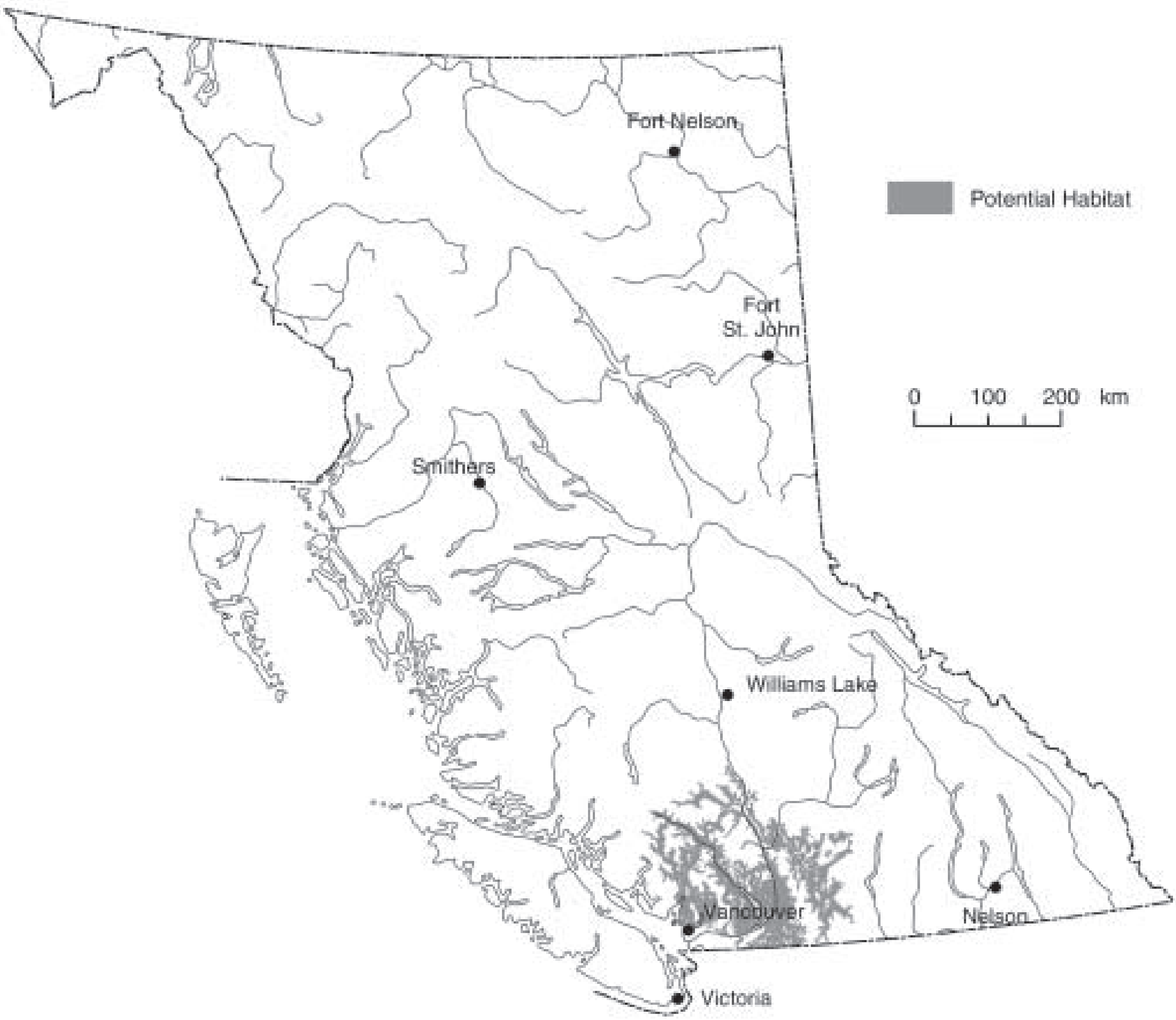
Global

The Spotted Owl occurs from southern British Columbia south to central Mexico. The Mexican Spotted Owl ranges from southern Utah and central Colorado, south through the mountainous regions of Arizona and New Mexico; Guadelupe Mountains of western Texas; mountains of northern and Central Mexico south to Michoacan and Guanajuato. The California Spotted Owl ranges from southeastern Shasta County, south through the Sierra Nevada to Kern County, through the Coast Ranges from Monterey County to San Diego County to northern Baja California (Sierra San Pedro Martir). The Northern Spotted Owl ranges from southwestern mainland British Columbia, western Washington, western Oregon, to northwestern California.

British Columbia

Based on historic (pre-1985, n=28) and recent ($n = 65$) records, the current known range of the Spotted Owl in British Columbia extends from the international border north about 200 km to Carpenter Lake, and from Howe Sound and Pemberton east about 160 km to the slopes of the Cascade Mountain range (MWLAP 2003). There are unconfirmed historic records occurring as far northwest as Bute Inlet in the Sunshine Coast Forest District (Laing 1942). Although the Spotted Owl occurred historically in the lowlands of the lower Fraser River Valley, the species is thought to be extirpated from this area as a result of the extensive loss of old forests due to urbanization, agriculture, and forestry. Despite relatively recent historic records, survey efforts conducted between 1992 and 1997 in the Squamish and Whistler corridor were

Spotted Owl
(Strix occidentalis)



Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on several classifications (Forest Cover Data and Biogeoclimatic) 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.

unsuccessful at detecting Spotted Owls, suggesting that the species may have become locally extirpated in this area. The full extent of the range of Spotted Owls in British Columbia is still unknown. Inventories are still required to assess the western, northern, and eastern extent of the species range.

Forest region and districts

Coast: Chilliwack, Squamish

Southern Interior: Cascades

Ecoprovinces and ecosections

COM: EPR, NWC, SPR

GED: FRL

SOI: LPR, HOR

Biogeoclimatic units

CWH: dm, ds1, mm1, ms1, ms2, vm1, vm2

ESSF: mw

IDF: dk2, ww

MH: mm1

Broad ecosystem units

AU, AV, CD, CH, CW, DF, DL, EW, FR, IH, MF, RD

Elevation

~0–1370 m

Life History

Diet and foraging behaviour

Spotted Owls are nocturnal and considered a sit and wait predator that moves from perch to perch waiting to detect prey. Spotted Owls primarily prey on small mammals, although they have been known to predate on a broad array of taxa including birds, amphibians and insects (Forsman et al. 1984). The composition of their diet varies among regions and forest types. In general, their diet includes flying squirrels, deer mice, tree voles, woodrats, red-backed voles, and hares. Pellet analysis of Spotted Owls in British Columbia revealed the largest contribution (41.2%) to the owl's diet is Northern Flying Squirrels (*Glaucomys sabrinus*) and bushy-tailed woodrats (*Neotoma cinerea*) (27.8%; Horoupian et al. 2000), which is consistent with other studies throughout the species range (Forsman et al. 1984; Forsman et al. 2001). Flying squirrels are also nocturnal, and tend to be more abundant in old forests than in young forests; however, their density in old forests is low (Carey et al. 1992). In British Columbia, Ransome (2001) found the density of Flying Squirrels in old forest in the wet coastal ecosystem to be 1.5 ± 1.8 squirrels/ha (range 0.3–2.9) and in second-growth stands to be 1.0 ± 1.4 squirrels/ha (range 0.06–1.8). Although the densities in British Columbia were not significantly different, the results suggest densities of flying squirrels may be higher in old forests. Even a potential 0.5 squirrel/ha more in old forest than second growth could translate to significantly more squirrels within a home range and improve the owls' likelihood of survival and reproduction. Due to this low density of prey, the Spotted Owl requires large amounts of old forest for foraging (Carey et al. 1992).

Reproduction

Spotted Owls are typically monogamous, although evidence suggests a low, but frequent occurrence of separation between pairs (Forsman et al. 2002). In late winter, Spotted Owls begin roosting together near the nest 4–6 weeks prior to egg laying, with copulation generally occurring 2–3 weeks before nesting (Forsman et al. 1984). The average clutch size is two owlets ± one owlet. The incubation period is estimated to be approximately 30 days ± 2 days (Forsman et al. 1984). Females incubate and brood the juveniles while the males provide food for both females and juveniles (Forsman et al. 1984). Most juveniles leave the nest when they are 34–36 days old. Although the mean date when juveniles left the nest varied among years, Forsman et al. (2002) reported mean dates of June 8 ± 0.53 days in Oregon (n = 320 owls, range May 15 to July 1) and June 18 ± 1.67 days in Washington (n = 77, range May 13 to July 15). Similar to Washington, juveniles at two locations in British Columbia were observed off the nest between June 15 and June 20 (Hobbs 2002); however, juveniles have been observed off the nest in British Columbia as early as on June 7 (D. Dunbar, pers. comm.). The results support Forsman et al. (1984) that nesting typically occurs earlier in southern portions of the species range in

North America. In Washington and Oregon, re-nesting after a nest failure was rare, only occurring 1.4% of the time after an initial failure (Forsman et al. 1995).

In Washington and Oregon, Forsman et al. (2002) reported that 22% of males and 44% of females were paired at 1 year of age; however, only 1.5% of 1-year-old males and 1.6% of 1-year-old females actually bred. Typically, Spotted Owls begin breeding at 3 years of age. Franklin et al. (1999) note that fecundity appears to vary over time with evidence of a bi-annual cycle where by more young fledged in even years than odd years (even/odd effect). The cause of this cyclic pattern is unknown, but may be linked to weather or prey populations (Franklin et al. 1999).

Site fidelity

Spotted Owls typically have strong fidelity to breeding sites and tend to occupy the same geographic area for long periods of time (Forsman et al. 1984). Forsman et al. (2002) observed a minimum 6% of non-juvenile owls changed territories annually. The frequency of these non-juvenile movements was higher for female owls, younger owls, and owls without a mate or who had lost their mate through death or separation in the previous year. In the Olympic Mountain range in Washington, owl pairs changed nests in 75% of sequential nesting attempts; 40% returned to a nest used previously (Forsman and Giese 1997). The median distance between these alternate nests was 0.52 km (range 0.03–3.35 km; $n = 92$).

Home range

Home range sizes vary by geographic location, with a general increasing trend from southern to northern portions of the species range (Thomas et al. 1990). For example, home range sizes have been reported as small as 549 ha for a single owl in Oregon (Forsman et al. 1984) and as large as 11 047 ha for a pair of owls in Washington (Hanson et al. 1993). The size of an owl's home range depends on many factors including food availability; interspecific and intra-specific competition; presence of predators; and the quantity, quality, and dispersion of suitable habitats (USDI 1992). For example, decreasing the density of suitable habitat or prey populations within the landscape may result in an increase in home range size as owls expand their foraging area to find sufficient amounts of habitat with prey.

In Washington, the median annual home range for a pair of owls for the west side and east side of the Cascade Mountain range was estimated at about 3321 ha (range 1302–7258 ha) and 2675 ha (range 1490–6305 ha), respectively, with a total suitable habitat composition of 67% and 71%, respectively (Hanson et al. 1993). In British Columbia, annual home range estimates for 3 pairs of owls in the drier ecosystem ranged from 1732 to 4644 ha, with suitable habitat compositions ranging from 60 to 66% (A. Hilton, pers. comm.). However, these home ranges for British Columbia are likely under-estimated due to the small sample size and limited seasonal tracking duration. Annual home range sizes for British Columbia are likely comparable to those in Washington, if not slightly larger.

Forsman et al. (1984) observed an average 68% home range overlap between paired individuals. Despite this overlap, paired individuals used the same locations for foraging only 4–10% of the time, suggesting little competition for food between paired individuals. In contrast, adjacent, non-paired individuals overlap their home ranges by about 12% where both owls tend to spend relatively small portions of their time in the periphery of their home range (Forsman et al. 1984).

Movements and dispersal

Juveniles are obligate dispersers and typically leave their natal area by September 19 (95% CI, September 17 to 21) in Oregon and September 30 (95% CI, September 25 to October 4) in Washington (Forsman et al. 2002). In British Columbia, the latest date that juveniles owls were observed with their parents was September 28 (2 records; MWLAP 2003), suggesting that the initial date of dispersal is likely similar to Washington. The direction of dispersal appears random; however, it may be influenced by barriers such as high elevation terrain, large bodies of water, and large open areas of unsuitable habitat (Thomas et al. 1990; Miller et al. 1997; Forsman et al. 2002). Distances between the natal area and where the owls eventually settled ranged from 0.6 to 111.2 km apart; however, the distribution of distances were skewed towards shorter distances (Forsman et al. 2002). Female juveniles typically disperse farther than males, with 50% of female and male juveniles settling within 22.9–24.5 km and 13.5–14.6 km from their natal areas, respectively (Forsman et al. 2002).

Habitat

Structural stage

6: mature forest
7: old forest

Important habitats and habitat features

Nesting

Spotted Owls do not create their owl nest structures, but use a variety of pre-formed structures that includes cavities in the side and top of trees, and platforms constructed by other birds or by natural accumulations of debris (Forsman et al. 1984; Dawson et al. 1986; Buchanan et al. 1993; Forsman and Giese 1997). Nest structures are about 50 cm in diameter, and typically do not differ in size by nest type or geographic region (Forsman and Giese 1997). However, tree species and size of nest trees (dbh) are geographically variable and selection is thought to be based largely on the availability of suitable cavities and platforms. Regardless of geographic region, cavity nests were in trees with greater diameters than platform nests (Table 1).

In wetter ecosystems, Spotted Owls primarily nest in cavities in large diameter trees typically found in old forest stands or younger stands with residual large diameter old trees (Thomas et al. 1990; Forsman and Giese 1997). In the Olympic Mountain range, nest trees averaged 136.6 cm dbh and were predominantly western hemlock (*Tsuga heterophylla*), western redcedar (*Thuja plicata*), and Douglas-fir (*Pseudotsuga menziesii*) ranging from 114 to 1189 m in elevation. In drier ecosystems, Spotted Owls nest in a wide range of forest stand ages ($n = 62$, median age = 147 yr, range 66–700 yr; Buchanan et al. 1993) and forest structures. On the eastern slopes of the Cascade Mountain range in Washington, nest trees averaged 66.5 cm dbh and were found almost exclusively in Douglas-fir trees ranging from 381 to 1463 m in elevation (Buchanan et al. 1993, 1995). In contrast to wetter ecosystems, 84% ($n = 85$) of Spotted Owl nests were on platforms in trees created by abandoned Northern Goshawk (*Accipiter gentilis*) nests ($n = 47$) or mistletoe brooms ($n = 21$), with only 16% of nests found in cavities or tops of trees (Buchanan et al. 1993). In British Columbia, nests have been similarly found in cavities of large diameter living western redcedar, western hemlock, and Douglas-fir trees, in tops of large diameter dead Douglas-fir snags, and in abandoned Northern Goshawk nests.

Foraging

Three habitat types have been defined in Washington based on their use by Spotted Owls for nesting, roosting and foraging (Hanson et al. 1993). Superior habitats are preferred by Spotted Owls as these habitats are used by the owl in greater proportion than the availability of this habitat type in the landscape. Moderate habitats are used by Spotted Owls in equal proportion to the availability of this habitat type in the landscape. Marginal habitats are used less than this habitat type's availability in the landscape, and are considered unsuitable for sustained use by Spotted Owls. Table 2 defines the stand characteristics for superior and moderate habitats for the wetter and drier ecosystems.

Spotted owls are a sit and wait predator that usually roost within or adjacent to forest stands used for foraging. The structural diversity found in superior habitat type provides for numerous roosting and foraging perches at various heights in the canopy and understorey. The openness of these stands allow for greater maneuverability within the canopy layers and greater access to prey. These open stands tend to possess higher quantities of understorey shrubs and herbs that support higher densities of prey. The characteristics of superior habitat is predominantly found within old forest (forests >140 yr); however, some younger forests, particularly in drier ecosystems, may also possess these characteristics.

Table 1. Comparison of nest tree diameter at breast height (dbh), tree height, and nest diameter among three geographic regions in Washington and Oregon

	Cavity nests			Platform nests		
	n	mean	SD/SE	*n*	mean	SD/SE
Washington Olympic Mountains – (Forsman and Giese 1997)						
dbh (cm)	99	141.8	6.15 SE	11	88.7	15.74 SE
Tree height (m)	95	40.7	1.36 SE	11	39.8	3.99 SE
Nest diameter (cm)	76	45.3	1.15 SE	10	48.0	4.59 SE
Washington Eastern Slopes of Cascade Mountains – (Buchanan et al. 1993)						
dbh (cm)	14	94.7	23.1 SD	71	59.4	21.8 SD
Tree height (m)		Not reported			Not reported	
Nest diameter (cm)		Not reported			Not reported	
Oregon – (Forsman et al. 1984)						
dbh (cm)	28	135.0	6.03 SE	16	106.0	11.93 SE
Tree height (m)	28	38.1	2.37 SE	16	42.0	3.42 SE
Nest diameter (cm)	20	50.0	0.93 SE	8	62.0	1.32 SE

Table 2. Suitable Spotted Owl habitat definitions for British Columbia (SOMIT 1997)

Superior habitat (nest, roost, forage and dispersal)	**Moderate habitat** (roost, forage, and dispersal)
Wetter ecosystems: maritime CWH and MH biogeoclimatic zones (CWHdm, CWHvm1, CWHvm2, MHmm1)	
• ≥3 canopy layers, multi-species canopy dominated by large (>75 cm dbh) overstorey trees (typically 37–185 stems/ha) • moderate to high (60–80%) canopy closure • ≥5 large (>50 cm dbh) trees/ha with various deformities (e.g., large cavities, broken tops, dwarf mistletoe infections) • ≥5 large (>75 cm dbh) snags/ha. • accumulations (≥268 m³/ha) of fallen trees and other CWD on ground	• ≥2 canopy layers, multi-species canopy dominated by large (>50 cm dbh) overstorey trees (typically 247–457 stems/ha, although densities as low as 86 stems/ha are possible where large diameter trees are present) • moderate to high (60–80%) canopy closure • ≥5 large trees/ha (>50 cm dbh) with various deformities (e.g., large cavities, broken tops, dwarf mistletoe infections) • ≥5 large (>50 cm dbh) snags/ha • accumulations (≥100 m³/ha) of fallen trees and other CWD on ground
Drier ecosystems: sub-maritime CWH and MH, IDF, and ESSF biogeoclimatic zones (CWHds1, CWHms1, CWHms2, MHmm2, ESSFmw, IDFww)	
• ≥3 canopy layers, multi-species canopy dominated by large (>50 cm dbh) overstorey trees (typically 173–247 stems/ha, although densities as low as 86 stems/ha are possible where large diameter trees are present) • moderate to high (60–85%) canopy closure • ≥5 large trees/ha (>30 cm dbh) with various deformities (e.g., large cavities, broken tops, dwarf mistletoe infections) • ≥7 large (>50 cm dbh) snags/ha. • accumulations (≥268 m³/ha) of fallen trees and other CWD on ground	• ≥2 canopy layers, multi-species canopy dominated by large (>30 cm dbh) overstorey trees (typically greater than 247 stems/ha) • stands must contain 20% Fd and/or Hw in the overstorey • >50% canopy closure. • ≥5 large trees/ha (>30 cm dbh) with various deformities (e.g., large cavities, broken tops, dwarf mistletoe infections) • ≥5 large (>30 cm dbh) snags/ha • accumulations (≥100 m³/ha) of fallen trees and other CWD on ground

Conservation and Management

Status

The Spotted Owl is on the provincial *Red List* in British Columbia. It is considered *Endangered* in Canada (COSEWIC 2002). The "Northern" Spotted Owl is federally designated as Threatened throughout its entire range in the United States under the U.S. *Endangered Species Act*.

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

BC	CA	OR	WA	Canada	Global
S1	S2	S3	S3	N1	G3T3

Trends

Population trends

Blackburn et al. (2002) estimated the historic (pre-European settlement) Spotted Owl population size in British Columbia as about 500 pairs of owls. Between 1992 and 2001, the Spotted Owl population declined by about 49% at an average annual rate of -7.2% (± 1.7% for 90% CI; Blackburn et al. 2002). Survey results from 2002 suggest that the population declined by an additional 35% between 2001 and 2002. Combined, the Spotted Owl population has declined by about 67% since 1992 at an average rate of -10.4%/yr (Blackburn and Godwin 2003). Applying this observed decline to the fewer than 100 pairs of owls estimated in British Columbia in the early 1990s (Dunbar et al. 1991) suggests that the current Spotted Owl population in British Columbia may be fewer than 30 pairs of owls. It is reasonable to assume that the extirpation of the Spotted Owl from British Columbia is imminent if the observed annual rate of decline continues (Blackburn et al. 2002).

The observed large decline is Spotted Owl numbers is not exclusive to British Columbia. In the United States, monitoring of Spotted Owls at 15 different demographic study areas between 1985 and 1998 suggests a range-wide annual population decline of -3.9% (± 3.6% for 95% C.I.; Franklin et al. 1999).

Habitat trends

Since European settlement, timber harvesting for urbanization, agriculture, and resource extraction has occurred, with almost the entire forested area in the lower Fraser River Valley converted to non-forest uses. It is estimated that suitable habitat represents about 50% of the current capable forested area in the two forest districts (Blackburn et al. 2002). Some of these habitats are currently unusable by Spotted Owl due to their small patch size, isolation from other habitat patches, or distribution in landscapes with suitable habitat densities too low to support the species. Over the next 25 years, the rate of habitat loss caused by timber harvest and natural disturbance is expected to exceed the recruitment of suitable habitat from young forests, resulting in further fragmentation and isolation of habitats available to the owl (Blackburn and Godwin 2003).

Threats

Due to their small population size and low densities, Spotted Owls in British Columbia are vulnerable to extirpation. Factors that threaten the species can be divided into primary and secondary factors (Blackburn and Godwin 2003). Primary factors cause long-term sustained effects that limit the carrying capacity, or total capable population size. Primary factors include habitat loss and fragmentation, competition with Barred Owls (*Strix varia*), and global warming. Secondary factors cause short-term effects in population size, but the population recovers from these factors relatively soon after the influence of the factor changes to a more favourable condition. Secondary factors include stochastic environmental and demographic events, genetic variability, predation, disease, parasites, and viruses. Although primary factors limit population size and may cause extirpation, secondary factors are likely the leading cause of extirpation of small populations.

Population threats

Since the 1960s, Barred Owls have invaded the range of the Spotted Owl. Although some niche segregation is evident (Hamer et al. 1989), Barred Owls likely exclude Spotted Owls from utilizing some mature and old forests found within core Barred Owl territories. As well, the presence of both species within the same geographic area may suppress prey populations. The combined competitive effect of habitat exclusion and prey suppression may cause Spotted Owls to increase their home range size to compensate for this loss, or cause the displacement of Spotted Owls as they leave their territory to find new territories with less competition (Kelly 2001). In addition to these competitive effects, the low occurrence of cross breeding between Spotted Owls and Barred Owls negatively impacts the reproductive success of the Spotted Owl population by effectively removing adult Spotted Owls from the pool of potential breeders.

Catastrophic environmental events such as fire, windstorms, and insect outbreaks may eliminate both habitat and Spotted Owls that they support (Thomas et al. 1990). As well, severe weather events may cause poor reproductive performance or high adult mortality, resulting in periodic gaps in the demographic profile. If the population cannot recover from these events, the population may continue to decline to extirpation as future stochastic events occur.

Isolated small populations are prone to decreased genetic variability caused by founder effects, increased incidence of inbreeding, and/or genetic drift. Isolated populations may have higher incidences of adult and juvenile mortality caused by pronounced deleterious recessive genes, reduced adaptability to environmental change, and/or higher susceptibility to disease. Furthermore, closely related individuals may not mate at all, thereby reducing the productivity and recruitment of the population. Decreasing population size and increasing isolation of individuals and populations places the Spotted Owl population in British Columbia at greater risk of extirpation caused by the loss of genetic variability.

Spotted Owls are incidental prey to several predators including Great Horned Owls (*Bubo virginianus*) and Northern Goshawks. Ravens are also predators, more likely preying on very young owls and eggs rather than adult owls. Some researchers also include Barred Owls as a possible predator, although evidence is limited (Kelly 2001). Most predation of individuals is thought to occur during juvenile dispersal, when young owls are inexperienced and searching for new habitats. Perhaps the increasing abundance of unsuitable habitats within the landscape has increased the exposure of dispersing Spotted Owls to predators as they move through these unsuitable habitats resulting in an increased rate of mortality. For predators to be the main cause of the population decline requires the rate of mortality to be higher than normal mortality rates caused by predation.

Spotted Owls are prone to disease, parasites, and viruses; however, these seldom result in sufficient mortality to cause population declines. Of recent concern is the range expansion of the West Nile Virus. The West Nile Virus is usually transmitted to birds through mosquitoes, where once established in a bird, mortality may follow. Those that survive may act as carriers to help spread the virus. Although the West Nile Virus does not occur within southwestern British Columbia, it likely is only a matter of time before it does. Its potential impact on the Spotted Owl is not known; however, there is a risk that it could cause further declines in Spotted Owl numbers in British Columbia.

Habitat threats

Habitat is threatened by timber harvesting, urbanization, and natural disturbances such as fire, wind, insects, and diseases. Habitat loss and fragmentation may increase the risk of mortality caused by predation and exposure of owls that must move through unsuitable habitats to reach other suitable habitats. Within an owl's territory, habitat loss and fragmentation may cause the resident owls to increase their home range size to compensate for this habitat loss and need to find sufficient prey. As well, habitat loss and fragmentation may reduce the reproductive success and adult survivorship as adult owls must expend more energy to find food farther away from their core area. Eventually continued habitat loss and fragmentation within a home range will surpass the minimum threshold needed to sustain owls, and the area will remain vacant from Spotted Owls until habitats are restored. As a result, the number of potential territories available in the landscape is reduced. Isolation of territories occurs as the interspatial distances between territories exceed the maximum distance needed for successful dispersal. Without successful dispersal, isolated territories and populations will eventually decline to extirpation.

Legal Protection and Habitat Conservation

The Spotted Owl, its nests, and its eggs are protected under the provincial *Wildlife Act.*

A Spotted Owl Recovery Team was formed in 1990 to develop a recovery plan for the species. At the request of the provincial government, the recovery team developed a range of management options that spans the scale from minimum to maximum protection for Spotted Owl with correspondingly minimum to maximum socio-economic consequences (Dunbar and Blackburn 1994). In 1997, the provincial Cabinet approved the Spotted Owl Management Plan (SOMP) with the goal of achieving a reasonable level of probability that owl populations will stabilize, and possibly improve, over the long term without significant short-term impacts on timber supply and forest employment. The SOMP recognizes that the Spotted Owl population will continue to decline over the next 20–30 years with a 60% chance of the population stabilizing, and possibly improving its status over the long term. Timber supply impacts of SOMP are estimated at between 3 to 5% reduction in allowable annual cut. The SOMP includes a strategic and operational guidelines component, and Resource Management Plans. The strategic component describes the strategic objectives and policies for Spotted Owl management in 21 special resource management zones (SRMZs) totalling about 363 000 ha) identified for the long-term conservation of the species. The operational guidelines component provides resource managers with further guidance for developing long-term Resource Management Plans within SRMZs, and forest practices that will create or retain forest attributes critical for Spotted Owl survival. Resource Management Plans demonstrate how, over a long-term planning horizon of one or more forest rotations, the Spotted Owl and forest management objectives and policies will be achieved in each SRMZ. Resource Management Plans identify landscape and stand level management strategies that are expected to best protect suitable habitat and to provide forestry, economic and employment opportunities.

The 21 SRMZs include 159 000 ha of protected areas (includes capable/suitable habitats within the Greater Vancouver Watershed Districts: Seymour, Capilano, and Coquitlam; protected areas: Seymour, Cypress, Garibaldi, Golden Ears, Sasquatch, Manning, Skagit, Pinecone/Burke Mountain, Birkenhead Lake, Mehatl Creek, and Liumchen) and 204 000 ha of Crown forest land. The SRMZs are spaced a maximum 20 km apart to provide a reasonable chance that owls can disperse from one SRMZ to another. Each SRMZ varies in size and contains between 2 to 13 Long-term Activity Centre (LTACs), each about 3200 ha and capable of sustaining a breeding pair of Spotted Owls in the future. The long-term stabilization, and possible improvement, of the Spotted Owl population is dependent upon maintaining, or restoring, a minimum 67% of the gross forested area as suitable habitat (i.e., forests >100 years old, taller than 19.4 m, and below 1370 m) in each LTAC. Of the 101 LTACs identified within SRMZs, only 55 LTACs currently meet the minimum 67% habitat target. Recruitment of habitat up to this minimum target in the other 45 LTACs may require up to 60 years.

The SOMP provides temporary protection for an additional eight activity centres (referred to as Matrix Activity Centres) that are found entirely or partially outside of SRMZs. These Matrix Activity Centres are to be phased out by allowing, over a

50-year period, limited clearcutting of suitable habitat at a similar rate as suitable habitat is recruited within SRMZs. However, some Matrix Activity Centres will be phased out sooner to achieve forest company timber needs to offset the impacts associated with the creation of the Mehatl Creek Protected Area (SOMIT 1997).

The SOMP does not provide protection over existing provisions of the *Forest and Range Practices Act*, to Spotted Owl activity centres found outside of SRMZs, Matrix Activity Centres, and protected areas discovered after June 1995. Since June 1995, 19 Spotted Owl activity centres have been discovered and remain unprotected. Fourteen of these occur farther north beyond the managed range of SOMP, eight of which occur in the Cascades Forest District (formerly the Lillooet Forest District).

Due to concern over the Endangered status and immediate threat of extirpation, a Spotted Owl Recovery Team was re-established in 2002 to develop a Recovery Plan including assessing the SOMPs effectiveness for stabilizing the population. Completion of the Spotted Owl Recovery Plan is expected by 2005.

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

Due to the status of the Spotted Owl in British Columbia, all individual owls are critical to the recovery of the species and should be considered for protection. The following recommendations may be considered within strategic level planning processes. These recommendations are consistent with the Spotted Owl Management Plan, and its associated documents, and are recommended for the management of habitat to sustain a pair of Spotted Owls (see SOMP for more information). These management provisions may change pending the implementation of a Spotted Owl Recovery Plan or other direction from government.

- ❖ Maintain suitable Spotted Owl habitat (i.e., coniferous forest >100 years old, >19.4 m tall and <1370 m elevation).
- ❖ Maintain LTACs throughout the range of the Spotted Owl.
- ❖ Where possible aggregate LTACs into clusters of multiple breeding territories.
- ❖ Where possible the distance between LTACs and clusters of LTACs should be <20 km.
- ❖ Where the distance between LTACs is >20 km, consider establishing an additional LTAC to ensure habitat connectivity to facilitate dispersal.
- ❖ Maintain or restore suitable habitat within LTACs.
- ❖ Wherever possible and practicable, overlap LTACs with other constrained areas (i.e., protected areas, non-contributing areas) to minimize timber supply impacts.

Wildlife habitat area

Goal

Maintain areas of suitable habitat throughout the range of the Spotted Owl.

Feature

Establish WHAs at resident Spotted Owl areas consistent with current government direction. WHAs may be established to legalize existing LTACs under FRPA, to modify existing LTACs, to protect new resident Spotted Owl areas or to protect other habitat for recovery.

Size

The size of the WHA will generally be 3200 ha of forested area.

Design

The WHA should include a core area(s) (80 ha), and a management zone which includes a long-term owl habitat area (light volume removal) and a forest management area (heavy volume removal). The WHA should include an 80 ha core area around all known nesting or roosting sites. The WHA should also include a minimum of 67% suitable habitat (i.e., coniferous forest >100 years old, >19.4 m tall and <1370 m). The long-term owl habitat areas (LTOHAs) define where, over the long term, the minimum 67% suitable habitat target will be maintained or restored within each WHA. The forest management areas (FMAs) define where, over the long term, timber harvesting can occur to reduce the amount of suitable habitat as low as the 67% habitat target for the WHA.

General wildlife measures

Goals

1. Protect known nest and roost areas. Recruit suitable nesting and roosting habitat and habitat structures.
2. Minimize disturbance at known nesting and roosting sites.
3. Maximize forest interior habitat.
4. Create, enhance, or maintain suitable habitat (i.e., multi-layered, variable density, multi-species stand structure with canopies dominated by dominant and co-dominant trees within areas).
5. Maintain important habitat features (e.g., coarse woody debris, wildlife trees, interior forest, large diameter trees, moderate to high canopy closure; see Table 2).
6. Maintain or enhance habitat for prey species.

Measures

Access

- Do not construct, modify, or deactivate roads or landings within the core area. Where approved, do not construct, modify or deactivate between 1 March and 31 July.
- Minimize road clearing widths to ≤3 m between the timbers edge and either the toe of the fill or the top of the cut, unless no other practicable option exists.

Harvesting and silviculture

- Do not harvest or salvage within core area(s).
- Do not salvage in the management zone.
- Do not remove non-timber forest products.
- Maintain or restore at least 67% of the gross forested area within the WHA in suitable owl habitat of which 75% should be maintained or restored as superior habitat (>140 years, >19.4 m tall and <1370 m). When there is <67%, do not harvest the next oldest age class and/or stands that best achieve Spotted Owl habitat distribution objectives. Heavy volume removal is permitted within the FMA when WHA includes >67% suitable habitat.
- Distribute the 67% suitable habitat into large unfragmented patches >500 ha that are connected by movement corridors of suitable habitat that are a minimum of 1 km wide.
- When harvesting in the management zone (LTOAC and FMA) implement the following measures:
  - Patch cuts (0.05–0.5 ha in size) can represent no more than 5% of the prescribed cut block. Patch cuts must be minimum 100 m (edge to edge) from adjacent patch cuts, clearcuts or natural openings >0.25 ha in size.
  - Remove up to one-third of the basal area from each 10 cm stand diameter class distributed evenly across the treatment area.
  - Retention of trees should be relatively evenly distributed throughout cut blocks. Timber extraction corridors will not exceed the average inter-tree spacing requirement of the treatment area as described in Table 3.
  - For cut blocks within CWHds1, CWHms1, CWHms2, MHmm2, ESSFmw, and IDFww, maintain or create on average 5 snags >30 cm dbh/ha and maintain existing coarse woody debris, and add 25 cubic m/ha of unmerchantable logs >30 cm dbh.
  - For cut blocks within CWHdm, CWHvm1, CWHvm2 and MHmm1, maintain or create on average 5 snags >50 cm dbh/ha and maintain existing coarse woody debris, and add 25 cubic m/ha of unmerchantable logs >50 cm dbh.

Table 3. Average corridor width spacing requirements for partial harvests

Retention of dominant trees/ha	Average corridor widths
173	7.6 m
200	7.0 m
250	6.3 m
300	5.8 m
400	5.0 m
500	4.5 m
625	4.0 m
800	3.5 m
1000	3.2 m

Pesticides

- Do not use pesticides.

Within the FMA

- Locate cut blocks in areas that minimize impacts to suitable habitat objectives and Spotted Owls activity.
- Maintain a minimum of 10% wildlife tree retention areas. Wildlife tree retention areas that consist of non-suitable habitat may be enhanced utilizing partial harvest.
- Maintain or create on average 5 snags >76 cm dbh/ha in CWHdm, CWHvm1, CWHvm2 and MHmm1, or maintain or create on average 5 snags >51 cm dbh/ha in the CWHds1, CWHms1, CWHms2, MHmm2, ESSFmw, and IDFww.
- For cut blocks within CWHds1, CWHms1, CWHms2, MHmm2, ESSFmw, and IDFww, there should be an average of 40 windfirm leave trees maintained from the top 80 largest diameter trees/ha.
- For cut blocks within CWHdm, CWHvm1, CWHvm2, and MHmm1, there should be an average of 15 windfirm leave trees maintained from the top 30 largest diameter trees/ha.

Information Needs

1. Current range and distribution in the province.
2. Short-term population changes and long-term population demographics.
3. Habitat selection/preference requirements.

Cross References

Bull Trout, Coastal Giant Salamander, Coastal Tailed Frog, Keen's Long-eared Myotis, Marbled Murrelet, Pacific Water Shrew

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"Vancouver Island" Northern Pygmy-Owl

Glaucidium gnoma swarthi

Original prepared by John Cooper and Suzanne M. Beauchesne

Species Information

Taxonomy

Of the seven subspecies of Northern Pygmy-Owl currently recognized in North America, three breed in British Columbia including *Glaucidium gnoma swarthi* that is endemic to Vancouver Island and adjacent islands (AOU 1957; Cannings 1998; Campbell et al. 1990; Holt and Petersen 2000). *Glaucidium gnoma swarthi* is noticeably darker than other subspecies; however, there is some uncertainty in the validity of *swarthi*'s status as a subspecies (Munro and McTaggart-Cowan 1947; Godfrey 1986). Taxonomy of the entire *G. gnoma* complex requires further examination as there may be two or more species within the complex (Johnsgard 1988; Holt and Petersen 2000).

Description

The Northern Pygmy-Owl is a very small owl (~17 cm in length). It has no ear tufts and has a relatively long tail. A pair of black patches on the nape is a distinguishing feature.

Distribution

Global

The Northern Pygmy-Owl is resident in a variety of forest types from southeastern Alaska, northern British Columbia (absent from Queen Charlotte Islands), and southwestern Alberta, south through mountainous regions of the western states and central Mexico to central Honduras (Holt and Petersen 2000).

British Columbia

The Vancouver Island Northern Pygmy-Owl is endemic to Vancouver Island and possibly the adjacent Gulf Islands (AOU 1957; Campbell et al. 1990; Cannings 1998).

Forest regions and districts

Coast: Campbell River, North Island, South Island

Ecoprovinces and ecosections

COM: NIM, NWL, OUF, QCT, WIM
GED: LIM, NAL, SGI

Biogeoclimatic units

CDF: mm
CWH: dm, mm, vh, vm, xm
MH: mm, mmp, wh

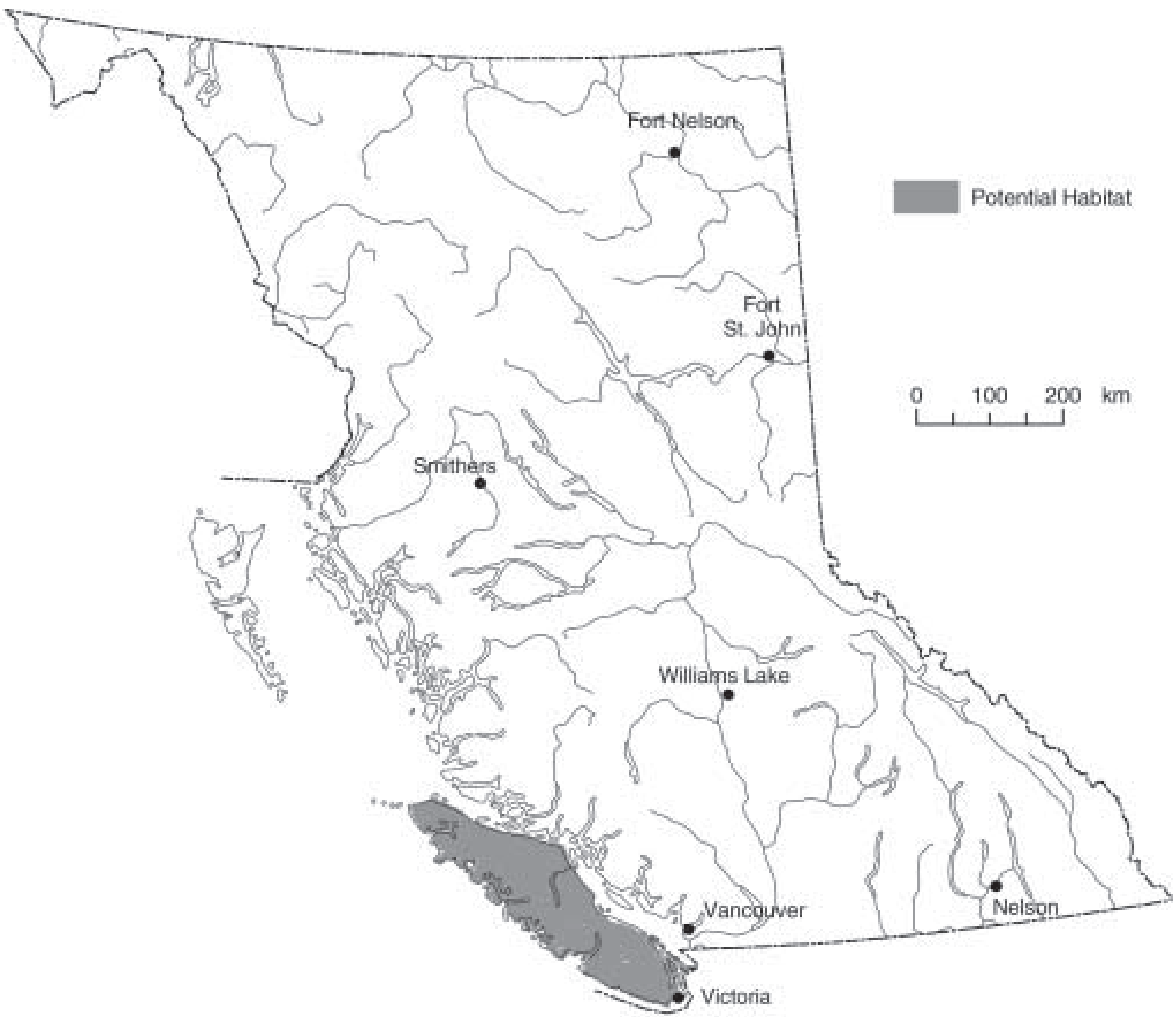
Broad ecosystem units

CD, CG, CH, CW, DA, FR, GO, HP, MF, SR

Elevation

In British Columbia, Northern Pygmy-Owls (not *G. gnoma swarthi*) nests have been found between 440 and 1220 m although individuals have been recorded from sea level to 1710 m (Campbell et al. 1990). *Glaucidium gnoma swarthi* has been detected in the breeding season in the Nimpkish Valley between 50 and 950 m (Deal and Lamont 1996; Matkoski 1997), but likely occur at higher elevations.

Northern Pygmy-Owl - subspecies *swarthi*
(Glaucidium gnoma swarthi)



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

Little is known about the specifics of the biology of the Northern Pygmy-Owl on Vancouver Island; although one study was conducted in Tree Farm Licence 37 on northern Vancouver Island (Setterington 1998). Much of the following information is inferred from the limited data available for other races of this species.

Diet and foraging

Northern Pygmy-Owls are crepuscular or diurnal, and use a perch and pounce hunting method to capture small mammals including voles and mice, a wide range of bird species, invertebrates, reptiles, and amphibians (Johnsgard 1988; Holt and Leroux 1996). It has also been observed raiding nests of a variety of other bird species (Holt and Petersen 2000). The Northern Pygmy-Owl on Vancouver Island forages along roads through forested areas, openings within continuous forest, more open stands, riparian corridors, or mosaics of forested and open habitats along lakeshores and at higher elevations where stands tend to thin.

Reproduction

Clutches contain one to seven eggs (Frost 1972; Campbell et al. 1990; Holt and Petersen 2000). Unlike most other owls, incubation probably begins after the clutch is complete (Johnsgard 1988). The female alone incubates the eggs for 28 days. The male brings food to the female in the cavity during incubation and until the hatchlings are about 9 days old, at which point both parents feed the nestlings. Nestlings fledge after about 23 days and may stay near the nest, dependent upon the parents for food, for up to 3 weeks (Bent 1938; Holt and Norton 1986). In British Columbia, nests with eggs or young could be found between late April through to late August (Campbell et al. 1990). One brood is produced annually (Holt and Petersen 2000).

Little information exists for pair formation, nest site selection, or nest building behaviours (Holt and Petersen 2000). Nesting habitat details are also scarce; however, the Northern Pygmy-Owl is an obligate secondary cavity nester, dependent upon woodpecker or natural cavities as nest sites (Campbell et al. 1990; Holt and Leroux 1996). In British Columbia, all of the nests reported in Campbell et al. (1990) were found in old woodpecker cavities in coniferous trees.

Site fidelity

Nest cavities have been reused by this species, although it is not known if it was by the same or different individuals (Holt and Petersen 2000). The closely related Eurasian Pygmy-Owl has been documented reusing a nest for at least four consecutive years (Johnsgard 1988).

Home range

Home range details for this species are limited; however, these birds are usually sparsely distributed within appropriate habitat. Outside of the province, calling Northern Pygmy-Owls have been documented as close as 600 m apart in Oregon, home ranges were estimated at 75 ha in Colorado, and nests have been found as close as 1.25 km apart in Washington (Holt and Petersen 2000).

Movements and dispersal

It is a resident although there may be some seasonal altitudinal movement with birds descending to lower elevations in the fall (Campbell et al. 1990).

Habitat

Structural stage

Nesting
5: young forest (provided suitable wildlife trees)
6: mature forest
7: old forest

Foraging
3: shrub/herb
4: pole/sapling
5: young forest
6: mature forest
7: old forest

Important habitats and habitat features

Nesting

The Northern Pygmy-Owl has been reported breeding in mature and second-growth coniferous forests, mixed riparian forest, and pure deciduous stands. This owl tends to breed near the edge of forest openings, rather than in interior forest. Although this species may be a habitat generalist, using a variety of forest types during the breeding season, it is likely that the availability of suitable nesting sites (woodpecker or natural cavities) is the limiting factor influencing pygmy-owl distribution and abundance. Availability of prey could also affect distribution, although as a prey generalist this is not likely a critical factor.

Of the five known nests in British Columbia, three were in Douglas-fir (*Pseudotsuga menziesii*), one in western hemlock (*Tsuga heterophylla*), and one in western larch (*Larix occidentalis*) (Campbell et al. 1990). In northeastern Oregon, two nest trees (Douglas-fir and grand fir) (45.5 ± 9.2 cm dbh; $n = 2$) were in edge habitat, on or near steep slopes, within 110 m of streams, and had >80% canopy closure (Bull et al. 1987). Both nest-site stands were unlogged, ≤200 m wide and 2 km long. In the Oregon Coast Ranges, Northern Pygmy-Owl abundance was correlated positively with densities of bigleaf maple (*Acer macrophyllum*), although it is not known whether it uses maple for nesting (Nelson 1988). In this study, three nest trees were recorded (54.0 ± 1.7 cm dbh, 18.3 ± 1.2 m tree height, 6.3 ± 1.2 m nest height). Nest trees have been reported from southwest and east-facing slopes in Colorado; slope aspect is not available for other regions (Holt and Petersen 2000). Within British Columbia, its nests are often found on steep hillsides (Campbell et al. 1990)

A study in the Nimpkish Valley found that forest plots with Northern Pygmy-Owl present had lower basal area, crown closure, and average tree height, and were younger than random plots. These plots were also closer to lakes or wetlands than random plots (Setterington 1998). Evidence suggests that this owl is able to nest in wildlife tree retention areas within logged areas, presumably because these areas provide the required nesting sites (Bull et al. 1987; Gyug and Bennett 1995).

Cavities excavated by Northern Flickers (*Colaptes auratus*) and Hairy Woodpeckers (*Picoides villosus*) are likely the most useful for pygmy-owls. Thus the following information about nesting habitats for Hairy Woodpeckers, Northern Flickers, and Pileated Woodpeckers (*Dryocopus pileatus*) may assist in identifying potential nesting habitats for the Northern Pygmy-Owl.

Variables that best characterized Hairy Woodpecker nest plots in the Nimpkish Valley included a greater dbh and density of western hemlock, a greater basal area of deciduous and Douglas-fir trees, and a higher density of Douglas-fir stems (Deal and Setterington 2000). This same study found that the variables that best characterized Northern Flicker habitat were a greater dbh of amabilis fir (*Abies amabilis*), a greater basal area of western hemlock and western white pine (*Pinus monticola*), a greater volume of western hemlock and Sitka spruce, a greater density of western hemlock, and a lower density of yellow-cedar stems (Deal and Setterington 2000). On southeastern Vancouver Island in Coastal Western Hemlock and Coastal Douglas-fir biogeoclimatic zones, Pileated Woodpecker nest sites had significantly greater percentage canopy cover of maple and grand fir and a lower percentage cover of western hemlock than sites without nest trees (Hartwig 1999). Nest tree sites had significantly greater basal area, older structural stage, older successional stage, less disturbance, and significantly lower elevation than non-nest sites. In the Nimpkish Valley of northern Vancouver Island, 77% of Hairy Woodpecker and Northern Flicker nests were found on slopes <20%.

On northern Vancouver Island, in the Coastal Western Hemlock and Mountain Hemlock biogeoclimatic zones, most of Hairy Woodpecker nests ($n = 73$) were found in western hemlock (60%), Douglas-fir (20%), amabilis fir (10%), red alder (4%), and western white pine (3%). Nests were found less than expected in western redcedar, but in other tree species according to their availability. In the Nimpkish Valley, Northern Flicker nests were found in western hemlock (47%), Douglas-fir (18%), amabilis fir (15%), western white pine (9%), mountain hemlock (7%), and red alder (4%) (Deal and Setterington 2000). Northern flicker nests were found more than expected in western white pine and Douglas-fir. On southeastern Vancouver Island, Pileated Woodpecker nest cavities were found in grand fir, Douglas-fir, and red alder (Hartwig 1999). In western Oregon, nest and roost trees were found in Douglas-fir and red alder (Mellen 1987). The dbh of nest trees for these three species of woodpeckers differed depending on species of woodpecker and nesting location (Table 1). The dbh also differed depending on species of woodpecker and species of nest tree on northern Vancouver Island (Table 2).

Hairy Woodpeckers used wildlife tree classes 2–7 inclusive for nesting while the highest number of nests were found in classes 4 and 5 suggesting they prefer to nest in trees in a significant state of decay (Deal and Setterington 2000). Hairy Woodpecker nests were found more often than expected in bark class 1 trees (all bark present) and 55% of the Hairy Woodpecker nests were found in snags with >95% of the bark remaining (Deal and Setterington 2000).

In the Nimpkish Valley, Northern Flickers appeared to be select trees of decay classes 3–6 and trees with all the bark in tact. Pileated Woodpecker nest and roost trees usually had broken tops and were within the upper canopy (Hartwig 1999). Nest or roost trees ranged from being live and healthy to dead with most branches gone or absent, decay classes 2–5. In western Oregon, nest or roost trees typically had a broken top and retained most of the bark (Mellen 1987).

Foraging

This owl forages in a variety of forest types, ranging from deciduous or mixed forests in the valley bottoms to purely coniferous forest at higher altitudes. It is usually associated with the forest edge,

Table 1. Dbh (mean ± SD) (cm) of nest trees of Hairy Woodpeckers (HAWO), Northern Flickers (NOFL), and Pileated Woodpeckers (PIWO) in four locations

Forest	Location	*n*	HAWO	N	NOFL	*n*	PIWO	Citation
Western hemlock	Oregon Coast Ranges	23	72.2 ± 48.0	9	95.8 ± 30.0	15	68.9 ± 25	Nelson 1988
Mixed conifer to Douglas-fir	South. Cascades	18	73.9 ±33.4	3	127.7 ± 38.5	2	88.0 ±19.8	Lundquist 1988
CWHxm, CWHvm, MHmm	Northern Vancouver	73	78.6 ± 28.1	85	73.1 ± 3.4	2	84.2 ± 17.5	Deal and Setterington 2000
CWHxm, CDF	SE Vancouver Island					7	82 ± 42	Hartwig 1999

Table 2. Dbh (mean ± SD) (cm) of nest trees of Hairy Woodpeckers (HAWO), and Northern Flickers (NOFL) by tree species found in the Nimpkish Valley (after Deal and Setterington 2000)

Species	HAWO	*n*	NOFL	*n*
Amabilis fir	66.4 ± 23.0	8	71.0 ± 36.6	11
Douglas-fir	95.1 ± 37.6	15	110.6 ± 37.2	15
Western hemlock	76.6 ± 22.9	48	64.7 ± 18.7	39
Western white pine	77.5 ± 34.6	2	60.1 ± 18.1	9

rather than continuous tracts of forest (Campbell et al. 1990; Holt and Petersen 2000), including road edges and regenerating clearcuts. It seems to prefer habitats with a diverse understorey structure, which provides habitat for a variety of small mammals and birds.

Conservation and Management

Status

The Vancouver Island Pygmy-Owl 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	Canada	Global
S3	N3	G5T3Q

Trends

Population trends

Population size is unknown but is presumably small. There are few breeding records and no data on breeding ecology. Populations were generally thought to be declining (Campbell et al. 1990; Fraser et al. 1999). Sufficient data are lacking and long-term trends cannot be estimated. In the Nimpkish Valley, on northern Vancouver Island, numbers of Northern Pygmy-Owls remained relatively stable from 1995 to 1997, and were much more stable compared with other small forest owls such as the Western Screech-Owl (*Otus kennicotti*) and Northern Saw-whet Owl (*Aegolius acadicus*) (Setterington 1998).

Habitat trends

The Northern Pygmy-Owl is not a bird of continuous old-growth coniferous forest. It is most frequently encountered along forest edges or in disturbed areas. Since the Northern Flicker, the primary provider of nest cavities for Northern Pygmy-Owls, prefers edge habitat, and modern forestry practices include conservation of riparian forest, smaller cutblocks, and wildlife tree retention areas, it seems likely that breeding habitat is increasing rather than decreasing.

Threats

Population threats

Barred Owls (*Strix varia*) are increasing throughout Vancouver Island. Anecdotal evidence suggests that the increased population of the larger Barred Owl, following forest fragmentation, may have led to local declines in Northern Pygmy-Owls, Western Screech-Owls and Northern Saw-whet Owls on Vancouver Island where Barred Owls occur. However, data on impacts of Barred Owls are not available.

Populations of this subspecies are endemic to Vancouver Island and the Gulf Islands.

Habitat threats

Holt et al. (1999) stated that no populations of Northern Pygmy-Owl are threatened or endangered, but one local population was extirpated from a California redwood forest in which snags had been removed while owls still occurred in an unlogged adjacent forest (Marshall 1988). This example suggests there is potential for inappropriate forest management practices to negatively impact on pygmy-owl populations.

Populations of *G. gnoma swarthi* likely have few long-term threats even though nesting habitat was thought to be generally threatened by forest harvesting (Campbell et al. 1990; Fraser et al. 1999). Traditional clearcuts remove entire stands as nesting habitat, whereas historical partial cut logging often removed the larger trees needed for recruitment as future nest trees for woodpeckers and subsequently pygmy-owls (Fraser et al. 1999). With the current practices of smaller clearcuts with wildlife tree retention areas and riparian reserve zones, large-scale population reduction is unlikely. In fact, since this owl prefers edge habitat to continuous forest, current forest practices may be increasing available habitat.

Local population fluctuations can be expected if owl territories are logged without adequate retention of wildlife tree habitat. Workers' Compensation Board (WCB) regulations require cutting of decadent trees that have been identified as "danger trees" in partial cut situations, both within the work area and within falling distance of the edge of the work area. Cutting of these "danger trees" removes potential high-quality nest trees.

Legal Protection and Habitat Conservation

The Northern Pygmy-Owl, its nests, and its eggs are protected from direct persecution by the provincial *Wildlife Act*.

Much of the *G. gnoma swarthi*'s habitat is on Crown land, some of which is currently conserved in provincial or federal protected areas (e.g., Goldstream, Strathcona, Englishman River Falls, Carmanah-Walbran Provincial Parks, and Clayoquot Sound and Pacific Rim National Parks).

Under the results based code, the old forest retention targets (old growth management areas), riparian reserves, and wildlife tree retention area recommendations may partially address the requirements of this subspecies. Habitat may also be conserved in other management areas that have specific management guidelines concerning the retention of wildlife trees and related forest structure (e.g., ungulate winter range). Patches of mature or old forest habitat that include potential nest trees and recruitment trees should maintain breeding pairs because foraging could be accommodated in younger stands (Gyug and Bennett 1995).

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

Because this species is largely dependent on woodpecker cavities, particularly those of medium-sized woodpeckers (e.g., Hairy Woodpecker and Northern Flicker), for nest sites, management practices that benefit woodpeckers will also enhance habitat for the Northern Pygmy-Owl.

- ❖ The objective for this species is to maintain suitable wildlife trees and green recruitment trees for nesting across the breeding range and over time. Consider WTR, OGMA, or riparian objectives for this species in all forest districts on Vancouver Island.
- ❖ Blocks should be assessed to identify potentially suitable WTR areas for the Northern Pygmy-Owl on Vancouver Island. Suitable WTR areas or OGMAs for this species should be based on the information in Table 3.
- ❖ It is recommended that salvage 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 that should be maintained over the long term (>80 years).

Maintain forest riparian management zones.

Wildlife habitat area

Goal

Since there are very few known nest areas for this subspecies, these sites should be established as WHAs. Suitable habitat should be managed through wildlife tree or old forest retention objectives.

Feature

Establish WHAs at known nests or occupied residences. Residency is indicated by detection during the breeding season.

Size

Typically between 80 and 100 ha but size will depend on site-specific conditions.

Design

Design WHA to minimize disturbance and maintain suitable foraging habitat. The WHA should include a 12 ha core area around the nest area if known and a 300–400 m management zone. The management zone should encompass the remaining home range, which should be estimated based on suitable habitat. When the exact location of nest site is not known, design core area to include highly suitable nest trees or known roost sites.

Table 3. Preferred WTP considerations for the Vancouver Island Northern Pygmy-Owl

Attribute	Characteristics
Size (ha)	≥1 ha in size
Features	large dbh and highest density of western hemlock, Douglas-fir, and/or deciduous stems; greater dbh of amabilis fir, greater basal area of western hemlock and western white pine, greater volume of western hemlock and Sitka spruce; greater percentage canopy cover of maple and grand fir, Douglas-fir dominant overstorey
Location	CWHvh, CWHxm, CWHdm, CWHmm, CWHvm, MHwh, MHmmp, MHmm; preferably within 500 m of riparian areas, gully/ravine complexes or forest-meadow edges; steeper gradients may be preferred
Tree features	visible woodpecker or natural cavities; broken tops; trees in upper canopy
Tree species	western hemlock, Douglas-fir, amabilis fir, grand fir, red alder, bigleaf maple, western white pine, western redcedar, mountain hemlock
Tree size (dbh*)	75–105 cm preferred: amabilis fir (70–100), Douglas-fir (100–140), western hemlock (70–95), western white pine (60–85). In the absence of trees of the preferred dbh, trees ≥40 cm dbh should be retained for recruitment
Wildlife tree class	2–6; mix of live and dead trees particularly those with an indication of heart rot
Bark class	1–2

* Weighted mean and pooled standard deviation for Hairy Woodpecker and Northern Flicker (Deal and Setterington 2000).

General wildlife measures

Goals

1. Maintain nest site or potential nest tress.
2. Minimize disturbance during critical breeding times (1 March to 30 June).
3. Maintain important structural elements for breeding and foraging.
4. Ensure WHA is windfirm.

Measures

Access

- Do not construct roads or trails within the core area unless there is no other practicable option.
- Do not construct roads during critical breeding times (1 March to 30 June) within the management zone.

Harvesting and silviculture

- Do not harvest or salvage within the core area.
- Do not salvage within the management zone. If the nest tree and other potential nest trees are not damaged, limit salvage to trees on the ground or hung-up.
- In the management zone, use partial harvesting methods that retain at least 40% basal area. Retain wildlife trees as described in Table 3 or, where not available, retain the largest dbh class trees to meet 40% retention and maintain for a full rotation with no additional harvest entries.
- Do not harvest in the management zone during the breeding season (1 March to 30 June).
- Retain a minimum 10 m riparian reserve zones on all reaches of small streams (i.e., S4, S5, S6) within WHA.

Pesticides

- Do not use pesticides.

Additional Management Considerations

Because nesting habitat is likely much more limiting than foraging habitat, silvicultural systems and practices that benefit Northern Flickers and Hairy Woodpeckers will likely enhance habitat for Northern Pygmy-Owls as well. This includes the application of various partial cut harvesting systems that retain individual trees and/or groups of trees (e.g., variable retention, sheltered, seed tree, clearcut with reserves). In these systems, both patches and individual leave trees should be considered for long-term retention to enhance recruitment of larger diameter dead and dying wildlife trees. In stand-tending operations such as juvenile spacing, if any large diameter wildlife trees are residual, these should be assessed for safety concerns and retained wherever possible. Also avoid isolating quality habitat patches.

Information Needs

1. Population estimates and trends.
2. Distribution and relative abundance in various BEC subzones.
3. Suitability of various sizes and quality of wildlife tree retention areas for nesting habitat.

Cross References

Marbled Murrelet

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Ancient Murrelet

Synthliboramphus antiquus

Original[1] prepared by Anne Harfenist

Species Information

Taxonomy

The Ancient Murrelet belongs to the family Alcidae, the auks. It is the only one of four species in the genus *Synthliboramphus* to occur commonly and regularly in British Columbia (Gaston 1994a). Within the alcids, the Ancient Murrelet is most closely related to the Japanese Murrelet (*Synthliboramphus wumizusume*) found only near Japan; the other two *Synthliboramphus* murrelets are Craveri's (*S. craveri)* and Xantus' (*S. hypoleucus)* murrelets, which are found primarily near the Gulf of California and along the coast of California to Baja California, respectively (Gaston and Jones 1998). Two races of Ancient Murrelet have been described: *Synthliboramphus antiquus antiquus* and *S. antiquus microrhynchos* but Gaston and Jones (1998) call the validity of the latter race, found only on the Commander Islands, doubtful.

Description

The Ancient Murrelet is a relatively small auk with a wing length of ~14 cm and weighing about 200–250 g (Gaston 1994a). Males and females are similar in appearance: in adults the back, upper wings, and upper tail are moderate grey; the head is black; the belly is white; legs and feet are pale blue; and the short pointed bill is pinkish. In breeding plumage, Ancient Murrelets have a black bib that extends from the throat down to the upper breast and long white filamentous plumes along the sides of the crown which are the feature that give the bird the "ancient" look for which they are named (Gaston 1994a). The non-breeding plumage lacks the black bib and the plumes are reduced; this plumage is not maintained for very long and many birds seen in December are in breeding plumage (Gaston and Jones 1998). The plumage of immature Ancient Murrelets is similar to that of the winter adult with no plumes and a white throat (Gaston 1994a). Chicks are covered with down in a colour pattern similar to that of immature birds.

Distribution

The Ancient Murrelet spends most of its life at sea, coming to land only to breed.

Global

The range of the Ancient Murrelet describes an arc around the rim of the northern Pacific Ocean. Breeding colonies are found on offshore islands north from China in the western Pacific (35–62° N), across the Aleutian Islands and south through the Queen Charlotte Islands/Haida Gwaii in the eastern Pacific (52–60° N) (Gaston and Jones 1998). The at-sea distribution of the birds during the breeding season covers approximately the same geographic range. The wintering distribution includes the waters used during the breeding season, but extends into the Bering Sea in the north and along the eastern Pacific coast south to Baja California (Gaston and Jones 1998). In the eastern Pacific Ocean, Ancient Murrelets are probably most numerous in winter between 40 and 50° N (Gaston 1994a). The distribution of this species during the post-breeding season until the birds reach the wintering grounds is unknown.

British Columbia

Known Ancient Murrelet breeding colonies in British Columbia are confined to offshore islands in the Queen Charlotte Islands/Haida Gwaii (Rodway 1991). Approximately one-half of the birds nest at three large colonies off the northwest side of

1 Volume 1 account prepared by A. Derocher.

Ancient Murrelet

(Synthliboramphus antiquus)

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

Graham Island and about 44% breed at 17 colonies off the east coast of Moresby Island; the remaining 7% nest at 10 small colonies off the northwest side of Moresby Island (Rodway et al. 1988, 1990, 1994). A single incubating adult was reported from the Moore Islands along the mainland coast in 1970 (Campbell et al. 1990), but a subsequent survey in 1988 did not find evidence of breeding at that site (Rodway and Lemon 1991). The presence of Ancient Murrelets in breeding plumage on the waters off northwestern Vancouver Island during the breeding season may indicate a small colony/colonies in that area but nesting has not been confirmed (Gaston 1994b). Birds are common and abundant on the waters near their colonies during the breeding season.

Ancient Murrelets are rarely seen in British Columbia waters during late summer and early fall (Campbell et al. 1990). Wintering aggregations occur in the marine waters around Vancouver Island including Queen Charlotte Strait, Strait of Juan de Fuca, Haro Strait, and Active Pass (Campbell et al. 1990). Smaller numbers of Ancient Murrelets winter throughout coastal British Columbia, but the birds are rarely found in protected inland waters such as fjords and inlets.

Forest region and district[2]

Coast: Queen Charlotte Islands

Ecoprovinces and ecosections

Nesting:

COM: SKP, WQC

At-sea:

COM: DIE, HES, QCS, QCT, VIS

GED: JDF, SOG

NOP: JOS, NCF, OQC, QCC, SAP, TPR, VIC

Biogeoclimatic units (nesting)

CWH: vh2, wh1

Broad ecosystem units

CH, HS

2 Only forest districts with breeding habitats are listed.

Life History

Diet and foraging behaviour

Few data are available on the diet of the Ancient Murrelet. The diet appears to consist primarily of large zooplankton and small schooling fish; specific prey species and relative proportions in the diet vary across the range of the murrelet (e.g., Gaston 1994a) and among years (Sealy 1975; Vermeer et al. 1985). In one study conducted near Langara Island, the diet of adults was comprised primarily of euphausiids early in the breeding season: *Euphausia pacifica* in late March/early April and *Thysanoessa spinifera* in late April/May (Sealy 1975). In June, approximately half of the diet was juvenile sand lance (*Ammodytes hexapterus)* with euphausiids making up the other half. Juvenile shiner perch (*Cymatogaster aggregata)* and rockfishes (*Sebastes* spp.) were also consumed later in the breeding season (Sealy 1975). The diet of subadults was dominated by euphausiids (primarily *Thysanoessa spinifera)* and sand lance. Another study in the same area but in a different year found significant amounts of fishes in the diet of adults in May; in June the diet was almost exclusively larval and juvenile fish including ~25% rockfish as well as greenlings (*Hexagrammas* spp.) and flatfish (Pleuronectidae) (Vermeer et al. 1985). Young-of-the-year, presumably shortly after independence from their parents, forage almost entirely on sand lance (Sealy 1975; Gaston 1992).

The only information on the winter diet of Ancient Murrelets comes from birds off southeastern Vancouver Island (Gaston et al. 1993). Almost the entire diet was comprised of *Euphausia pacifica* throughout the winter except in November when significant amounts of juvenile herring (*Clupea harengus)* were eaten.

Ancient Murrelets forage in marine waters. They tend to forage over the continental shelf and slope; in British Columbia they forage most commonly over the shelf break and in areas where tidal upwellings force food close to the surface (Vermeer et al. 1985; Gaston 1994a). The main method of prey capture is pursuit diving to depths of 10–20 m; the birds use their wings to propel themselves under water (Gaston 1992). On occasion, murrelets also feed at the surface (Gaston 1992). Ancient Murrelets usually forage in small groups and are found in either single species or mixed species feeding flocks (Gaston 1992; Gaston et al. 1993). Chicks are fed by their parents for more than a month after leaving the nesting colony (Litvinenko and Shibaev 1987).

Reproduction

The timing of breeding in Ancient Murrelets varies across the species' range: there is a 6-day delay for every 1° C decrease in mean April sea surface temperature near the colonies (Gaston 1992). Timing is not related to latitude, which suggests that food supply rather than day length is a critical factor (Gaston 1994a). The information presented below is for the Queen Charlotte Islands/Haida Gwaii, the only breeding area in British Columbia.

Ancient Murrelets are colonial burrow-nesters. The birds begin to visit their colonies in March and begin laying eggs 1–10 April (Gaston and Jones 1998). During the pre-laying period, the birds are seen in late afternoon on the waters around the nesting colonies and on land at night (Gaston 1992). Egg-laying at a colony occurs over about 45 days, but approximately one-half of all clutches are initiated within a single 6–10 day period (Gaston and Jones 1998). Dates of median clutch completion are 17 April–9 May (Gaston and Jones 1998). Almost all clutches consist of 2 eggs laid 6–10 days apart (Gaston 1994a). Adults begin incubation 1–2 days after the second egg is laid; the eggs may be neglected up to 7 days before incubation begins (Gaston 1994a). Only one clutch is produced per year.

Incubation lasts for approximately 1 month and is shared equally between parents, with incubation shifts of 2–4 days (Sealy 1976; Gaston 1992). The precocial chicks hatch within 12 hours of each other and weigh an average of 31 g one day post-hatching (Gaston 1992). The chicks are not fed in the burrows and leave the colony at night by running to join their parents at sea about 2–3 days after hatching. Median dates of chick departure differ significantly among colonies and years: in the 1990s, the earliest median date was recorded at Reef Island in 1995 and Limestone Island in 1996 (21 May) and the latest at Frederick Island in 1997 (3 June; Gaston and Harfenist 1998). The timing of departures was 8–11 days later off the northwest coast of Graham Island than off the east coast of Moresby Island; the difference is too large to be accounted for solely by variation in sea surface temperature around the archipelago (Gaston and Harfenist 1998).

Family groups swim quickly away from the breeding colony and are rarely seen inshore (Sealy 1975; Gaston 1992). Both parents feed their chicks at sea for at least a month until they are fully grown (Litvinenko and Shibaev 1987). *Synthliboramphus* is the only genus of seabirds in which the young are raised entirely at sea (Gaston 1994a).

Non-breeding birds visit breeding colonies at night; numbers peak during the second half of the incubation period (Gaston 1992). There is little activity by either breeders or non-breeders at the colonies by the end of June off eastern Moresby and early July off western Graham (Gaston 1992, 1994a).

The age at first breeding in Ancient Murrelets is 3–4 years (Gaston and Jones 1998). On Reef Island the age structure of the population at the beginning of the breeding season was 30% first-year birds, 29% non-breeding second- and third-year birds, and 41% breeding birds (Gaston 1994a). Mean annual survival of adults at Reef Island was estimated at 77% (Gaston 1990). Survival is relatively low for an alcid, but reproductive success is relatively high: almost all pairs lay a two-egg clutch and reproductive success up to the time that the chicks leave the colony is 1.44–1.69 chicks per laying pair (Vermeer and Lemon 1986; Rodway et al. 1988; Gaston 1994a). Most reproductive failure is caused by desertion of the eggs before incubation begins (Gaston and Jones 1998).

Site fidelity

Two types of site fidelity are considered for colonially nesting seabirds: fidelity to natal colony and fidelity to nest site. There is little information about fidelity of Ancient Murrelet to their natal colony as few birds banded as chicks have been recovered. Prospecting pre-breeders visit colonies close to their natal colonies and some recruitment to a non-natal colony has been observed (Gaston and Lemon 1996). Fidelity to nest site is difficult to determine as the birds nest in burrows and disturbance at their nests can cause desertion, but limited data suggest that there is some site fidelity at the burrow level. Burrows in which a pair bred successfully are more likely to be occupied in the following year than burrows in which eggs were deserted (Gaston 1992). Murrelets that have abandoned a burrow rarely return to that burrow (Gaston 1992).

Home range

Not applicable.

Movements and dispersal

The post-breeding season movements of Ancient Murrelets are largely unknown. Family groups immediately disperse from the waters around the breeding colony once the chicks have joined their parents at sea; within 6–8 hours of departure, family parties traveled an average of 13 km from the colony (Duncan and Gaston 1990). In British Columbia, Ancient Murrelet families from colonies off the east side of Moresby Island remained in offshore waters of Hecate Strait for several weeks (Duncan and Gaston 1990). Small numbers of birds have also been observed in offshore waters off Barkley Sound following the breeding season (Vermeer et al. 1987). During late summer and early fall, Ancient Murrelets are rarely seen in British Columbia's waters or elsewhere along coastal North America and their movements during this season are unknown (Campbell et al. 1990; Gaston 1994a). The birds reappear farther south at their wintering grounds in inshore waters around Vancouver Island by mid-October and off California by November (Campbell et al. 1990; Gaston 1994a). However, a small number of Ancient Murrelets move northward to winter in the Bering Sea and others winter throughout the breeding range (Gaston 1994a). Adults return to the marine waters adjacent to their colonies by March (Gaston 1992).

Ancient Murrelets are occasionally recorded from sites in the Interior of British Columbia; these are presumed to be windblown from the Coast (Campbell et al. 1990; Gaston 1994a).

Habitat

Structural stage

7: old forest

Important habitats and habitat features

Nesting

Ancient Murrelets require islands without alien mammalian predators. Colony areas and adjacent shorelines must also be free of most human disturbances. Ancient Murrelets require nearby marine areas with no lights or gill net fishery.

In British Columbia, Ancient Murrelet colonies are located on forested islands offshore from the main islands in the Queen Charlotte Islands/Haida Gwaii archipelago. Almost all Ancient Murrelets nest in burrows dug into the ground beneath mature Sitka spruce or western hemlock on seaward slopes or flat areas (Vermeer et al. 1984; Gaston 1992). On Frederick Island, nesting was densest on mossy slopes lacking understorey beneath hemlocks: 79%, 19%, and 2% of burrows were under western hemlock, Sitka spruce, or western redcedar, respectively (Vermeer et al. 1984). On Reef Island, most burrows are under >50% canopy cover (Gaston 1992). Most burrow entrances are found at the base of trees, stumps, or fallen logs; infrequently the birds nest in rock crevices or natural cavities in rotten logs (Vermeer and Lemon 1986; Gaston 1994a). Burrow tunnels are up to 2 m long (Vermeer and Lemon 1986; Gaston 1992). Ancient Murrelets excavate their own burrows or use burrows excavated by other individuals in previous years.

Most Ancient Murrelet burrows are located within 300 m of the ocean, but may be found up to 450 m from shore (Rodway et al. 1988, 1990, 1994). On Reef Island, peak burrow density was about 100 m from shore and densities were highest on slopes >30° (Gaston 1992). However, the birds also nest densely on flatter islands (Rodway et al. 1988, 1990, 1994). A summary of habitat plot data from colonies throughout the Queen Charlotte Islands/Haida Gwaii indicates that almost half of the plots had burrow densities below $0.33/m^2$ (G.W. Kaiser, unpubl. data).

Marine

During the breeding season, Ancient Murrelets are found primarily over the continental shelf and slope in waters with sea surface temperature between 4° and 20° C (Gaston 1994a). Highest densities are found near the shelf break (Vermeer et al. 1985); less frequently the birds are found in inshore waters (Gaston 1992). The waters adjacent to breeding colonies are used as gathering grounds in early evening and near dawn, but the birds are not usually seen near their colonies for most of the day. Important marine habitat features during late summer/early fall are unknown. In winter Ancient Murrelets are found over the continental shelf and slope in British Columbia, where aggregations of birds are found in areas of tidal upwelling that concentrates prey (Morgan et al. 1991; Gaston et al. 1993).

Conservation and Management

Status

The Ancient Murrelet is on the provincial *Blue List* in British Columbia. In Canada, it is considered a species of *Special Concern* (COSEWIC 2002).

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

AK	BC	CA	OR	WA	Canada	Global
S4	S2S3B, S4N	S?	SZN	S3S4N	N3	G4

Trends

Population trends

The Canadian breeding population of Ancient Murrelets is approximately 256 000 pairs, all of which nest on the Queen Charlotte Islands/Haida Gwaii (Vermeer et al. 1997). Although population estimates in British Columbia are fairly accurate, estimates for much of the range are poor with only presence/absence data available from some sites and rough approximations of colony size at others (Springer et al. 1993). A best guess is that the B.C. population represents about one half of the world population (Gaston 1994a).

Ancient Murrelet populations have declined throughout the species' range due to depredation at the colonies by introduced mammals including rats, raccoons, and foxes (Bailey and Kaiser 1993). Some colonies, such as those on Lucy and Cox islands, have been extirpated by introduced predators (Gaston 1994b). The Aleutian Island population may have declined by 80% (Springer et al. 1993). Trend information is not available for the western Pacific populations, but breeding populations there have probably declined due to introduced predators; some small unprotected colonies in Japan, Korea, and China may be in danger of extirpation (Springer et al. 1993; Gaston 1994a). On the Queen Charlotte Islands/Haida Gwaii, all estimates from colonies without introduced predators indicate that breeding populations have increased by 0.2–9.5% annually since 1980 (Lemon and Gaston 1999). However, populations at those colonies with introduced predators have decreased at an annual rate of 1–23%. The total breeding population in the archipelago has declined by an estimated 50% in the last few decades (Gaston 1992). On Langara Island, the population declined from a historical level of about 200 000 pairs (Gaston 1992) to <15 000 pairs in 1993 (Harfenist 1994). Introduced rats are believed to be largely responsible for the decline; mortality caused by commercial gill net fisheries was also a contributor (Bertram 1995). Rats were eradicated from Langara Island in 1995 (Kaiser et al. 1997), but the Ancient Murrelet population had not shown evidence of recovery 5 years later (Drever 2000). Population declines or extirpations have also been attributed to rats at Kunghit, Lyell, Cox, Lucy, Murchison, and Bischof islands (Harfenist and Kaiser 1997). Introduced raccoons are believed responsible for declines on Limestone, Saunders, and Helgesen islands: the breeding population on Helgesen Island declined by over 80% over a 7-year period when 8–12 raccoons were present (Gaston and Masselink 1997).

Habitat trends

The presence of introduced mammalian predators on present, former, and potential colony islands has rendered those islands unsuitable for nesting Ancient Murrelets. With the exception of the presence of introduced species, potential suitable nesting habitat in British Columbia is likely relatively stable as the forests on colony islands have not been altered by industrial activities or urban development since the creation of Gwaii Haanas National Park Reserve/Haida Heritage Site. On Langara Island, a sports fishing lodge was constructed on an area historically used for nesting by Ancient Murrelets. On a regional level, there is no evidence that the availability of suitable breeding habitat limits the breeding population: some colony islands have large areas of unused suitable habitat (Gaston 1994b).

It is difficult to estimate the availability of suitable marine habitat for Ancient Murrelets. Suitable marine habitat adjacent to colonies may have increased with the decline in the commercial gill net fishery.

Threats

Population threats

Introduced mammalian predators pose the most serious immediate threat to nesting Ancient Murrelets in British Columbia (e.g., Gaston 1994b). Rats and raccoons have killed hundreds of thousands of adults and chicks (see "Population trends" above). At least one-half of the Ancient Murrelet colonies in the Queen Charlotte Islands/ Haida Gwaii are vulnerable to invasion by raccoons (Lemon and Gaston 1999). Rats are less likely to swim between islands but may reach new colonies on commercial or pleasure boats or ship wrecks.

Other significant threats are contaminants, exploitation of ocean resources, human recreation, and climate change (e.g., Vermeer et al. 1997). Oil pollution is the main contaminant threat to Ancient Murrelets: effect of oil on seabirds is well documented (e.g., Burger and Fry 1993). Ancient Murrelet carcasses comprised 2.4% of the birds washed up on Vancouver Island following the Nestucca oil spill (Rodway et al. 1989), but was one of most common species killed in oil spills in the Sea of Japan (Kazama 1971). Mortality from large episodic spills receive most of the attention, but impacts from chronic low-level pollution from ship operations such as bilge-flushing or leaking tanks may be more of a threat (Burger et al. 1997). Levels of organochlorine contaminants found in Ancient Murrelets nesting in British Columbia are probably below levels likely to seriously affect populations (Elliott et al. 1997).

The main issues of concern related to exploitation of ocean resources are bird/fisheries interactions and oil and gas development. The most serious threat to this species from the commercial fishery is that of bycatch in fishing nets. Significant numbers of Ancient Murrelets drowned in nets during gill net fisheries off Langara Island (Bertram 1995). Collisions with wires and ropes by birds attracted to lights on the boats caused additional mortality. Commercial and recreational overfishing of Ancient Murrelet prey species such as rockfish and herring may lead to a decrease in the availability of juvenile stages of these species for the birds (Vermeer et al. 1997). Oil and gas development in the oceans around the Queen Charlotte Islands/Haida Gwaii has the potential to increase mortality of Ancient Murrelets caused by oil or metal contamination as well as that caused by collisions around lights (Montevecchi et al. 1999). Wind turbines, such as those recently proposed for a site off Rose Spit, may also present a risk to migrating birds.

The activities of tourists involved in recreational boating or camping can damage the birds' habitat (see following section) or injure or kill to adults and chicks. The main risk is from campfires built on shorelines near colony sites. The birds are attracted to lights and will fly or run into fires; this was the main hunting technique used by the Haida (Ellis 1991). Lights around recreational boats or campsites will also disorient the birds.

Climate change has been indirectly linked to changes in seabird populations via alterations of their prey species' ecology (e.g., Anderson and Piatt 1999). Although there have been no studies of effects of climate change on Ancient Murrelets, warm marine waters during an El Niño event have been linked to a reduction in reproductive success in this species (Gaston and Smith 2001).

In the past Ancient Murrelet adults and eggs formed a significant part of the diet of Haida (Ellis 1991), but at present there is little threat to the breeding populations from human harvesting.

Habitat threats

The main threats to habitat are visitor activities that damage burrows and habitat destruction at sites from which the birds have been eradicated by introduced predators. On Langara Island, a sports fishing lodge was recently built on a former colony area, precluding full recovery of the Ancient Murrelet population on that island following the removal of the predators (Kaiser et al. 1997). In addition, development or activities that significantly alter the shoreline such as mariculture or recreational sites are a threat to the suitability of nesting habitat because chicks and adults require a relatively unobstructed route between their burrows and the ocean.

Forest harvesting at breeding colonies can be a significant threat; however, almost all of the currently active Ancient Murrelet breeding colony sites in British Columbia are protected or proposed for protection (i.e., WHAs).

Marine habitats adjacent to colonies and important feeding areas are threatened by oil pollution, oil and gas development, log sorts, and mariculture operations. The marine habitat can be rendered temporarily unsuitable for Ancient Murrelets by the presence of a commercial fishing fleet or a nearby sports fishing lodge.

Legal Protection and Habitat Conservation

The Ancient Murrelet, its nests, and eggs are protected in Canada and the United States from hunting and collecting under the *Migratory Birds Convention Act*. In British Columbia, it is protected from killing, or wounding, taking, and transporting under the *Wildlife Act*. However, Ancient Murrelets were traditionally an important food source for members of the Haida Nation and Haida can still legally hunt the birds for subsistence purposes.

In British Columbia, 16 of the 31 active nesting colonies are within Gwaii Haanas National Park Reserve/Haida Heritage Site and are protected under the *Canada National Parks Act.* Two additional colonies are within a B.C. Provincial Wildlife Management Area and covered under the *Wildlife Act.* One colony is within an ecological reserve and protected under the *Ecological Reserves Act.* The remaining 12 colonies have been designated as wildlife habitat areas under the *Forest Range and Practices Act*. Two colony islands (Lucy and Cox islands) from which Ancient Murrelets were eradicated by rats are on provincial Crown land.

Marine protected areas for the conservation of Ancient Murrelets can be created under the *Canada Wildlife Act,* although none have been designated to date. The *Canada National Marine Conservation Areas Act* came into force in June 2002. This act provides authority for the establishment of marine conservation areas. Marine bird bycatch in fisheries is covered under the *Fisheries Act.*

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

The establishment of WHAs may not be adequate to address the threats faced by Ancient Murrelets. The link between terrestrial nesting habitats and adjacent and nearby terrestrial and marine habitats should be considered.

- ❖ Provide unobstructed access to the open ocean for adults and chicks departing the colony (i.e., no development such as log sorts, fishing lodges, mariculture operations, or recreation sites on shore, in intertidal areas or nearshore areas, or along opposite shores of non-colony islands).
- ❖ Provide undisturbed access to marine foraging grounds for adults during the breeding season.
- ❖ Discourage commercial and sports fishing activities in adjacent marine waters or in key foraging areas during the breeding season.

- ❖ Provide uncontaminated marine waters around colonies and foraging areas: to prevent exposure to chronic oil pollution from commercial or recreational boats, no mooring buoys in inshore areas around colonies.
- ❖ Provide colony and near-colony habitats free of light pollution.
- ❖ Maintain integrity of marine habitats of prey species.
- ❖ Restrict recreational use and access to colony sites (see "Additional Management Considerations").

Wildlife habitat area

Goal

Protect and maintain integrity of breeding colonies.

Feature

Establish WHAs at all extant and extirpated breeding colonies not already within national parks, national park reserves, ecological reserves, or wildlife management areas. Where Ancient Murrelet nesting colonies have been negatively impacted by introduced predators, WHAs should be established on former colony sites once the threat has been removed to allow the re-establishment of the colony and the recovery of the population.

Size

Generally between 5 and 50 ha but will vary with size and shape of nesting area.

Design

Ancient Murrelets nest around the periphery of islands and adults and chicks need unhindered access to the ocean. WHAs should include all areas with active nesting and the adjacent shoreline areas plus 200 m to maintain the quality and isolated nature of the forest and forest floor. In some cases, it may be necessary to include more area (possibly entire island) to ensure the integrity of a WHA is maintained (i.e., when active nesting occurs around the entire or significant proportion of an island and the only access for development would impact the colony such as impacting the integrity of the forest or forest floor).

General wildlife measures

Goals

1. Protect breeding colonies from development and disturbance.
2. Prevent mortality and disturbance of breeding birds and young on and adjacent to nesting areas.
3. Maintain important habitat features (i.e., intact forest structure and forest floor).
4. Prevent the introduction of non-native species.

Measures

Access

- Do not develop roads or access structures and restrict access to qualified biologists for monitoring populations.

Harvesting and silviculture

- Do not harvest or salvage timber. Do not allow development of any form in WHA or adjacent inshore waters.

Pesticides

- Do not use pesticides.

Recreation

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

Additional Management Considerations

Under the results based code (RBC), colonies can be protected from forest practices (including restrictions on establishing Ministry of Forests recreational facilities); however, it is not the mandate of the RBC to regulate recreational activities. Recreational activity at these colonies is considered a serious threat to this species. The following recommendations should be considered at colony sites.

Restrict access and do not allow recreational activities on colony islands.

Do not allow sports fishing lodges adjacent to colonies or on nearby shorelines.

Avoid activities involving lights or fires on nearby shorelines or in inshore waters around colonies.

Educate public on how to avoid disturbing nesting colonies. Clearly mark on marine and recreation maps with a notation that human access is prohibited at WHAs and other sites protected for these species.

Remove introduced species from colony islands. Ensure that non-endemic plants and animals are not introduced to colony islands. If necessary, reintroduce Ancient Murrelets to islands where colonies have been extirpated once introduced predators have been eradicated.

Information Needs

1. Population trend data have wide confidence intervals. Methodologies should be used to produce more precise population estimates and trends should be monitored.
2. The species' marine habitat is not well described. Important feeding areas should be determined.
3. Methods of eradicating introduced predators should be refined and those of attracting Ancient Murrelets back to areas from which they have been eradicated should be tested.

Cross References

Cassin's Auklet, Keen's Long-eared Myotis,"Queen Charlotte" Northern Saw-whet Owl, "Queen Charlotte" Hairy Woodpecker

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Cassin's Auklet

Ptychoramphus aleuticus

Original[1] prepared by Anne Harfenist

Species Information

Taxonomy

The Cassin's Auklet is a member of the family Alcidae, the auks, and is the only species in the genus *Ptychoramphus.* According to mitochondrial DNA evidence, it is most closely related to the other genera of Pacific planktivorous auklets, *Aethia* and *Cyclorrhynchus* (Friesen et al. 1996). There are two subspecies of Cassin's Auklet: *Ptychoramphus aleuticus aleuticus* and *P. aleuticus australe* (Manuwal and Thoresen 1993). *P. aleuticus aleuticus* is found over most of the species' range from Alaska to Guadalupe Island in Baja California; *P. aleuticus australe* is the more southern form.

Description

The two subspecies are almost identical in appearance although the more southerly birds are smaller in length and mass (Manuwal and Thoresen 1993). For the *aleuticus* subspecies, adult length is ~23 cm, wing length is about 125 mm (Nelson 1981), and adult mass is 150–200 g (Manuwal and Thoresen 1993). There is a significant clinal increase in body size from Baja California through California (Manuwal and Thoresen 1993); birds from British Columbia and Alaska are similar to California birds (Gaston and Jones 1998). Within British Columbia, birds breeding on Frederick Island have a longer mean tarsus length than those breeding on Triangle Island. However, too few data exist to determine whether other measurements of the Frederick Island birds are also larger (A. Harfenist, unpubl. data).

The Cassin's Auklet is a small grey seabird with short, broad rounded wings and chunky body shape (Manuwal and Thoresen 1993; Gaston and Jones 1998). Males and females are similar in appearance and the plumage does not change during the year. The upper parts are dark grey and the underparts are dark grey shading to paler grey with a white belly. There is a white crescent above and below each eye; the upper crescent is more prominent. The short pointed bill is black; legs and feet are blue. Iris colour changes with age: chicks have a brown iris which gradually change to the silver-white colour found in adults; the irides of intermediate-aged birds are usually a combination of brown and silver (Manuwal 1978).

Juveniles are generally paler than adults and have a white throat. Nestlings are covered with grey down over most of the body with white down on the belly until they develop feathers.

Distribution

The Cassin's Auklet spends almost its entire life on the ocean, coming to land only to breed through most of its range.

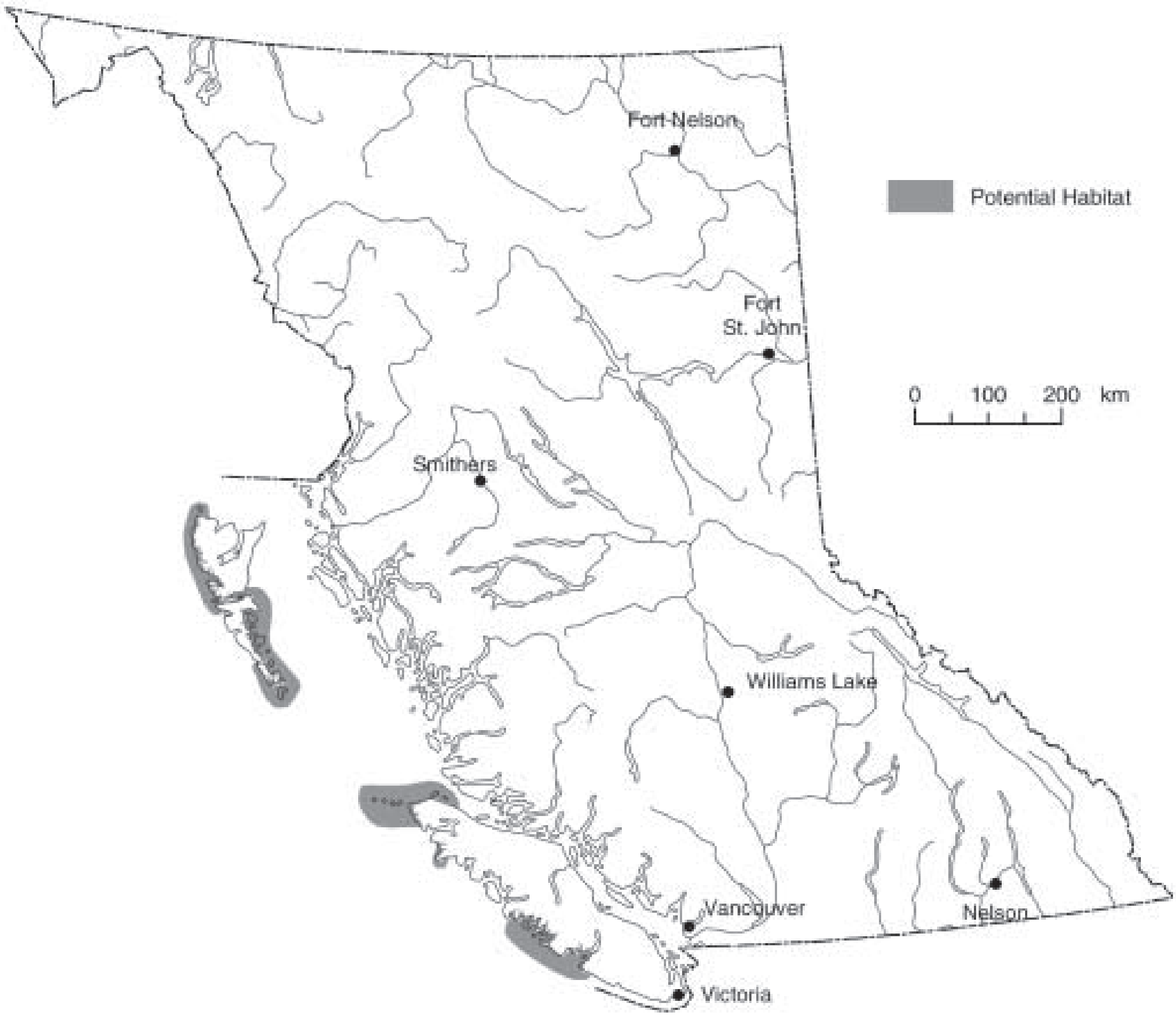
Global

The breeding range of the Cassin's Auklet extends from the middle of Baja California north along the west coast of North America to southeast Alaska and along the south coast of the Alaska Peninsula west along the Aleutian Islands (Manuwal and Thoresen 1993; Gaston and Jones 1998). No Cassin's Auklet colonies have been reported from Kodiak Island to Prince William Sound in the Gulf of Alaska despite the availability of suitable nesting habitat (Manuwal and Thoresen 1993; Gaston and Jones 1998). The at-sea distribution of the birds during the breeding season covers approximately the same geographic range.

The winter range of the Cassin's Auklet extends farther offshore into deeper oceanic waters than does

1 Volume 1 account prepared by A. Derocher.

Cassin's Auklet
(Ptychoramphus aleuticus)



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

the summer range (Gaston and Jones 1998). In addition, the birds winter along the entire western coast of the Baja Peninsula. They do not seem to winter in southeast Alaska.

British Columbia

The Cassin's Auklet breeds at 61 colonies on offshore islands along the western and northern coasts of Vancouver Island, the northern mainland coast and the Queen Charlotte Islands/Haida Gwaii (Rodway et al. 1988, 1990a, 1990b, 1994; Rodway and Lemon 1990, 1991a, 1991b). The largest breeding colony in the world is at Triangle Island in the Scott Island group off northwestern Vancouver Island (Manuwal and Thoresen 1993). The marine distribution includes the entire B.C. Coast during the breeding season and all but perhaps the waters around the northwestern side of the Queen Charlotte Islands/ Haida Gwaii archipelago in the winter (Campbell et al. 1990; Gaston and Jones 1998). There are no records from the Interior of British Columbia (Gaston and Jones 1998).

Forest region and districts

Coast: Campbell River, North Coast, North Island, Queen Charlotte Islands, South Island

Ecoprovinces and ecosections

Nesting:

COM: HEL, NCF, NWL, QCT, SKP, WIM, WQC

At-sea:

COM: DIE, HES, JOS, NCF, QCS, QCT, VIS
GED: JDF, SOG
NOP: SAP, TRP

Biogeoclimatic units (nesting)

CWH: vh1, vh2, vm1, wh1

Broad ecosystem units

CH, HS

Distance to ocean

Throughout their range, most burrows are within 500 m of the ocean (Gaston and Jones 1998). On the Queen Charlotte Islands/Haida Gwaii and northern mainland coast, most burrows are within 30 m of the outer vegetation edge (Campbell et al. 1990; Rodway and Lemon 1991a); on Triangle Island, burrows extend several hundred metres inland (Rodway et al. 1990b).

Life History

Diet and foraging behaviour

Cassin's Auklets are planktivores that feed mainly on macrozooplankton (primarily copepods and euphausiids) and larval fish (e.g., Vermeer et al. 1985; Manuwal and Thoresen 1993; Hedd et al. 2002). The diet of Cassin's Auklets varies across its range and significant interannual variation has been observed at some sites (Manuwal and Thoresen 1993; Gaston and Jones 1998). Diet studies carried out on Triangle and Frederick islands in 1994–1998 found that copepods (mainly *Neocalanus cristatus),* euphausiids (primarily *Euphausiia pacifica, Thysanoessa spinifera, T. inspinata)* and larval fish (including *Sebastes* spp., *Ammodytes* spp.) comprised 90–99% of the diets by mass (Hedd et al. 2002; A. Harfenist, unpubl. data). Other items in the diet included amphipods, brachyurans, and carideans. The relative importance of each prey type varied between years, but the diet of birds on Frederick Island included higher percentages of copepods and euphausiids and a lower percentage of fish than that of auklets nesting on Triangle Island. Chick growth was depressed on Triangle Island when copepods were replaced in the diet by larval rockfish (Hedd et al. 2002). At three colonies in the Queen Charlotte Islands/Haida Gwaii in the 1980s, copepods (*N. cristatus),* and euphausiids (*T. pinifera, T. longipes)* dominated the diet (Vermeer et al. 1985).

Almost all of the information about diet of the Cassin's Auklet is from studies of the food that adults bring back to their nestlings at the colony; the overlap between the diet of nestlings and that of adults and non-breeding birds is unknown. Chick meal sizes averaged 26–27 g over 2 years on Triangle Island.

Cassin's Auklets forage solely in marine waters, usually in areas of cold upwellings near the continental shelf break or over seamounts (Vermeer et al. 1985; Manuwal and Thoresen 1993). Birds nesting on Triangle Island foraged 30–90 km from their colony in waters >1500 m deep (Boyd et al. 2002). Their foraging behaviour is described as pursuit diving and they use their wings to propel them under water as they dive to depths of 20–80 m (Burger and Powell 1990). Cassin's Auklets usually feed in small groups but occasionally forage in large flocks (Manuwal and Thoresen 1993). They feed during both day and night (Manuwal and Thoresen 1993). During the breeding season, adults transport captured prey back to their chicks in a specialized throat pouch.

Reproduction

Cassin's Auklets nest in burrows at colonies of up to over 500 000 pairs (Manuwal and Thoresen 1993). The timing of reproduction varies across the species' range: in British Columbia peak laying is from late March–late April, peak hatching from late April–late May and peak fledging from early June–early July (Gaston and Jones 1998). Timing is delayed in warm water El Niño years (Bertram et al. 1999). In the Queen Charlotte Islands/Haida Gwaii, birds nesting off the southeast coast tend to breed about 2 weeks earlier than those nesting off the northwest coast (Vermeer et al. 1997). Breeding is earlier and more extended in the southern part of the birds' range: in Baja California breeding begins in late November and continues over a 6-month period (Jehl and Everett 1985).

Cassin's Auklets can begin breeding at 2 years of age, but most do not begin before 3 years of age (Speich and Manuwal 1974). Cassin's Auklets lay one egg per year, except during exceptional conditions on the Farallon islands in California where pairs can raise two broods in a year (Manuwal 1979). Incubation usually begins immediately after laying and is shared by both parents; incubation typically lasts about 38–39 days (e.g., Ainley and Boekelheide 1990; Manuwal and Thoresen 1993). Chicks are semi-precocial and are brooded in the nest for about 4 days. Following the brooding phase, adults return to the burrows only at night to feed the nestlings. There is significant intercolony and interannual variation in nestling growth rate: growth at Triangle Island (3.5–5.4 g/day) was lower than that at Frederick Island (5.0–5.7 g/day) over 5 years of study (Hedd et al. 2002; A. Harfenist, unpubl. data). Nestling growth was reduced during an El Niño year on Triangle Island, but not on Frederick Island (Bertram et al. 1999). The nestling period averages ~45 days in British Columbia (Gaston and Jones 1998). In most years, chicks fledge at an average mass of 162–175 g in British Columbia (Vermeer and Lemon 1986; Vermeer et al. 1997; Gaston and Jones 1998; Hedd et al. 2002). However, in a poor growth year, fledging mass averaged 126 g on Triangle Island. Chicks depart from the colonies at night unaccompanied by their parents.

Productivity is between 0.5 and 0.7 fledged chicks per breeding pair per year at most colonies in most years (Gaston and Jones 1998). Hatching success is difficult to measure because disturbance during incubation can cause desertion. Thus, the 70% hatching success figure given for Frederick Island (Vermeer and Lemon 1986) is probably low. Fledging success (chicks fledged/egg hatched) was 89–99% on Frederick Island (Vermeer and Lemon 1986; Vermeer et al. 1997; A. Harfenist, unpubl. data) and 47–93% on Triangle Island (Hedd et al. 2002). Annual variation in reproductive success is related to availability of prey which is, in turn, related to oceanographic conditions (Manuwal 1979; Ainley and Boekelheide 1990; Bertram et al. 2001). In British Columbia, reproductive success declined in a warm water El Niño year on Triangle Island, but a similar effect was not noted at more northerly Frederick Island (Bertram et al. 1999).

Site fidelity

Two types of site fidelity are considered for colonially nesting seabirds: fidelity to natal colony and fidelity to nest site. On the Farallon Islands in California, there is a strong tendency for Cassin's Auklets to return to breed on the islands where they hatched (Manuwal and Thoresen 1993). The birds are very faithful to nest sites on the Farallons as well. Fidelity to natal colony is unstudied in British Columbia. On Frederick Island, although most pairs returned to the same burrow to breed, on occasion pairs moved to a nearby burrow to nest and returned either to the new burrow or to the original burrow in subsequent years (A. Harfenist, unpubl. data).

Home range

Does not apply.

Movements and dispersal

There is little movement between breeding and wintering grounds: following the breeding season, many Cassin's Auklets move offshore to occupy a wider extent of coastal waters for the winter (Gaston and Jones 1998). Although the winter range overlaps the summer range, there is some southward movement by at least part of the northern population: numbers wintering off the coast of California are far higher than the number that breed in California so some birds must be moving in from British Columbia and/or Alaska (Briggs et al. 1987; Manuwal and Thoresen 1993).

Habitat

Structural stage

2: herb (grass tussocks)
7: old forest

Important habitats and habitat features

Nesting

Cassin's Auklets require nesting colony islands without alien mammalian predators. Colony areas and adjacent shorelines must be free of most human disturbance; nearby marine areas must by free of light pollution and gill net fisheries.

Cassin's Auklets nest on either forested or non-forested offshore islands of varying sizes (e.g., Manuwal and Thoresen 1993; Gaston and Jones 1998). Nesting islands along Vancouver Island are covered with grasses (including *Calamagrostis, Elymus)*, forbs (including *Heracleum, Maianthemum)* and shrubs (including salmonberry, *Rubus spectabilis;* wild rose, *Rosa* spp.) with little or no tree cover (Rodway and Lemon 1990, 1991b; Rodway et al. 1990b). Most of the colony islands along the northern mainland coast and in the Queen Charlotte Island/Haida Gwaii archipelago are covered with a forest of Sitka spruce, western hemlock, and western redcedar (Rodway et al. 1988, 1990a, 1994; Rodway and Lemon 1991a).

Cassin's Auklets tend to burrow in deep soil on steep cliffs, seaward facing slopes or level areas (Manuwal and Thoresen 1993). On forested islands, they burrow under mature forest as well as in grass tussocks. A summary of habitat plots from Cassin's Auklet colonies throughout the Queen Charlotte Islands/Haida Gwaii indicates that 25% were in forested habitat with mossy or bare forest floor, 20% in forested habitat with grass tussocks, and 25% in non-forested areas with grass tussocks; the remainder were scattered among 10 different habitat types including driftwood piles, rock crevices, and middens (Vermeer et al. 1997). Burrow entrances are commonly under tree roots, stumps, fallen logs, or tussocks: on Frederick Island, 55% of burrows were under tree roots, stumps, or fallen logs; 33% in grass tussocks; 8% in bare ground or moss tussocks; and 4% in rock or cliff crevices (Vermeer and Lemon 1986). On Triangle Island, a non-forested site, preferred nesting areas are covered with short grass, ferns, or forbs; the birds also nest under low salmonberry bushes (Campbell et al. 1990).

The average burrow length was 1.0 m in the Queen Charlotte Islands/Haida Gwaii (Vermeer and Lemon 1986), but burrows may be >5 m in length with many branches and turns (A. Harfenist, pers. obs.). Burrow densities vary with habitat but averaged 1.36 burrows/m^2 on Triangle Island (Rodway et al. 1990b); in the Queen Charlotte Islands/Haida Gwaii, about half of the birds were nesting at densities higher than 0.7 burrows/m^2 (Vermeer et al. 1997).

Marine

Cassin's Auklets occur in marine habitats with mean sea surface temperatures between 9° and 20° C and 6° and 20° C in summer and winter, respectively (Gaston and Jones 1998). Most birds are found beyond the continental shelf, near the shelf break where it approaches the coast or over seamounts (Vermeer et al. 1985; Morgan et al. 1991; Morgan 1997). In British Columbia, Cassin's Auklets are not commonly observed inshore and rarely gather on the water near their colonies during the breeding season, unlike some other species of auks (Campbell et al. 1990; Gaston and Jones 1998). In contrast, in the southern part of their range, some birds winter near breeding colonies (Manuwal and Thoresen 1993).

Conservation and Management

Status

The Cassin's Auklet is on the provincial *Blue List* in British Columbia. Its status in Canada has not been assessed (COSEWIC 2002).

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

AK	BC	CA	OR	WA	Canada	Global
S4	S2S3B, S4N	S?	S2B	S4	N3B, NZN	G4

Trends

Population trends

An estimated 1 354 800 pairs of Cassin's Auklets nested at 61 colonies in British Columbia in 1991 (Rodway 1991), which represents ~80% of the world population. As population trend data have been determined for few sites throughout the species' range, quantitative global trend estimates are not available. However, it is likely that populations are significantly lower than historic levels (Springer et al. 1993; Gaston and Jones 1998). The main cause of population declines has been depredation by introduced rats, raccoons, mink, foxes, and cats to colony islands (Bailey and Kaiser 1993; Springer et al. 1993; Harfenist and Kaiser 1997). Colonies in the Aleutian Islands and Gulf of Alaska were eliminated by foxes; feral cats destroyed colonies off California and Mexico (Springer et al. 1993). A small colony in Washington declined in the 1980s as the Peregrine Falcon population increased (Paine et al. 1990).

Population trend information from British Columbia suggests that the total breeding population has declined here also. Declines or eradications have been noted at six islands (Helgesen, Saunders, St. James, Langara, Cox, Lanz) with introduced rats, raccoons, or mink (Rodway et al. 1990b; Harfenist and Kaiser 1997). At Triangle Island, the world's largest colony, the population has declined at a rate of about 2%/yr since 1989 (D. Bertram, pers. comm.), possibly due to ocean warming (Bertram et al. 2000, 2001). A population decline on the Rankine Islands between 1984 and 2000 was probably due to a radical change in the vegetation cover following major windfall in the areas where the birds nested (M. Lemon, pers. comm.). In contrast, populations on Frederick Island, the second largest colony in British Columbia, as well as George and East Copper islands seem to be relatively stable (Lemon 1992, 1997, pers. comm.).

Habitat trends

The presence of introduced mammalian predators on present, former, and potential colony islands has rendered those islands unavailable for nesting Cassin's Auklets. With the exception of the presence of introduced mammals, potential suitable nesting habitat in British Columbia is likely relatively stable as colony islands are fairly isolated, and thus have not been subjected to urban development or industrial activities.

It is difficult to estimate trends in the availability of suitable marine habitat for Cassin's Auklets. The marine habitat adjacent to colonies can be rendered temporarily unsuitable by the presence of a commercial fishing fleet or a nearby sports fishing lodge. Ocean warming may have altered the location or decreased the number of suitable foraging sites for Cassin's Auklets in some regions (Ainley and Lewis 1974; Bertram et al. 2001).

Threats

Population threats

Introduced mammalian predators pose the most serious immediate threat to nesting Cassin's Auklets in British Columbia and elsewhere throughout its range (e.g., Manuwal and Thoresen 1993; Vermeer et al. 1997). In British Columbia, rats, raccoons, and mink have killed thousands of adults and chicks (Bailey and Kaiser 1993; Harfenist and Kaiser 1997). At least half of the Cassin's Auklet colonies in the Queen Charlotte Islands/Haida Gwaii are vulnerable to invasion by raccoons; rats are less likely to swim between islands but may reach new colonies on commercial or pleasure boats or ship wrecks.

Other significant threats are contaminants, exploitation of ocean resources, human recreation, and climate change (e.g., Vermeer et al. 1997). Cassin's Auklets are extremely vulnerable to oil pollution: ~32% of the total carcasses found along Vancouver Island following the Nestucca oil spill were Cassin's Auklets (Burger 1992) and high mortality has been reported from oil spills off California as well (Manuwal and Thoresen 1993). Lethal and sublethal effects of oil on seabirds is well documented (e.g., Burger and Fry 1993). Impacts of chronic low-level pollution from ship operations such as bilge-flushing or leaking tanks may be more of a threat than large spills in British Columbia (Burger et al. 1997). Levels of organochlorine contaminants found in Cassin's Auklets in British Columbia are probably below those likely to cause serious effects on populations (Elliott et al. 1997).

The main issues of concern related to exploitation of ocean resources are bird/fisheries interactions and oil and gas development. The most serious threat from the commercial fishery is that of bycatch in fishing nets (DeGange et al. 1993). Birds attracted to lights on the boats also kill or injure themselves in collisions with wires and ropes. Commercial and recreational overfishing of Cassin's Auklet fish prey species such as rockfish may lead to a decrease in the availability of juvenile stages of these fishes for the birds (Vermeer et al. 1997). Oil and gas development in the oceans around the Queen Charlotte Islands/Haida Gwaii has the potential to increase mortality of Cassin's Auklets caused by oil or metal contamination, as well as that caused by collisions around lights (Montevecchi et al. 1999). Wind turbines, such as those recently proposed for a site off Rose Spit, may present a risk to migrating birds.

The activities of tourists involved in recreational boating or camping can damage the birds' habitat or cause injury or mortality to adults and chicks. The main risk is from campfires built on the shorelines near colony sites. The birds are attracted to lights and will fly into the fires: this was the main hunting technique used by the Haida (Ellis 1991). Lights around recreational boats or campsites will also disorient the birds.

Climate change has been indirectly linked to changes in seabird populations via alterations of their prey species' ecology (e.g., Anderson and Piatt 1999). It has been suggested that the decline in the population of Cassin's Auklets breeding on Triangle Island may be related to changes in the timing and availability of prey species caused by warming oceanic temperatures (Bertram et al. 2000, 2001).

In the past, Cassin's Auklet adults and eggs formed a significant part of the diet of Haida (Ellis 1991) and probably that of other First Nations people, but at present there is little threat to the breeding populations from human harvesting.

Habitat threats

The main threats to habitat are from activities of visitors to colony areas. Walking on areas with fragile or shallow soil can cause burrows to collapse (Manuwal and Thoresen 1993). Nesting habitat on Triangle Island may be threatened by rabbits, an introduced species. The rabbits dig burrows and, thus may compete for or alter auklet burrowing habitat.

In addition, development or activities that significantly alter the shoreline such as log salvage operations, mariculture, or recreational sites are a threat to the suitability of nesting habitat because chicks and adults require a relatively unobstructed route between their burrows and the ocean.

Forest harvesting at breeding colonies can be a significant threat; however, currently all but one of the active Cassin's Auklet breeding colony sites in British Columbia are protected or proposed for protection (i.e., WHAs).

Marine habitats adjacent to colonies and important feeding areas are threatened by oil pollution, oil and gas development, log sorts, and mariculture operations. The marine habitat can be rendered temporarily unusable by Cassin's Auklets by the presence of a commercial fishing fleet or a nearby sports fishing lodge.

Legal Protection and Habitat Conservation

The Cassin's Auklet and its nests and eggs are protected in Canada and the United States from hunting and collecting under the *Migratory Birds Convention Act*. In British Columbia, it is protected from killing, or wounding, taking, and transporting under the *Wildlife Act*. However, Cassin's Auklets were traditionally an important food source for members of the Haida Nation and Haida can still legally hunt the birds for subsistence purposes.

In British Columbia, 23 of 61 nesting colonies are within Gwaii Haanas National Park Reserve/Haida Heritage Site and 1 colony is within Pacific Rim National Park; those sites are protected under the *Canada National Parks Act.* Eighteen colonies are within ecological reserves and protected under the *Ecological Reserves Act.* Three additional colonies are within a British Columbia Provincial Wildlife Management Area and covered under the *Wildlife Act.* Fifteen of the remaining 16 colonies have been designated as wildlife habitat areas under *Forest Range and Practices Act*. One colony, on Egg Island, is on provincial Crown land. Two colony islands (Lanz and Cox islands) from which Cassin's Auklets were eradicated by raccoons or mink are on provincial Crown land.

Marine protected areas for the conservation of Cassin's Auklets can be created under the *Canada Wildlife Act,* although none have been designated to date. The *Canada National Marine Conservation Areas Act,* which came into force in June 2002, provides authority for the establishment of marine conservation areas. Marine bird bycatch in fisheries is covered under the *Fisheries Act.*

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

The establishment of WHAs may not be adequate for addressing the threats faced by Cassin's Auklets. The link between terrestrial nesting habitats and adjacent and nearby terrestrial and marine habitats should be considered.

- ❖ Provide unobstructed access to the open ocean for adults and chicks departing the colony: no development such as log sorts, fishing lodges, mariculture operations, or recreation sites on shore, intertidal areas, or nearshore areas, or along opposite shores of the mainland or non-colony islands.
- ❖ Provide undisturbed access to marine foraging grounds for provisioning adults during the breeding season.
- ❖ Discourage commercial and sports fishing activities in adjacent marine waters during the breeding season.
- ❖ Provide uncontaminated marine waters around colonies: to prevent exposure to chronic oil pollution from commercial or recreational boats, no mooring buoys in inshore areas around colonies. Restrict oil and gas development near colonies and foraging areas.
- ❖ Provide colony and near-colony habitats free of pollution from artificial lights.
- ❖ Maintain integrity of marine habitats of prey species.
- ❖ Restrict recreational use and access to colony sites (see "Additional Management Considerations").

Wildlife habitat area

Goal

Protect and maintain integrity of breeding colonies.

Feature

Establish WHAs at breeding colonies not already within national parks, national park reserves, ecological reserves, and wildlife management areas or other protected areas. Where Cassin's Auklet nesting colonies have been negatively impacted by introduced predators, WHAs should be established on former colony sites once the threat has been removed to allow the re-establishment of the colony and the recovery of the population.

Size

Generally between 5 and 50 ha but will vary with size and shape of nesting area.

Design

Cassin's Auklets nest around the periphery of islands and adults and chicks need unhindered access to the ocean. WHAs should include all areas with active nesting and the adjacent shoreline areas plus 200 m to maintain the quality and isolated nature of the forest and forest floor. In some cases, it may be necessary to include more area (possibly entire island) to ensure the integrity of a WHA is maintained (i.e., when active nesting occurs around the entire or significant proportion of an island and the only access for development would impact the colony such as impacting the integrity of the forest or forest floor).

General wildlife measures

Goals

1. Protect breeding colonies from development and disturbance.
2. Prevent mortality and disturbance of breeding birds and young on and adjacent to nesting areas.
3. Maintain important habitat features (i.e., intact forest structure and forest floor).
4. Prevent the introduction of non-native species.

Measures

Access

- Do not develop roads or access structures and restrict access to qualified biologists for purposes of monitoring populations.

Harvesting and silviculture

- Do not harvest or salvage timber.
- Do not allow development of any form in WHA or adjacent inshore waters.

Pesticides

- Do not use pesticides.

Recreation

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

Additional Management Considerations

Under the results based code (RBC), colonies can be protected from forest practices (including restrictions on establishing MOF recreational facilities); however, it is not the mandate of the RBC to regulate recreational activities. Recreational activity at these colonies is considered a serious threat to this species. The following recommendations should be considered at colony sites.

Restrict access and do not allow recreational activities on colony islands.

Do not allow sports fishing lodges adjacent to colonies or on nearby shorelines.

Avoid activities involving lights or fires on nearby shorelines or in inshore waters around colonies.

Educate public on how to avoid disturbing nesting colonies. Clearly mark on marine and recreation maps with a notation that human access is prohibited at WHAs and other sites protected for these species.

Remove introduced species from colony islands. Ensure that non-endemic plants and animals are not introduced to colony islands. If necessary, reintroduce Cassin's Auklets to islands where colonies have been extirpated once introduced predators have been eradicated.

Information Needs

1. Improve methods to estimate population size. Monitor populations.
2. Marine habitat information and identification of important feeding areas.
3. Test methods of attracting species back to areas from which they have been eradicated.

Cross References

Ancient Murrelet, Keen's Long-eared Myotis, "Queen Charlotte" Hairy Woodpecker, "Queen Charlotte" Northern Saw-whet Owl

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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

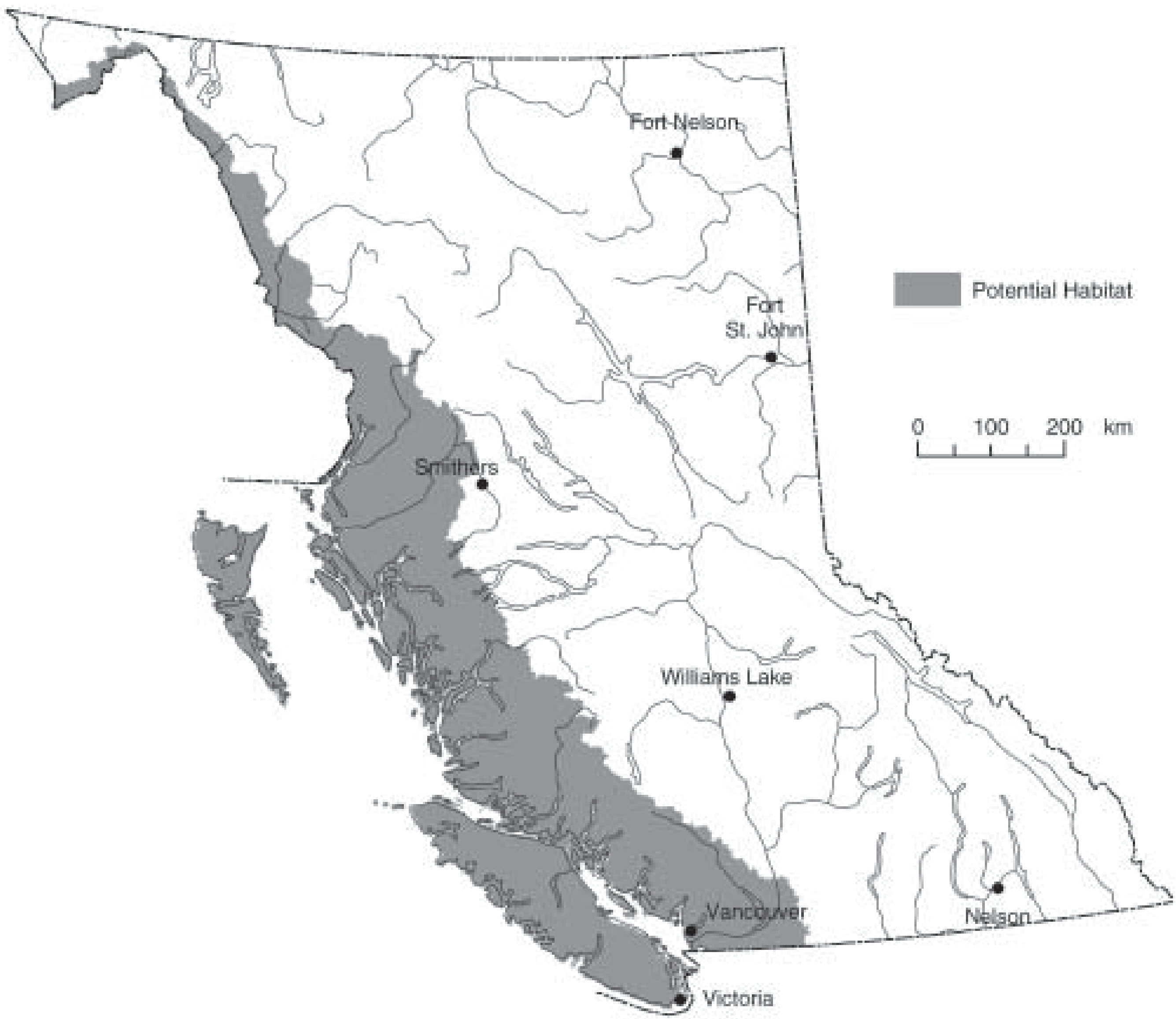
Broad ecosystem units

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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Yellow-breasted Chat

Icteria virens

Original[1] prepared by Martin Gebauer

Species Information

Taxonomy

The Yellow-breasted Chat is the only species of the Tribe Parulini (i.e., wood warblers) in the genus *Icteria* (Sibley 1996). According to Sibley (1996), an additional 119 species of wood warbler are found in the Tribe Parulini worldwide. Although placed in the family Parulidae, its relationship to other avian groups has been controversial over the years, being first described by Linnaeus in the thrush genus *Turdus* (Cannings 2000). Two subspecies of Yellow-breasted Chat are recognized: *I. virens virens* that occurs in southeast Canada and the eastern United States and *I. virens auricollis* that occurs in western North America (Cannings 1998).

Description

The Yellow-breasted Chat is the largest warbler occurring in British Columbia. Upper parts, including the wings and tail, are a uniform greyish olive-green colour, whereas the throat, breast, and underwing coverts are bright yellow. Remaining underparts are white with sides tinged with buffy grey. A bold white stripe from the bill back over the eye is distinct. White patches are also present under the eye and from the base of the bill back over the jaw. Lores are black in males and grey in females. The Yellow-breasted Chat often sings at night, similar to some of the mimic thrushes, and has the lowest voice of any American wood warbler (Aslop 2001). The unmusical song is comprised of a jumble of harsh, clucks, rattles, whistles, and squawks (Godfrey 1986; NGS 1999). Yellow-breasted Chats inhabit dense thickets and brush and are retiring and shy, making them very difficult to observe. Their loud song is often the only indication an observer has of their presence in an area.

Distribution

Global

The Yellow-breasted Chat breeds from southern British Columbia, southern Alberta, southern Saskatchewan, and southern Ontario south through most of the United States to west and central Baja California and the central Mexican mainland (Howell and Webb 1995; Campbell et al. 2001). It winters from southern Baja California, southern Texas, and Florida south to Panama (Howell and Webb 1995; Sauer et al. 2000).

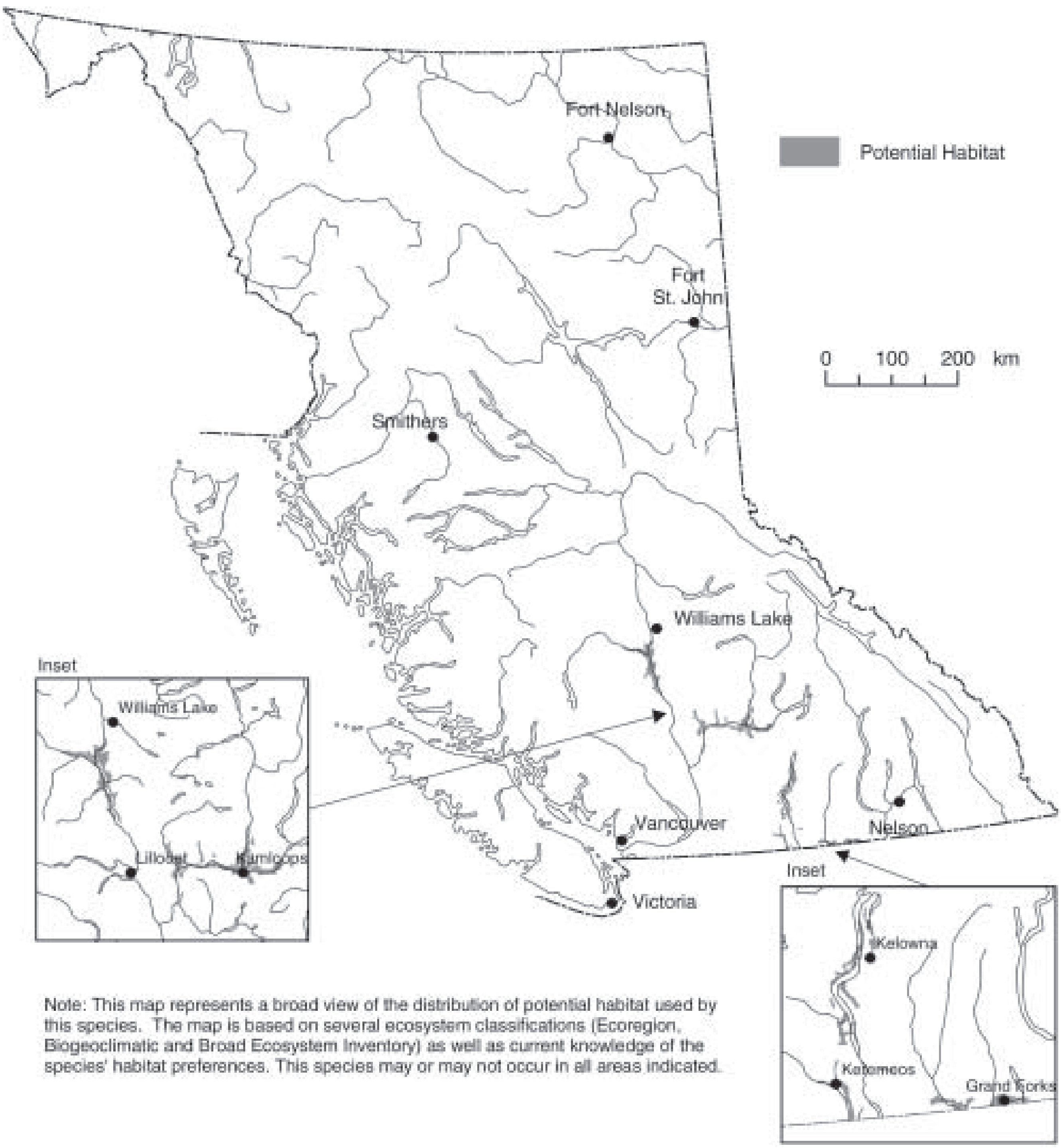
British Columbia

The Yellow-breasted Chat breeds in the extreme southern portions of the province in the Okanagan and Similkameen valleys (Cannings et al. 1987; Campbell et al. 2001). Singing males are occasionally reported from Creston and the Thompson and Fraser River valleys, as far north as the Chilcotin River (Fraser et al. 1999). A possible historic breeding population at Ashcroft has been extirpated (Campbell et al. 2001). Two singing males were recently reported singing in the Pavilion area of British Columbia but evidence of breeding was not confirmed (Cannings 2000). Chats occur irregularly in the lower Fraser Valley with one breeding record at Mission in 1966 (Cannings 2000). Recent unconfirmed reports suggest that a small breeding population has become established near Mission and Chilliwack (MOF and MELP 1998). A singing male was observed at Colony Farm regional park, Coquitlam on 23 June 2001 (C. Bishop, pers. comm.).

1 Volume 1 account prepared by J. Cooper.

Yellow-breasted Chat

(Icteria 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.

Forest regions and districts

Coast: Chilliwack

Southern Interior: 100 Mile House (possible), Cascades, Central Cariboo, Kamloops, Kootenay Lake, Okanagan Shuswap

Ecoprovinces and ecosections

CEI: suspected in FRB

GED: likely in FRL

SIM: possible in SCM

SOI: OKR, NOB, SOB, SOH, possible in THB

Biogeoclimatic units

BG: xh, xw

CWH: dm

PP: dh, xh

Broad ecosystem units

BS, CF (hedgerows), CR

Elevation

In British Columbia, the Yellow-breasted Chat occurs from sea level to 70 m elevation on the Coast and between 250 and 800 m elevation in the Interior (Campbell et al. 2001).

Life History

Diet and foraging behaviour

Insects are the primary food source during the breeding season, with berries becoming a more important food source in summer. Young are fed exclusively insects (Ehrlich et al. 1988). Petrides (1938) found that food brought to young in Washington, D.C., consisted primarily of caterpillars. Yellow-breasted Chats forage in the foliage and lower branches of low shrubs and herb layers of thickets (Cannings 1995). Chats are the only warbler species known to hold food with their feet (Aslop 2001).

Reproduction

Dates for 19 clutches in British Columbia ranged from 15 May to 02 July, with 58% recorded between 15 June and 25 June (Campbell et al. 2001). Of nine nests observed by Bishop (pers. comm., 2001) in the south Okanagan in 2001, seven (77%) had clutch dates ranging from 10 June and 20 June, and one clutch was observed on 04 July 2001. Size of 16 clutches ranged from one to four eggs with 88% having three or four eggs (Campbell et al. 2001). Bishop (pers. comm., 2001) found six of nine nests (66%) in the south Okanagan contained clutches of three to four eggs. Clutches of three to four eggs were also most common in an intensive study of chat populations in southern Indiana (Thompson and Nolan 1973).

Incubation period is reported as being 11–12 days (Ehrlich et al. 1988; Aslop 2001). Dates for 12 broods in British Columbia ranged from 29 May to 31 July (Campbell et al. 2001). In the south Okanagan in 2001, dates for eight broods ranged from 07 June to 12 July (C. Bishop, pers. comm., 2001). Sizes of five broods in British Columbia ranged from one to three young (Campbell et al. 2001). The fledgling period is approximately 9 days (Ehrlich et al. 1988), although Bishop (pers. comm., 2001), reported one nest with a fledgling period of 11–12 days. In southern Indiana, Thompson and Nolan (1973) found that 31 of 39 breeding pairs attempted second broods. The spread of clutch initiation dates (i.e., 12 May to 23 June) in the Okanagan Valley (Cannings et al. 1987) suggests that chats may attempt to raise two broods per season in British Columbia as well (Cannings 1995). Bishop (pers. comm., 2001) had concrete evidence of a second brood in one nest in the south Okanagan in 2001, and noted regular singing and flight displays in males following fledging of a first brood.

Yellow-breasted Chats are frequent hosts of Brown-headed Cowbird (*Molothrus ater*) throughout their range (Friedmann 1963, as cited in Campbell et al. 2001). Thirteen percent of 23 nests found in British Columbia (Campbell et al. 2001) and 31% of 42 nests in Missouri were parasitized by cowbirds (Burhans and Thompson 1999). Bishop (pers. comm., 2001) indicated that as many as 55% (5/9) of nests observed in the south Okanagan in 2001 appeared to have been parasitized by cowbirds. Interestingly, young appear to be fledged at a similar rate from parasitized nests as unparasitized nests (Burhans and Thompson 1999), and growth rates do not appear to be reduced in parasitized nests

(Thompson and Nolan 1973). However, two parasitized chat nests in British Columbia were deserted before hatching (Campbell et al. 2001) and Bishop (pers. comm., 2001) found that 40% (2/5) of nests with cowbird presence were depredated early in the nesting cycle.

Site fidelity

Thompson and Nolan (1973) found that no females and only 11% of breeding males returned to their study area in southern Indiana in the years following first capture, suggesting that site fidelity in chats is low. Banding of 22 adult and chick chats in the south Okanagan in 2001 (C. Bishop, pers. comm., 2001) will provide interesting data if banded birds are recaptured in 2002.

Home range

A survey of known chat territories in the south Okanagan in 2000 detected singing male chats in territories estimated to be 0.1–24 ha (Bezener 2001). Bishop (pers. comm., 2001) found that territory size of 25 pairs in the south Okanagan ranged from 0.2 to 5.64 ha, with a mean territory size of 0.99 ha. In southern Indiana, Thompson and Nolan (1973) found that mean territory size ranged between 1.12 and 1.58 ha. Dennis (1958) reported breeding territory sizes of 1.25–2.5 acres in Virginia (i.e., ~0.5–1.0 ha).

Movements and dispersal

Most Yellow-breasted Chats arrive in southern British Columbia in mid-May (Cannings et al. 1987), but some arrive as early as late April (Campbell et al. 2001). No discernible autumn movements have been noted since reports of birds drop sharply once birds stop singing (Campbell et al. 2001). Most birds have likely left the province by early August soon after young have fledged (Cannings et al. 1987).

Habitat

Structural stage

3a: low shrub
3b: high shrub

Important habitats and habitat features

Breeding

Yellow-breasted Chats breed in dense thickets around woodland edges, riparian areas and overgrown clearings or clearcuts (Annand and Thompson 1997; Twedt et al. 1999; Campbell et al. 2001). Populations in British Columbia are associated with riparian habitats, particularly black cottonwood (*Populus balsamifera*) and water birch (*Betula occidentalis*) stands with dense understorey thickets of rose, willow, and common snowberry (*Symphoricarpos albus*). Chats also occupy dense forest-edge thickets where Columbian hawthorn (*Crataegus columbiana*), trembling aspen (*Populus tremuloides*), choke cherry (*Prunus virginiana*), snowberry, and Prairie Rose (*Rosa woodsii*) provide a dense undergrowth (Campbell et al. 2001). Thickets of rose, snowberry, or Himalayan Blackberry (*Rubus discolor*) in uncultivated corners of fields, orchards, and vineyards also provide some habitat (Campbell et al. 2001). Density of shrub cover is apparently more important than species composition of a thicket. Gibbard and Gibbard (1992) found that chats frequented rose thickets ranging in size from 9 to 195 m^2 and an average height of 1.25 m. Trees growing within or close to the thicket generally did not exceed 6 m in height, and large shrubs were usually 3.5 m in height. In the south Okanagan in 2001, Bishop (pers. comm., 2001) found continuous rose patches around nests ranging from ~0.3 to 135 m^2. Chats were generally not found in riparian habitats heavily dissected by cattle trails, in areas with overstorey of large trees, and areas with a high level of traffic noise (Gibbard and Gibbard 1992). Bishop (pers. comm., 2001) found that some territories in the south Okanagan were fragmented by current or recent livestock use and were occasionally close to a busy highway (i.e., #97).

Nests are well concealed in dense shrubbery usually 0.6 to 0.9 m above the ground, are often overgrown with vines, and are under a canopy of cottonwood or water birch (Bent 1953; Bryan et al. 2001; Campbell et al. 2001). The heights of nine nests monitored by Bishop (pers. comm., 2001) in the south Okanagan in 2001 ranged from 0.4 to 1.15 m with the overall average being 0.73 m. The nest is made of coarse leaves, bark, and plant stems, and lined with fine grasses (Godfrey 1986). Most nests in British Columbia were located in rose bushes (Cannings 1995), but snowberry and willow have also been used (Campbell et al. 2001). Burhans and Thompson (1999) found that chats selected larger shrub patches to locate their nests despite increased rates of parasitism. Losses to parasitism were apparently balanced by reduced depredation rates in larger patches. However, Bishop (pers. comm., 2001) found that a number of nests were close to patch edge (range from 0.08 to 10.0 m) with the average being 2.23 m.

Foraging

Yellow-breasted Chats forage within dense riparian breeding habitats during the nesting season. During migration or on their wintering grounds, they can be found in a wide variety of shrubby thickets and densely vegetated riparian areas (Skagen et al. 1998).

Conservation and Management

Status

The Yellow-breasted Chat is on the provincial *Red List* in British Columbia. The British Columbia population of the Yellow-breasted Chat was upgraded from *Threatened* to *Endangered* status in November 2000 (COSEWIC 2002).

Trends

Population trends

Breeding Bird Survey results for 1966 to 1999 (Sauer et al. 2000) indicate no significant changes in U.S. population of Yellow-breasted Chat, but significant increases in Canada (12.7%/yr; $p < 0.01$). Significant declines have been observed in several eastern states including Illinois, Maryland, Ohio, Pennsylvania, Tennessee, West Virginia, and Kentucky. Significant population increases have been documented in Georgia, Mississippi, and North Dakota. An analysis of Breeding Bird Surveys in British Columbia for 1966 to 2000 did not reveal a significant trend (Sauer et al. 2000).

In British Columbia, Cannings (2000) estimated a stable population of 25–30 pairs. Surveys in 2001 located 36 singing males in the Okanagan (highest count to date), 19 occupied territories, and 9 active nests (C. Bishop, pers. comm., 2001). A 1999 survey in the south Okanagan and lower Similkameen valleys in 1999 yielded 19 singing males, compared with the 15 singing males reported by Gibbard and Gibbard (1992). Although results from the various surveys differed substantially, differences are more likely due to variable survey intensity than to changing populations. Cooperation with First Nations in 2001 permitted surveys on Reserve lands, resulting in new location records (C. Bishop, pers. comm., 2001). Taverner (1922) stated that "the [Okanagan] valley is famous for chats…in spite of their apparent scarcity there were enough of them about to seize upon and occupy any specially

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

AB	BC	CA	ID	MT	OR	WA	Canada	Global
S3B	S1B	S3	S5B, SZN	S5B, SZN	S4?	S4B, SZN	N4B	G5

desirable locality that might be vacant." Population declines since the early part of the 19th century are largely due to loss of suitable riparian and shrubland habitats due to land development activities (Cannings 1995). Bishop (pers. comm., 2001) suggests that increased livestock use in previously "suitable" Yellow-breasted Chat habitats results in habitat damage through trampling and browsing, and an increase in Brown-headed Cowbird parasitism.

Habitat trends

Breeding habitat in British Columbia is primarily confined to extensive riparian habitats along the Similkameen River south of Keremeos, the old oxbows of the Okanagan River, and Inkaneep Creek on Osoyoos First Nations lands. Habitats associated with the Okanagan River have been heavily impacted in the last 50 years. An estimated 15% of the pre-European quantity of riparian vegetation suitable for chats remains in southern British Columbia (C. Bishop, pers. comm., 2001). Many riparian habitats were severely altered when the Okanagan River was channelized between 1954 and 1958 (Cannings 2000). Flood control effected by channelization permitted landowners to remove riparian habitats and use the land for agriculture. In the last 10 years, incremental loss of riparian habitat has been small; however, a proposed golf course development on the west side of the Okanagan River in Penticton threatens one or two breeding pairs of chats, representing approximately 10% of the B.C. population (Cannings 2000). Surveys of 119 potential sites only found singing males at 14 sites (Gibbard and Gibbard 1992).

Of 5078 ha of habitat considered suitable for chats in the south Okanagan, ownership includes provincial Crown land (6%), Indian Reserve (45%), private land (44%), and conservation lands (5%)(MELP 1998). Participation of "conservation minded landowners, many of whom desire to enhance and rehabilitate areas for chats, represents a critical link in maintaining viable Yellow-breasted Chat habitats.

Threats

Population threats

Pesticide spraying may be a problem in some areas because of the insectivorous feeding habitats of Yellow-breasted Chats (Cadman and Page 1994). Approximately 94% of nest failures reported in a study by Thompson and Nolan (1973) were attributed to predators including snakes, Blue Jay (*Cyanocitta cristata*), and Eastern Chipmunk (*Tamias striatus*). One south Okanagan nest with chicks showed indications of snake "punctures" on dead young (C. Bishop, pers. comm., 2001). In several nests in a study by Thompson and Nolan (1973), egg disappearance closely coincided with deposition of cowbird eggs. Bishop (pers. comm., 2001) found that 40% of five nests in the south Okanagan thought to be parasitized by Brown-headed Cowbirds were depredated early.

Habitat threats

Low elevation riparian habitats are threatened by continuing loss and fragmentation due to agricultural and urban development (Cannings 1995). Any activity that results in the loss or reduction in dense shrubby areas can be detrimental. Livestock grazing, which may result in trampling or damage to riparian thickets, may thus be detrimental (Eckerle and Thompson 2001). Thinning and logging of riparian woodlands is not a significant threat to most chat breeding areas in British Columbia.

Legal Protection and Habitat Conservation

The Yellow-breasted Chat, its nests and eggs are protected in Canada and the United States from hunting and collecting under the *Federal Migratory Birds Act* of 1917. In British Columbia, it is protected under the provincial *Wildlife Act*.

Protected areas in the south Okanagan include the Vaseux Bighorn National Wildlife Area, South Okanagan Wildlife Management Area, and Inkaneep Provincial Park. According to MELP (1998), 5% (i.e., 260 ha) of potentially suitable Yellow-breasted Chat habitat is currently designated as conservation lands in the south Okanagan.

A comprehensive riparian management plan for neotropical migrants is being developed by the Canadian Wildlife Service.

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

Maximize retention and connectivity of riparian habitats and natural grassland communities.

Wildlife habitat area

Goals

Maintain breeding and foraging habitats in areas with aggregations of one or more pairs of Yellow-breasted Chats and selected high suitability historic breeding aggregations.

Feature

Establish WHAs in areas with current breeding concentrations or at historical breeding concentrations in high capability or high suitability habitat.

Size

The size of the WHA will depend on the number of breeding pairs. Between 0.1 and 6 ha of suitable habitat should be secured for each breeding pair. Larger WHAs are more likely to maintain features and conditions for nesting.

Design

The WHAs should include the entire area of thickets that may be used by chats and degraded riparian areas that can be rehabilitated. When fencing of the WHA is being considered, ensure security of chats from predators by providing space between breeding habitat and fence.

General wildlife measures

Goals

1. Maintain or rehabilitate riparian thicket habitat.
2. Ensure livestock do not fragment or trample thicket habitat.
3. Maintain WHA in a properly functioning condition.

Measures

Access

- Do not build new roads and stream crossings unless there is no practicable option.

Pesticides

- Do not use pesticides.

Range

- Provide alternate water, forage, and salt licks for livestock to reduce impacts to wetland and riparian habitats.
- Exclude livestock from riparian or associated riparian habitats within the WHA. If there is no other practicable option to prevent livestock use (i.e., changing timing and intensity of grazing), fencing could be required by the statutory decision maker.

Additional Management Considerations

Rehabilitate riparian habitats damaged by cattle by excluding cattle and revegetating cleared areas with new wild rose thickets and other riparian shrub vegetation (see Bezener 2001). Construct fences between upland areas and riparian habitats to exclude cattle.

Plant wild rose and other shrub species within protected areas, such as Vaseux Lake and Osoyoos Oxbow areas, and inside exclusion fences.

Information Needs

1. Distribution, relative densities, and population trends.
2. Quantification of critical habitat characteristics, particularly those that support breeding chats.
3. Information on usefulness of fencing riparian areas and testing of riparian community response to fencing treatments in riparian corridors of varying widths.

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Fringed Myotis, “Great Basin” Gopher Snake, Lewis’s Woodpecker, Tiger Salamander, water birch–red-osier dogwood

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"Vancouver Island" White-tailed Ptarmigan

Lagopus leucurus saxatilis

Original prepared by Kathy Martin and Lindsay Forbes

Species Information

Taxonomy

Five subspecies of White-tailed Ptarmigan (*Lagopus leucurus*) are currently recognized including the Vancouver Island White-tailed Ptarmigan (*L. leucurus saxatilis*), which is believed to be endemic to Vancouver Island (Campbell et al. 1990; Braun et al. 1993). This subspecies was described in 1938 by Ian McTaggart-Cowan who found morphological and plumage differences between White-tailed Ptarmigan from Vancouver Island and the mainland of British Columbia and Washington State (McTaggart-Cowan 1938). McTaggart-Cowan reported that the Vancouver Island birds had a darker first primary feather, a greater tail length, and a bill that was more hooked than mainland specimens.

Description

Like other North American ptarmigan, White-tailed Ptarmigan are noted for their cryptic plumage that changes from mottled brown, grey, and white in summer to entirely white in winter. White-tailed Ptarmigan are the smallest grouse in North America, and are easily distinguished from other grouse by their white retrices.

Compared with White-tailed Ptarmigan in Colorado, Vancouver Island birds have shorter wings and a heavier body mass during the breeding season (no data for winter; K. Martin, unpubl. data). Breeding females are approximately 10 g heavier than females in Colorado in July and 40 g heavier in September (Braun et al. 1993; K. Martin, unpubl. data). Breeding males increase mass in late summer weighing an average of 411 g in September, 50 g heavier than males in Colorado at this same time. Wing chords of Vancouver Island birds average 180 ± 0.63 (s.e.) mm for adult females ($n = 57$) and 185 ± 0.79 (s.e.) mm for adult males ($n = 50$). Mean wing chords are 13 mm shorter for females and 15 mm shorter for males on Vancouver Island than in Colorado.

Distribution

Global

White-tailed Ptarmigan occur in western Alaska, south and central Yukon, and mountain ranges from northern British Columbia to New Mexico (Braun et al. 1993).

British Columbia

The Vancouver Island White-tailed Ptarmigan is considered endemic to Vancouver Island (Campbell et al. 1990; Braun et al. 1993). Historically, the distribution is known to range from as far south as Mount Brenton to as far north as Tsitika Mountain (based on 160 observations gathered from naturalists on Vancouver Island, 1905–2000; Hitchcock et al. 1998). All 25 mountains, ranging from El Capitan to Mount Cain, showed signs of White-tailed Ptarmigan between 1995 and 1999, suggesting the subspecies still occupies most of its historic range.

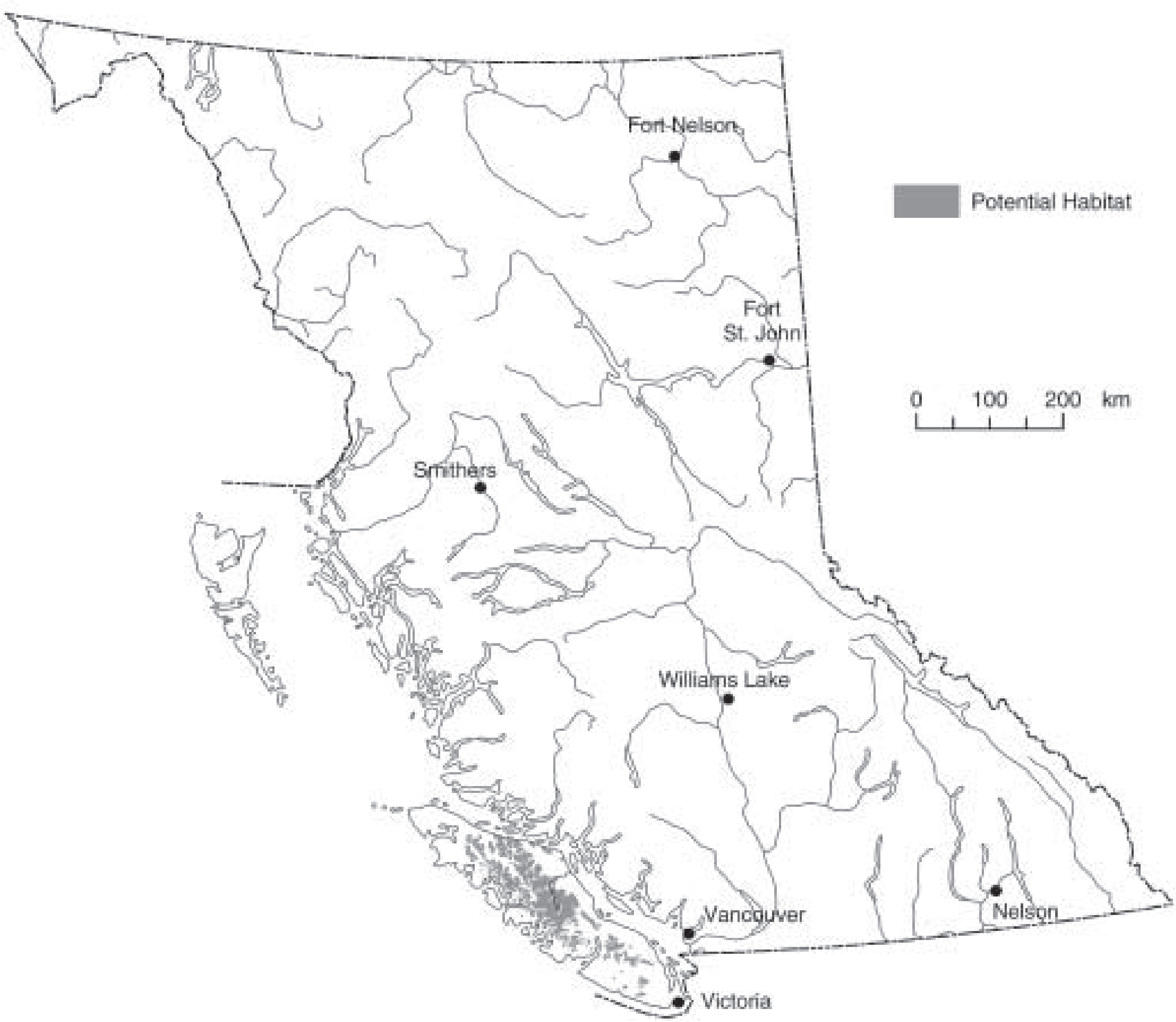
Forest region and districts

Coast: Campbell River, North Island, South Island

Ecoprovinces and ecosections

COM: NIM, WIM
GED: LIM

White-tailed Ptarmigan - subspecies *saxatilis*
(*Lagopus leucurus saxatilis*)



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

AT:

CWH: vm, xm

MH: mm

Broad ecosystem units

AU, AV, HP, MF

Elevation *(K. Martin, unpubl. data)*

South Island	Central and North Island
Summer: 1240–1890 m	Summer: 1320–2200 m
Winter: 822–1788 m	Winter: 966–1889 m

Life History

Diet and foraging behaviour

White-tailed Ptarmigan feed on buds, stems, seeds, leaves, fruits, flowers, and insects (Braun et al. 1993). Plants consumed by Vancouver Island birds include *Vaccinium*, *Poa,* and *Carex* species, *Empetrum nigrum*, *Arctostaphylos alpina, Cassiope mertensiana, Phyllodoce empetriformis*, and *Sedum oregonum* (Weeden 1967; K. Martin, unpubl. data).

Reproduction

Nesting for this typically monogamous species is initiated in early June to mid-July (Braun et al. 1993). Males accompany females from pair formation; mate guarding in this species is thought to be a result of behavioural co-ordination that enhances a female's foraging opportunities during incubation (Artiss and Martin 1995; Artiss et al. 1999). Renesting will occur if the first nest is lost (Braun et al. 1993).

Mean clutch size for *L. leucurus saxatilis* first clutches is 6.2 eggs ($n = 5$; s.d. = 0.45). Brood size of Vancouver Island females ranges from one to eight chicks and the average brood size of successful hens in July and August is 4.1 ± 0.31 (s.e.) chicks ($n = 32$ broods, 1995–1999). Fledging success may be higher on Vancouver Island than in Colorado (Martin and Commons 1997; K. Martin unpubl. data).

Nesting habitat varies but nests are always located on the ground (Braun et al. 1993). On Vancouver Island, nests were placed in exposed rocky areas with little vegetation and also in sites with good overhead cover from trees and shrubs (K. Martin, unpubl. data from six nests).

Site fidelity

White-tailed Ptarmigans exhibit strong fidelity to breeding territories after first breeding season (Braun and Rogers 1971; Martin et al. 2000).

Home range and movements

The *saxatilis* subspecies occurs at lower elevations and uses a wider range of habitats than White-tailed Ptarmigan on the mainland. Habitat elevation ranges differ between the breeding and winter seasons, and between the south, central, and north parts of the island. The distance that adult birds migrate between winter locations and breeding areas is on average 1.4 km in the southern portion of the island and 2.0 km in the northern portion of the island (based on 66 winter observations; Martin and Hitchcock 1997).

Habitat

Structural stage

1:	non-vegetated	6:	mature forest
2:	herb	7:	old forest

Important habitat and habitat features

Vancouver Island ptarmigan appear to use coastal alpine habitats differently from mainland White-tailed Ptarmigan. The majority of habitat used by White-tailed Ptarmigan on Vancouver Island could be considered marginal or suboptimal habitat when compared with the large expanses of alpine on the mainland (Martin and Elliot 1996). Although some habitat use data are available, habitat requirements are difficult to determine because of limited data on multiple sightings for individuals. Habitat requirements may vary between south and central island populations.

Nesting

During the breeding season, Vancouver Island birds are typically found in alpine and subalpine mountain habitats, particularly in rocky tundra areas with sparse vegetation above the treeline. Birds occur in alpine heather communities as well as in subalpine heather communities and fir or hemlock tree islands (K. Martin, unpubl. data). Snowfields are important for cooling, providing food resources, and enabling birds to remain cryptic when their plumage is changing.

Wintering

Like other White-tailed Ptarmigan, some Vancouver Island birds migrate to lower elevations in winter while others remain close to their breeding areas (Martin et al. 2000; K. Martin, unpubl. data). Habitats both above and below the treeline are used in winter; birds can be found in alpine bowls, hemlock and cedar forest, and clearcuts, as well as on unvegetated rocky outcrops and cliffs. Based on 104 observations, 93% and 70% of birds relocated during winter in the south (54 observations) and central (50 observations) portions of Vancouver Island, respectively, were found in the Mountain Hemlock biogeoclimatic zone (K. Martin, unpubl. data). Median tree height in these upper montane forest habitats was 4 m (range: 1–27.5 m, 26 observations). Additionally, 66% of relocated birds were found on south, southeast, or southwest facing slopes.

Unlike birds from Colorado, Vancouver Island White-tailed Ptarmigan have not been found to congregate in large flocks during winter (Martin and Hitchcock 1997). This may be due to patchy alpine habitats and the generally low densities of birds on Vancouver Island.

Dispersal

In Colorado, dispersal to other mountains is thought to sustain White-tailed Ptarmigan populations in patchy alpine habitats (Martin et al. 2000). On Vancouver Island ,chicks have dispersed up to 34 km to other mountains (mean = 2.4 km, n = 7; Martin and Hitchcock 1997). Based on observations of droppings, marginal or unsuitable habitat such as forested rocky outcrops may be used as stopover points when White-tailed Ptarmigan disperse to other peaks (K. Martin, pers. obs.).

Conservation and Management

Status

The Vancouver Island White-tailed Ptarmigan 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	Canada	Global
S3	N3	G5T3

Trends

Population trends

Total population size is unknown. Sufficient data for establishing total population size are currently unavailable so population trends cannot be estimated at this time. Some population size and life history data for different habitats and landscapes have been collected but have not been analyzed yet (K. Martin, unpubl. data).

Habitat trends

Vancouver Island ptarmigan are year-round residents of a variety of alpine, subalpine, and upper montane habitats during the year (Martin and Hitchcock 1997). The amount of alpine habitat on Vancouver Island has remained fairly constant, although ski resort developments in the central and southern portion of the island may have impacted localized areas. Forest harvesting in the southern part of the island may have changed habitat conditions in winter and early spring.

Threats

Population threats

The subspecies is vulnerable to population extinction processes because the birds exist in very low densities in patchy habitats with stochastic population dynamics and environmental conditions

(Martin et al. 2000). Additionally, their distribution is limited to higher elevations (>822 m) on Vancouver Island.

Habitat threats

The Vancouver Island White-tailed Ptarmigan habitat has four main threats: recreation, air- and ground-based pollutants, forest harvesting, and climate change. Generally, the extent of these threats has not been determined.

Numbers of alpine recreationists have increased throughout British Columbia over the past 50 years with the increase in popularity of activities such as skiing, heli-skiing, snowmobiling, mountain biking, and hiking. Human presence in the alpine can be associated with the introduction of generalist predators and exotic plant species and the creation of barriers to animal movement when trails and roads are developed (Martin 2001). The extent to which recreational activities disrupt White-tailed Ptarmigan populations on Vancouver Island is not well understood. However, negative impacts of these activities have been documented elsewhere with other grouse (Storch 2000; Martin 2001). Impacts can include loss of habitat, population declines, increased predation, and altered foraging behaviour (Martin 2001).

Regional air and water pollution is an increasing concern for high elevation species such as the White-Tailed Ptarmigan. Pollutants are carried by wind from urban and industrial centres and deposited at high elevations in many areas, including the Pacific Northwest (Blais et al. 1998; Brace and Peterson 1998). Consequently, the concentration of persistent organic pollutants (POPs) such as polychlorinated biphenyls (PCBs) in alpine snowpacks increases with increasing elevation in Western Canada (Blais et al. 1998). In addition to POPs, several authors have found a positive relationship between elevation and ozone concentration in Washington State; high concentrations of ozone are known to damage vegetation and human health (Brace and Peterson 1998; Cooper and Peterson 2000).

Logging decreases the amount of mature forest and increases fragmentation. Removing forest cover changes microclimate conditions including wind and insolation patterns, which may influence the rate of snowmelt. Fewer or smaller snowfields restrict birds to a smaller amount of snowfield habitat making them vulnerable to increased risk of predation and increasing travel distances between snowfield patches (Martin 2001). Because seasonal migration to lower elevations is a part of the life history of the subspecies, increased fragmentation of montane forest could result in longer seasonal migrations with predicted higher mortality (Martin and Hitchcock 1997).

Climate change, including global warming, has the potential to alter the amount of alpine and subalpine habitat and to increase alpine fragmentation because of rising subalpine treelines that may accompany higher temperatures (Roland et al. 2000; Martin 2001). Increased climatic variability and frequency of extreme weather events associated with climate change may impact ptarmigan populations adversely (Martin and Wiebe 2001, submitted). The cost for these cold-adapted birds to adjust behaviourally and physiologically to higher temperatures is also a concern.

Legal Protection and Habitat Conservation

The White-tailed Ptarmigan, its nests, and its eggs are protected from direct persecution by the provincial *Wildlife Act*. Hunting White-tailed Ptarmigan on Vancouver Island is prohibited.

A core area of White-tailed Ptarmigan habitat is protected in Strathcona Provincial Park. There is also an initiative to establish two White-tailed Ptarmigan Important Bird Areas on Vancouver Island: Strathcona Provincial Park and Mount Arrowsmith Area Mountains (see www.ibacanada.com for more information). Although these areas provide no legal protection to the birds or their habitat, this initiative signifies the national priority for conserving this subspecies.

Given that White-tailed Ptarmigan use montane forest, some White-tailed Ptarmigan habitat may be conserved where wildlife tree retention areas or old growth management areas are implemented under the results based code.

Identified Wildlife Provisions

Wildlife habitat area

Goal

Maintain suitable wintering habitat.

Feature

Establish WHAs in upper montane areas where concentrations of White-tailed Ptarmigan are known to occur regularly during the winter.

Size

Typically from 1 to 7 ha; however, size will ultimately depend on site-specific conditions required to maintain windfirmness and microclimatic conditions.

Design

The WHA should be 50–250 m wide on southerly aspects (S, SE, SW) and 25–250 m on northerly aspects (N, NE, NW), and a minimum length of 250 m. The WHA should include upper montane forest that will create a continuous zone around the adjacent subalpine and alpine habitat to provide cover, maintain microclimatic conditions suitable for retaining snowfields, and allow access to lower elevations.

General wildlife measure

Goals

1. Minimize disturbance during the critical winter season and spring dispersal (1 November to 5 May) as well as fall dispersal periods (1 September to 31 October).
2. Maintain microclimatic conditions that sustain subalpine and alpine snowfields during the summer months (5 May to 31 August). Important microclimatic conditions to maintain are low local temperatures and local wind patterns.
3. Ensure WHA boundaries are windfirm.

Measures

Access

- Do not construct roads unless there is no other practicable option. Where there are existing roads, restrict road use during critical times (1 November to 5 May and 1 September to 31 October).

Harvesting and silviculture

- Do not harvest.

Pesticides

- Do not use pesticides.

Recreation

- Do not develop recreation sites or trails.

Additional Management Considerations

Maintain ban on hunting Vancouver Island White-tailed Ptarmigan.

Free running dogs in the alpine should be restricted.

Hikers should be discouraged from leaving food in the alpine to avoid enhancing generalist predator survival.

Avoid spilling toxic substances and discarding cords and wire associated with installations of infrastructure in the alpine and subalpine (e.g., repeater towers).

Minimize the number of ground- and air-based motorized vehicles (such as snowmobiles and helicopters) in alpine and subalpine areas to minimize the disturbance they cause.

Information Needs

1. Breeding season, winter, and dispersal habitat use and requirements.
2. Population size.
3. Seasonal movements.

Cross References

Vancouver Island Marmot

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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

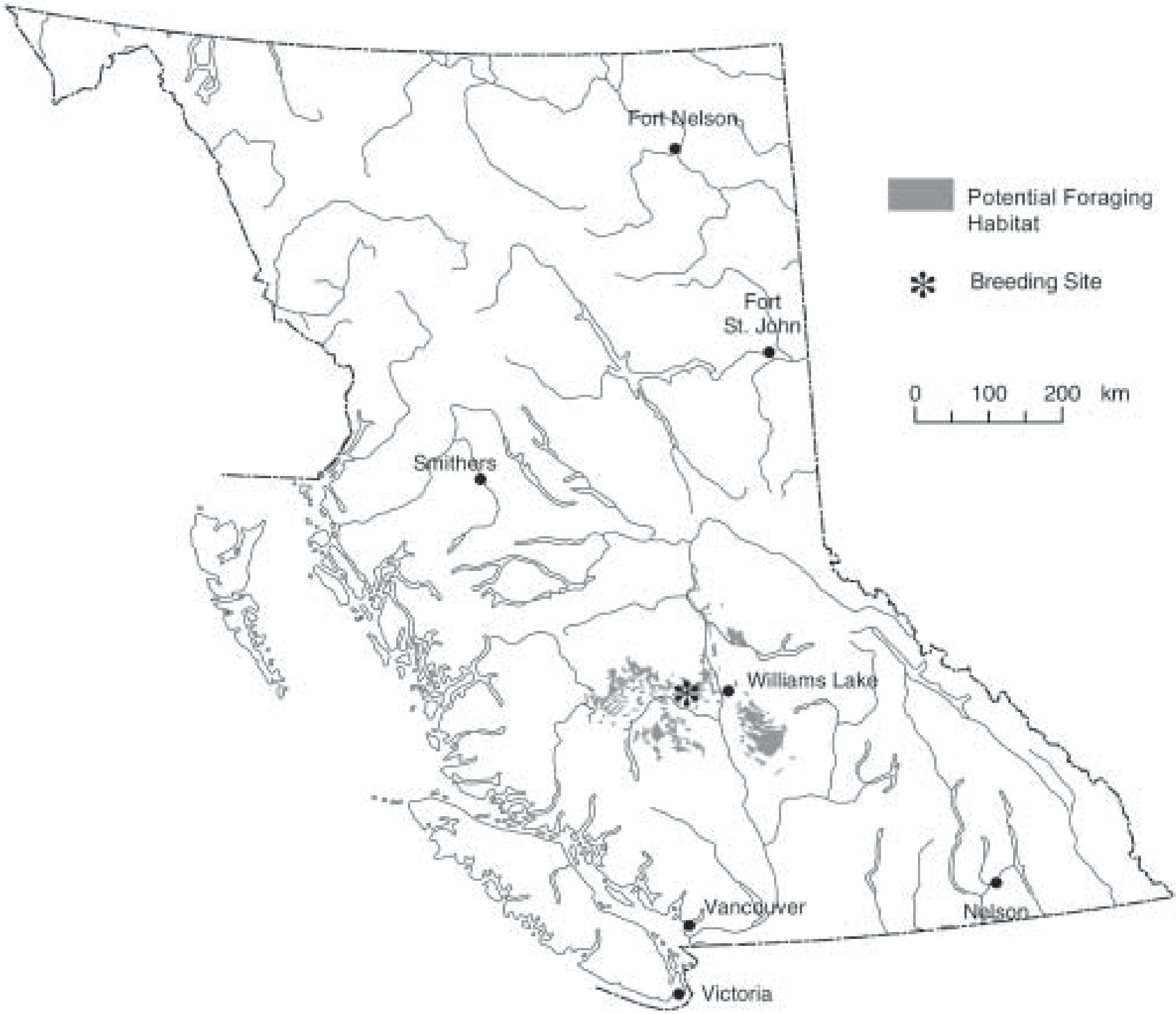
Coast: Chilliwack, South Island, Sunshine Coast

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 10°C) 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.

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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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

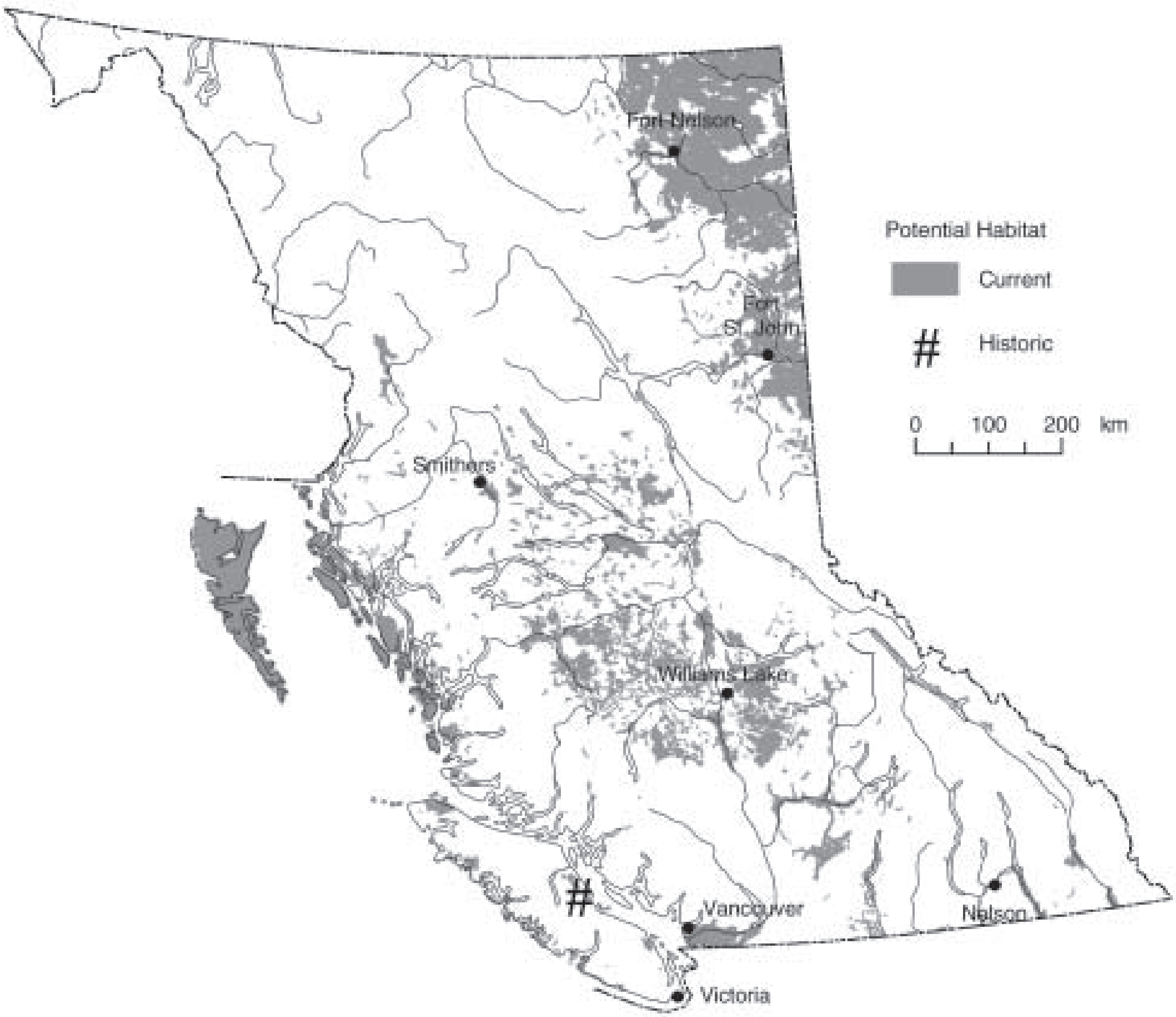
The Sandhill Crane is restricted to North America breeding primarily from the northwestern United States (e.g., northwestern California, Nevada, and Oregon) and the Great Lakes area north to Alaska, and the Northwest Territories including Baffin and Victoria Islands. Resident populations breed in the 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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"Queen Charlotte" Hairy Woodpecker

Picoides villosus picoides

*Original prepared by John M. Cooper,
Suzanne M. Beauchesne and E.T. Manning*

Species Information

Taxonomy

Twelve subspecies of Hairy Woodpecker are recognized, six of which occur in British Columbia (AOU 1957; Cannings 1998). Only *Picoides villosus picoides* is endemic to the Queen Charlotte Islands.

Description

This robin-sized woodpecker is patterned with black and buffy white. The forehead and crown are black; the nasal tufts and supercilium above the eye, back to the nape are white; a stripe in front of the eye and in a broad band over the ear coverts is black; the lores and a band below the ear covert, back to the sides of the neck, is white; and the "moustache" stripe is black. The upperparts (centre of the hindneck to the rump and uppertail coverts) are black with a black and white barred panel in the centre of the back from mid-mantle to the lower back. The underparts (throat, breast, belly, and vent) are dark buffy brown with streaking on the flanks. The upperwing is black, with white subterminal spots on the coverts and white checkering on the flight feathers. The underwing is striped black and white with white coverts. The tail is black with white outer feathers, barred with black. The male has a narrow red nape that distinguishes him from the black-naped female. The Hairy Woodpecker is similar in appearance to the Downy Woodpecker but is larger with a longer, stouter bill.

Picoides villosus picoides differs from the nominate race, *P. villosus villosus*, in that the pale area in the centre of the back is barred rather than pure white; the outer tail feathers are barred, not white; and the underparts are brownish rather than pure white (Miller et al. 1999).

Distribution

Global

The Hairy Woodpecker occurs from the treeline in Alaska and central Yukon, across the northern Prairie provinces, east to Newfoundland, and south to highland forests of Panama and the Bahamas (AOU 1983; Campbell et al. 1990).

British Columbia

Hairy Woodpeckers are found throughout forested British Columbia, but *P. villosus picoideus* is endemic to the Queen Charlotte Islands (Campbell et al. 1990).

Forest regions and districts

Coast: Queen Charlotte Islands

Ecoprovinces and ecosections

COM: QCL, SKP, WQC

Biogeoclimatic units

CWH: vh, wh
MH: wh

Broad ecosystem units

CH, HS, MF, SR

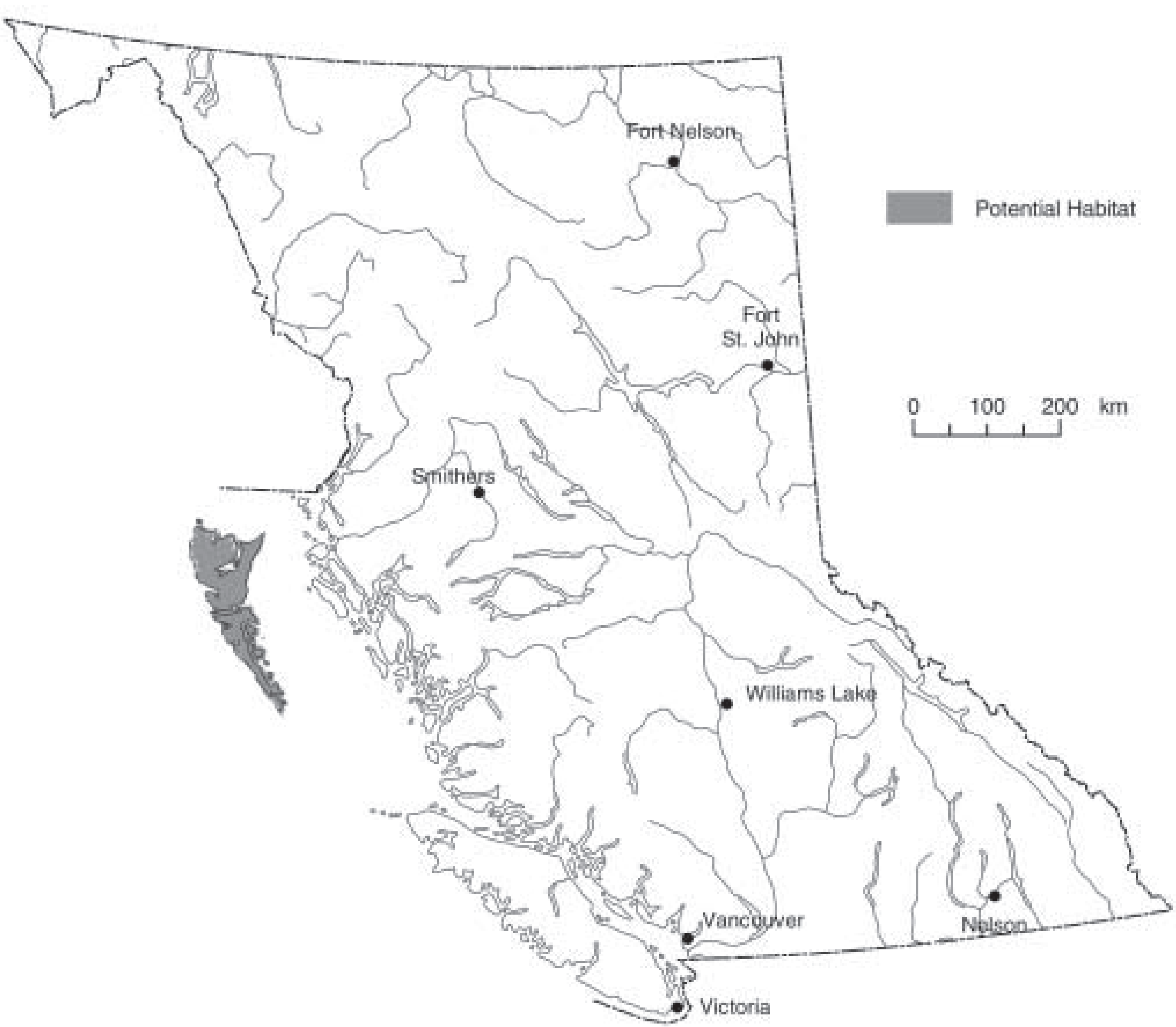
Elevation

Sea level – ~1800 m

Life History

Very little is known about the ecology of this subspecies; therefore most of the following information is inferred from studies elsewhere, especially from the morphologically similar subspecies, *P. villosus harrisi* of Pacific coastal regions.

Hairy Woodpecker - subspecies *picoideus*
(Picoides villosus picoideus)



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

Diet consists largely of wood-boring beetle (buprestids, cerambycids, and scolytids) larvae and adults especially when alternate food sources such as ants, caterpillars, and other insects are scarce (Crockett and Hansley 1978; Winkler et al. 1995, Steeger et al. 1998). Animal matter makes up over 80% of the total diet, and is supplemented by fruits and seeds, especially in the winter (Cannings et al. 1987; USFWS 1987). Sap is also taken at sapsucker wells (Winkler et al. 1995).

Hairy Woodpeckers are opportunistic foragers that find food by gleaning, probing, pecking, hammering, tearing away bark, or drilling funnel-shaped holes into bark (USFWS 1987; Winkler 1995). This woodpecker searches the trunks of living and dead trees, stumps, exposed roots, snags, downed logs, the ground, and logging debris in recent clearcuts (USFWS 1987). The branchless section of the trunk below the crown is the favoured foraging area (Winkler et al. 1995). Larger trees are more frequently searched during all seasons than smaller trees (Winkler et al. 1995).

Reproduction

Pair formation begins 2–3 months before nesting (Winkler et al. 1995). The male selects the nest site and excavates the nest cavity over 17–24 days. Clutches contain three to five eggs, which are incubated by both sexes for 11–12 days. Nestlings fledge after about 24–27 days. In British Columbia, nests have been found between 4 April and 20 June (Campbell et al. 1990). On the Queen Charlotte Islands, nests with young have been found on 31 May and 1 June.

Upon fledging, the brood divides between parents and fledglings accompany one parent for 2 weeks or more. Adults have been documented feeding fledglings on 8 June and 16 June on the Queen Charlotte Islands. One brood is probably produced annually.

In British Columbia, most recorded Hairy Woodpecker nest sites are cavities excavated in deciduous trees that may be live or dead (Cambpell et al. 1990), but on the coast most nests are built in conifers. Live nest trees are usually infected with heartrot decay, which leaves a strong sapwood shell protecting the cavity within the softened, decaying heartwood (Keisker 1987).

Home range

There are no data on breeding territory size or home ranges within British Columbia. In Oregon, territory size averaged 10.1 ha/pair. Elsewhere, reported territories range from 0.6 to 15 ha and are always strongly influenced by habitat quality. The minimum forest patch size required to support a breeding pair during the nesting season is estimated to be 4 ha and the minimum width of a riparian zone is 40 m (USFWS 1987).

Site fidelity

New cavities are usually excavated each year although some birds reuse old cavities.

Movements and dispersal

The Queen Charlotte Hairy Woodpecker is a non-migratory woodpecker, although some vertical movement is probable with birds moving towards the valley bottoms and coastal areas in the winter (Campbell et al. 1990).

Habitat

Structural stage

Variable, including some old growth and mature conifer stands (stages 6 and 7) as well as some mature hardwoods. In northwestern Washington, this species is found in a variety of successional stages although most were in or at the edge of old-growth forests (USFWS 1987).

Important habitats and habitat elements

Nesting

Hairy Woodpeckers inhabit a variety of forest types although they may prefer semi-open mixed forests or forest edges for nesting habitat (Campbell et al. 1990). Meadow edges, riparian zones, and burns are also important habitats.

The Hairy Woodpecker excavates nest and roost cavities in live trees with heart rot or dead trees. Four nests recorded from the Queen Charlotte Islands were found in dead trees, one of which was identified as a western hemlock (*Tsuga heterophylla*) (BC Nest Records Scheme). Other reports from the Queen Charlotte Islands suggest that large diameter (>80 cm dbh) Sitka spruce (*Picea sitchensis*) are used for nesting (Shepard, unpubl. data).

Hairy Woodpecker nest trees in other coastal areas have a large dbh and tall height (see Tables 1 and 2). On northern Vancouver Island, in the Coastal Western Hemlock and Mountain Hemlock biogeoclimatic zones, 73 Hairy Woodpecker nests were documented. Variables that best characterized Hairy Woodpecker nest plots in the Nimpkish Valley (Vancouver Island) included a greater dbh and density of western hemlock, a greater basal area of deciduous and Douglas-fir (*Pseudotsuga menziesii*) trees, and a higher density of Douglas-fir stems (Deal and Setterington 2000). This same study found that 77% of the three species of woodpecker nests were found on slopes <20%.

Hairy woodpeckers used wildlife tree classes 2–7 inclusive for nesting while the highest number of nests were found in classes 4 and 5, suggesting they prefer to nest in trees in a significant state of decay (Deal and Setterington 2000). Relative to overall availability, Hairy Woodpeckers appeared to be selecting for classes 4 and 6 trees (Deal and Setterington 2000). Hairy Woodpecker nests were found more often than expected in bark class 1 trees (all bark present) and 55% of the Hairy Woodpecker nests were found in snags with >95% of the bark remaining (Deal and Setterington 2000).

Most of the nests were found in western hemlock (60%), Douglas-fir (20%), amabilis fir (*Abies amabilis*) (10%), red alder (*Alnus rubra*) (4%), and western white pine (*Pinus monticola*) (3%). Nests were found less than expected in western redcedar,

Table 1. Characteristics (mean ± SD) of Hairy Woodpecker nest trees in three locations

Forest	Location	*n*	Tree dbh (cm)	Tree height (m)	Nest height (m)	Citation
Western hemlock zone conifer	Oregon Coast Ranges	23	72.2 ± 48.0	30.1 ± 16.8	21.7 ± 12.0	Nelson 1988
Mixed to Douglas-fir	South Cascades	18	73.9 ±33.4	28.6 ± 14.4	17.7 ± 10.4	Lundquist 1988
CWHxm, CWHvm, MHmm	North Vancouver Island	73	78.6 ± 28.1	26.5 ± 11.7	20.0 ± 10.3	Deal and Setterington 2000

Table 2. Characteristics (mean ± SD and range) of Hairy Woodpecker nest trees by species in the Nimpkish Valley, Vancouver Island (after Deal and Setterington 2000)

Species	*n*	dbh (cm)	Range	Tree height (m)	Range	Nest height (m)	Range
Amabilis fir	8	66.4 ± 23.0	38–96	19.6 ± 11.0	3–34	15.9 ± 10.8	2–31
Douglas-fir	15	95.1 ± 37.6	40–167	34.5 ± 13.5	15–65	24.7 ±13	10–52
Western hemlock	48	76.6 ± 22.9	34–139	26.4 ± 9.9	7–52	20.6 ± 9.7	5–51
Western white pine	2	77.5 ± 34.6	53–102	14 ± 5.7	10–18	9.0 ± 1.4	8–10

but in other tree species according to their availability. A northwestern Washington study in a similar ecosystem found that Hairy Woodpecker nests were found more than expected in western hemlock while western redcedar was avoided (Zarnowitz and Manuwal 1985). In the southern Washington Cascades, western white pine was also an important nesting tree for woodpecker species including Hairy Woodpeckers (Lundquist 1988).

In summary, relatively large-diameter live trees with rotted heartwood or dead in decay classes 2–6 are likely the preferred nest trees for this particular subspecies of Hairy Woodpecker. Also, mature to old conifer stands, or younger, diseased conifer stands are likely preferred habitats, especially if a mix of trees of decay classes (2–6) are present.

Foraging

Important foraging habitats include mature coniferous forests, deciduous and mixed forests, and openings such as meadows, marshes, ponds, logged area, or burns.

In old-growth stands in the southern Washington Cascades, Hairy Woodpeckers fed most frequently in and preferred Douglas-fir and fed in hardwoods less than expected (Lundquist 1988). In second growth, they preferred Douglas-fir and fed in species other than Douglas-fir and western hemlock, particularly hardwoods, significantly more than expected from availability. In this same study, Hairy Woodpeckers' use of dead trees over live trees was significant, given the lower availability of snags in both old growth and second growth. The large diameter (>50 cm dbh) class of trees were preferred as feeding substrates in both old growth and in second growth, although the 11–50 cm class was used more frequently in second growth and the >50 cm was used more frequently in old growth (Lundquist 1988).

Wintering

Winter habitat is similar to nesting habitat with this species frequenting a variety of forest types including openings within mature coniferous forest, burns, riparian areas, deciduous groves, and mixed-woods. Hairy Woodpeckers also frequently use residential areas where they feed in gardens and at feeders (Campbell et al. 1990). Hairy Woodpeckers take shelter in the winter in old tree cavities or excavate new cavities for roosting (Bent 1939; Kilham 1983; USFWS 1987, Winkler et al. 1995).

In similar ecosystems to the Queen Charlotte Islands, good foraging and wintering habitat is in mature forests with a mixture of coniferous trees in old-growth and Douglas-fir and deciduous trees in second growth. Good foraging and wintering habitat features include large diameter trees and particularly snags.

Conservation and Management

Status

The Queen Charlotte Hairy Woodpecker is on the provincial *Blue List* in British Columbia. Its status in Canada has not been determined. The five other subspecies of the Hairy Woodpecker that occur in British Columbia are not considered to be at risk (COSEWIC 2002).

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

BC	Canada	Global
S3	N3	G5T3

Trends

Population trends

Population trend data for this subspecies are not available. Breeding Bird Survey data for other subspecies within British Columbia indicate an increase in population from 1966 to 1996. Elsewhere, including the Pacific Northwest, Hairy Woodpecker populations have been declining (Ehrlich et al. 1992).

Habitat trends

Trends are unknown.

Threats

Population threats

The "Queen Charlotte" Hairy Woodpecker is endemic to the Queen Charlotte Islands and thus has a restricted range and is vulnerable to extinction.

Habitat threats

In British Columbia, the primary threat to this species is loss of young-to-old coniferous and hardwood forest habitat required for breeding and foraging habitat. Local population fluctuations can be expected if woodpecker territories are logged, without adequate retention of wildlife tree habitat. Snag removal and even-aged stand development have been suggested as the causes for reduction of Hairy Woodpecker populations in coastal Washington (Manuwal 1981). Traditional clearcuts remove entire stands of nesting habitat, while historical partial cut logging often removed the large trees needed for recruitment as future nest trees for woodpeckers. Cutting of decadent trees that have been identified as danger trees near work areas also removes high quality nest trees. Because current forest practices of smaller clearcuts with wildlife tree retention (WTR) areas and riparian reserve zones may create more favourable edge habitat, as long as trees suitable for nesting are retained, it is possible that habitat may be increasing.

Legal Protection and Habitat Conservation

The Hairy Woodpecker, its nests, and its eggs are protected from direct persecution in Canada and the United States by the *Migratory Birds Convention Act*. In British Columbia, the same are protected from direct persecution by the provincial *Wildlife Act*.

Nesting habitat is protected within the Gwaii Haanas National Park Reserve on South Moresby Island and smaller islands; Naikoon Park; and other, smaller reserves such as Drizzle Lake Ecological Reserve (Fraser et al. 1999).

Most of the remainder of this woodpecker's nesting habitat on the Queen Charlotte Islands is on Crown land.

Habitat conservation may be partially addressed by the old forest retention targets (old growth management areas), riparian reserves, and WTR area recommendations in the results based code.

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

- ❖ The Hairy Woodpecker should be managed on an ecosystem level. Maintain connectivity between higher elevation summer habitats and lower elevation wintering habitats to maintain feeding, nesting, and roosting habitat as well as opportunities for dispersal.
- ❖ The objective for this species is to maintain suitable wildlife trees and green recruitment trees for nesting across the breeding range and over time. Consider WTR areas and old growth management areas (OGMA) objectives for this species on the Queen Charlotte Islands. Blocks should be assessed to identify potentially suitable WTR areas. Suitable WTR areas or OGMAs for this species should be based on the information in Table 3.
- ❖ It is recommended that salvage 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 maintained over the long term.

Wildlife habitat area

Goal

Because there are very few known nest areas for this subspecies, these sites should be established as WHAs. Suitable habitat should be managed through wildlife tree and old forest retention objectives.

Feature

Establish WHAs at known nests.

Size

Typically 4 ha but will depend on site-specific factors such as habitat quality.

Table 3. Preferred WTP characteristics for the Queen Charlotte Hairy Woodpecker

Attribute	Characteristics
Size (ha)	≥1 ha
Location	CWHwh, CWHvh, MHwh; optimal to locate WTP adjacent to larger, mature forest stands
Tree features	live trees with heartrot or other structural defects and harder wildlife trees are preferred. Bark classes 1 and 2
Tree species	coniferous species (particularly western hemlock, and Sitka spruce) as well as red alder
Tree size (dbh)	≥75 cm western hemlock; ≥80 cm Sitka spruce; in the absence of trees with the preferred dbh, trees ≥35 cm should be retained for recruitment and dead hardwoods >35 cm should be retained
Tree decay class	2–6

Design

Centre WHA around nest tree as best as possible. Also maximize inclusion of foraging and nesting habitat features.

General wildlife measure

Goals

1. Maintain nest site and potential nest trees.
2. Minimize disturbance during critical breeding times.
3. Maintain important structural elements for breeding and foraging.
4. Ensure WHA is windfirm.

Measures

Access

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

Harvesting and silviculture

- Do not harvest or salvage.

Pesticides

- Do not use pesticides.

Additional Management Considerations

Silvicultural systems that simulate openings caused by endemic natural disturbance agents such as windthrow and root rot should be considered. These include partial cutting systems such as variable retention, which retains trees in groups (patches) and as scattered individual green trees.

Encourage wildlife tree creation treatments (topping, scaring, cavity starts).

Information Needs

1. Breeding territory habitat use and size.
2. Home range habitat use and size.
3. Suitability of various sizes and quality of wildlife tree retention areas for nesting habitat, including configuration or geometry of shape as well as location relative to surrounding features (water bodies, slope, aspect).

Cross References

"Queen Charlotte" Northern Saw-whet Owl

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Mammals

KEEN'S LONG-EARED MYOTIS

Myotis keenii

Original[1] prepared by Trudy A. Chatwin

Species Information

Taxonomy

The Keen's Long-eared Myotis (*Myotis keenii*) is one of three long-eared bat "sister species." Differentiation between *M. keenii*, *M. evotis*, and *M. septentrionalis* is problematic. *Myotis keenii* formerly included its eastern sister taxon, but a study by van Zyll de Jong (1979) concluded that *M. septentrionalis* should be classified as a separate species. The two taxa were formally recognized by van Zyll de Jong (1985) and Jones et al. (1986). Van Zyll de Jong and Nagorsen (1994) analyzed specimens of *M. keenii* and *M. evotis* and found some morphological intermediates. However, based on distributions it was determined that these likely represent intraspecific variation and therefore the two were considered separate species. There are no recognized subspecies of *Myotis keenii*.

Description

Medium-sized (63–94 mm; 4–5.9 g) dark bat with paler underside. Ears and wing membranes are brown (not black). This species, like several other myotis species, have long ears and tragus. The Keen's Long-eared Myotis may be confused with the Western Long-eared Myotis (*Myotis evotis*) whose range overlaps that of the Keen's Long-eared Myotis. The two species can be reliably differentiated by analysis of skull measurements but cannot be distinguished with certainty in the field (see Nagorsen and Brigham 1993).

Distribution

Global

Restricted to the Pacific northwest coast. British Columbia is the centre of distribution but records exist from southeast Alaska and western Washington.

British Columbia

Occurs on Vancouver Island, the Queen Charlotte Islands, and the mainland coast.

Forest region and districts

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

Ecoprovinces and ecosections

GED: FRL, LIM, NAL

COM: CPR, KIM, KIR, NIM, NPR, NWL, OUF, QCL, SBR, SKP, SPR, WIM, WQC

Biogeoclimatic units

CDF: mm

CWH: dm, mm1, mm2, vm1, vm2, vh1, vh2, wh1, wh2, wm, wm1, wm2, xm1, xm2

MH: mm1, mm2, wh1, wh2

Broad ecosystem units

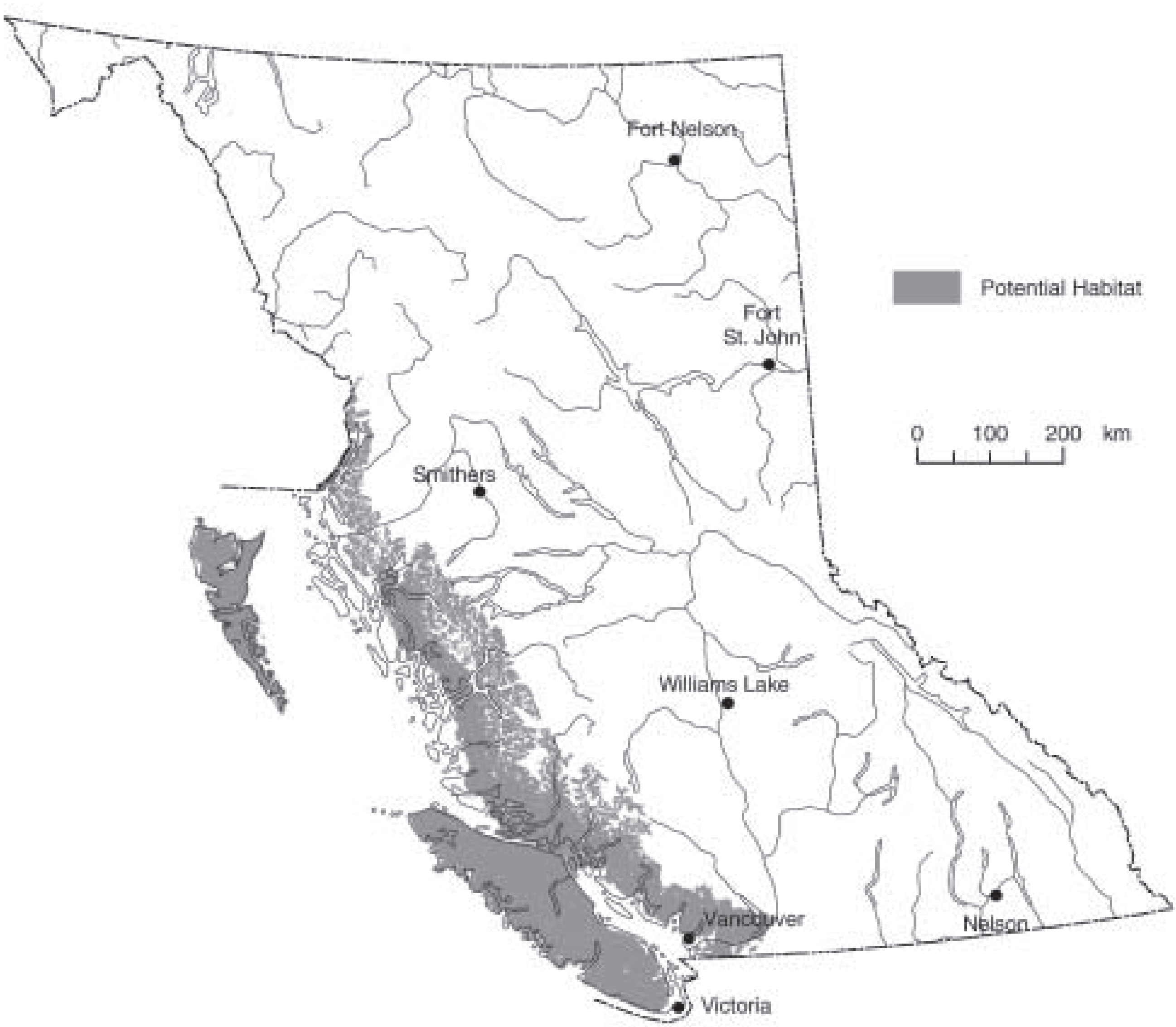
CD, CH, CW, FR, MF, RO, SR, YM

Elevation

0–1100 m

1 Volume 1 account prepared by P. Garcia and S. Rasheed.

Keen's Long-eared Myotis
(Myotis keenii)



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

Diet and foraging behaviour

Although foraging behaviour of this species is largely unknown, diet analysis from work in Gwaii Haanas National Park Reserve and southeast Alaska indicates that the main prey—in order of importance—are spiders, Tricopterans, moths, and flies (D. Burles, pers. comm.; Parker and Cook 1996). Parker and Cook (1996) suggest that this prey mixture of flying and non-flying arthropods points to a flexible feeding strategy of both pursuing prey in flight and gleaning and indicates that Keen's Long-eared Myotis is well adapted as an arthropod predator. Its small size, low wing-loading ratio, and very low intensity echolocation call makes it well adapted for flying and foraging within structurally complex old forest.

Reproduction

The Keen's Long-eared Myotis likely does not breed until its second summer. Mating occurs in the fall prior to hibernation. Fertilization is delayed until females leave the hibernacula in the following spring for maternity colonies. There is only one know maternity colony, consisting of at least 40 females, in British Columbia. It is located among geothermally heated boulders and crevices on Hotspring Island, Gwaii Haanas National Park. Females return to this colony in May. Young are born between early June to mid to late July (D. Burles, pers. comm.). Only one litter, usually a single pup, is produced per year.

Keen's Long-eared Myotis has been found roosting in southwest facing rock crevices, geothermally heated rocks, tree cavities, bark crevices, and even in buildings (D. Burles, pers. comm.; Firman et al. 1993; Nagorsen and Brigham 1993; Parker and Cook 1996; Mather et al. 2000). Maternity roosts and summer feeding occur at elevations below 240 m, while known hibernation sites occur over 400 m elevation in caves over 100 m long.

Site fidelity

There is little information on site fidelity of Keen's Long-eared Myotis. However, information collected from banded *Myotis* species show that other species of *Myotis* do show high site fidelity to maternity roost and hibernation sites. At the Gandl'kin maternity colony, two individuals that were banded in 1991 were recaptured near the same maternity roost in 1998.

Home range

Very little is known regarding the home range of Keen's Long-eared Myotis. From the very scant data, it appears that they may not move great distances in summer and may have small home ranges. The longest movement away from the capture site for three radio-tagged Keen's Long-eared Myotis tracked for 2–4 days in August 1999 was 1 km (Mather et al. 2000). Burles (pers. comm.) only captured Keen's Long-eared Myotis up to 500 m from the maternity roost.

Movements and dispersal

Although little is known about long-range movements, it appears that they leave the hibernaculum in May (Mather et al. 2000). At the Gandl'kin maternity colony some females arrive in mid-May, but the majority arrive at the end of May and remain at the colony after that time (D. Burles, pers. comm.). They abandon this maternity colony in mid- to late August.

Studies in British Columbia show that females seem to feed and raise young at low-elevations (<250 m) in summer. Low elevation ponds and riparian forests are warmer and have higher insect productivity. Males begin to visit and "swarm" at the cave hibernation sites in August. Females join the "swarming" males at the cave sites in September. *Myotis keenii* appears to go into hibernation in October (Mather et al. 2000)

Habitat

Structural stage

6: mature forest
7: old forest

Important habitats and habitat features

Keen's Long-eared Myotis appear to be associated with cool wet coastal montane forests and karst features.

Caves >100 m in length and above 500 m elevation are known to be important winter hibernation sites for myotis bats (Davis et al. 2000). Caves with stable temperatures between 2.4 and 4°C with a 100% relative humidity were important on northern Vancouver Island for myotis bats (Davies et al. 2000). In summer, rock faces and knolls with crevices that are solar or geothermally heated are important maternity roosts. The only known maternity colony is situated within geothermally heated rocks associated with hot spring activity. Tree cavities in wildlife trees (decay class 2 or greater) and loose bark (on trees with decay class 4 or greater) are important natural roost sites and may be limiting in some parts of their range. Low elevation coastal forest and riparian areas are important foraging areas.

Conservation and Management

Status

The Keen's Long-eared Myotis is on the provincial *Red 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	AK	WA	Canada	Global
S1S3	SH	SH	N1N3	G2G3

Trends

Population trends

Population size and trends are not known (Cannings et al. 1999). At least 18 occurrences are known in British Columbia but more are likely to exist (Cannings et al. 1999). The only known maternity colony contains at least 40 adults.

In an inventory at Clayoquot Sound, long-eared bats comprised <10% of the captures. In a study at Weymer Cave on the west side of Vancouver Island, long-eared bats comprised 14.5% of the captures. On the Queen Charlotte Islands, captures of Keen's Long-eared Myotis were rare away from the maternity colony (D. Burles, pers. comm.).

Burles captured banded adults at Gandl'kin and determined that these Keen's Long-eared Myotis were at least 8 years old. The age at first breeding is not known but all females are capable of becoming pregnant after their first winter. In most bat species, females typically produce one offspring per year. It is likely that Keen's Long-eared Myotis have an even lower reproductive rate because the species occurs at northern latitudes in coastal montane habitats which can experience severe weather fluctuations during the breeding season. This may affect prey availability and consequently productivity. In 1999 at the Weymer Creek study, only two females captured showed signs of reproduction. Burles found no evidence of successful fledging in 1998 during a dry warm summer. In 1999, during a cooler summer, there was some evidence of fledging (D. Burles, pers. comm.).

Habitat

There is no information on habitat trends. However, it is generally accepted that wildlife trees, and summer and winter roosts are affected by logging and roadbuilding due to loss of habitat and disturbance. Therefore it may be assumed that habitat quality and quantity is generally declining.

Threats

Population trends

This species has a limited distribution and is considered sparsely distributed, which could increase its risk of extirpation or extinction.

Habitat

The main threat to the habitat of this species is forest harvesting and mineral extraction. Disturbance during hibernation and while raising young is a major concern. Disturbance may result from recreational activities (e.g., caving) or industrial activities (e.g., blasting for road construction).

Legal Protection and Habitat Conservation

Under the provincial *Wildlife Act,* the Keen's Long-eared Myotis is protected from killing, wounding, hunting or trapping, taking, and transporting including exporting and importing.

The only known maternity colony is protected within Gwaii Haanas National Park Reserve. One other known female and young roost site is managed within an existing WHA. Cave hibernation sites are also protected in Weymer Creek Provincial Park (305 ha). The Vancouver Island Land Use Plan increased the percentage of protected areas on Vancouver Island from 10.3 to 13%. At least one of these parks (White Ridge Provincial Park) may include suitable hibernacula, and Artlish Caves Provincial Park contains karst.

Results based code provisions that may provide habitat include old growth management areas and riparian provisions. Karst management guidelines under the results based code are under development.

Identified Wildlife Provisions

Wildlife habitat area

Goal

Protect known colonies (maternity or hibernacula) and roosting sites as well as their adjacent foraging areas and movement corridors (e.g., riparian areas).

Feature

Establish a WHA at known hibernacula, maternity colonies, and roosting sites.

Size

Typically between 30 and 50 ha but will depend on site-specific factores including the type of feature (cave vs. tree), location of roosting trees, presence of wetlands or lakes, and potential movement corridors.

Design

The WHA should include a 100 m radius core area and a 200 m radius management zone (total 300 m). When cave habitat is the focus of the WHA, the core area and management zone should be centred on the cave entrance(s). The WHA should also include a minimum 20 m core area on either side of any stream, wetland, or lake within 500 m of the site that is considered by MWLAP to be valuable bat habitat to include within the WHA.

General wildlife measures

Goals

1. Maintain microclimate conditions of the colony or roosting site.
2. Minimize disturbance during critical times (maternity sites: 15 May to 30 September; hibernaculum sites: 1 October to 31 May).
3. Maintain forage opportunities and night roosting habitat near colonies.
4. Maintain important structural features of the forest and karst ecosystem.

Measures

Access

- No road construction should be carried out within the core area.
- Do not remove rock or talus within core area or management zone.
- Do not blast within core area or management zone.

Harvesting and silviculture

- Do not harvest or salvage in core areas.

- Within maternity WHAs, do not harvest within the management zone from mid-May through September.
- Within hibernation WHAs, do not harvest within the management zone from October through May.
- Where harvesting is planned within the management zone, use partial harvesting systems that maintain a minimum of 70% basal area.
- When harvesting within the management zone, retain important structural elements specifically wildlife trees (decay classes 2–7) with cracks, peeling bark, cavities and hollow interiors, canopy gaps, and older green trees that have either cracks or crevices in thick bark, bark pulling away from the trunk forming crevices, or holes in the bole where limbs have been shed.

Pesticides

- Do not use pesticides.

Recreation

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

Additional Management Recommendations

Any blasting within 1 km from the WHA cave entrance or maternity colony, should ensure that the peak particle velocity does not exceed 15 mm/sec. Sound concussion should be <150 decibels and the shock wave should be <1.5 p.s.i. (McQuarrie, pers. comm.).

Since karst areas, including limestone cliffs and caves, are important for this species they should be inventoried before development.

Restrict recreational use of caves during critical times.

Information Needs

1. Maternity roost characteristics and summer habitat use.
2. Measures of disturbance from blasting.
3. Location of hibernacula.

Cross References

Bull Trout, Coastal Tailed Frog, Fisher, Marbled Murrelet, Quatsino Cave Amphipod, "Queen Charlotte" Goshawk, Spotted Owl, "Vancouver Island" Common Water Shrew

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Badger

Taxidea taxus jeffersonii

Original[1] prepared by Ian T. Adams and Trevor A. Kinley

Species Information

Taxonomy

Of the seven species of badgers, only the "American" Badger, *Taxidea taxus* (Schreber), occurs in North America. The subspecific classification accepted by COSEWIC and the CDC follows that proposed by Long (1972) and accepted with no or few modifications by Banfield (1974), Hall (1981), Long and Killingley (1983), and Messick (1987). Based on skull morphology, pelage colour, and range, the four subspecies are *T. taxus berlandieri*, *T. taxus jacksoni*, *T. taxus jeffersonii*, and *T. taxus taxus*. Only *T. taxus jeffersonii* occurs in British Columbia.

Description

The most distinctive features of the Badger is its posture and head colouration. It is a squat carnivore weighing 6–12 kg, with dense, coarse hair reaching nearly to the ground, typically giving the impression of an animal with very short legs. The head is characterized by alternating black and white bands, including a white dorsal stripe, black immediately anterior to the eyes, white immediately posterior to the eyes, black on the cheeks, and white immediately anterior to the ears. Other aids to field identification include dark brown to black legs; mottled body hair of mixed white, black, grey, and brown; extremely long claws (front claws often in excess of 5 cm); and rapid burrowing when disturbed or in pursuit of food. The *jeffersonii* subspecies is distinguished by its range (below), reddish brown colouration, large size, and short dorsal stripe. See Long and Killingley (1983) for a detailed morphological description, including subspecific characteristics.

Distribution

Global

The American Badger occurs only in central and western North America, from southern Canada to northern Mexico. Hall (1981) indicates the *jeffersonii* subspecies to occur from the Rockies westward as far north as southern British Columbia and as far south as the southern parts of Colorado, Utah, Nevada, and California.

British Columbia

Badgers occur within the drier parts of the Kootenays, southern interior, and central interior. The southern boundary follows the U.S. border from Alberta to the Similkameen River headwaters. The approximate western limit is the Cascade Mountains and middle section of the Fraser River (except in the lower Chilcotin drainage). The northern limit approximates a line from Alexis Creek to Quesnel Lake. The eastern boundary follows the west edge of the Cariboo and Monashee mountains to Lower Arrow Lake, then east across the Selkirk Mountains to Kootenay Lake, then north through the Purcell Mountains, Rocky Mountain Trench and Rocky Mountains to the Trans-Canada Highway, then east to the Alberta boundary and southeast along the provincial border.

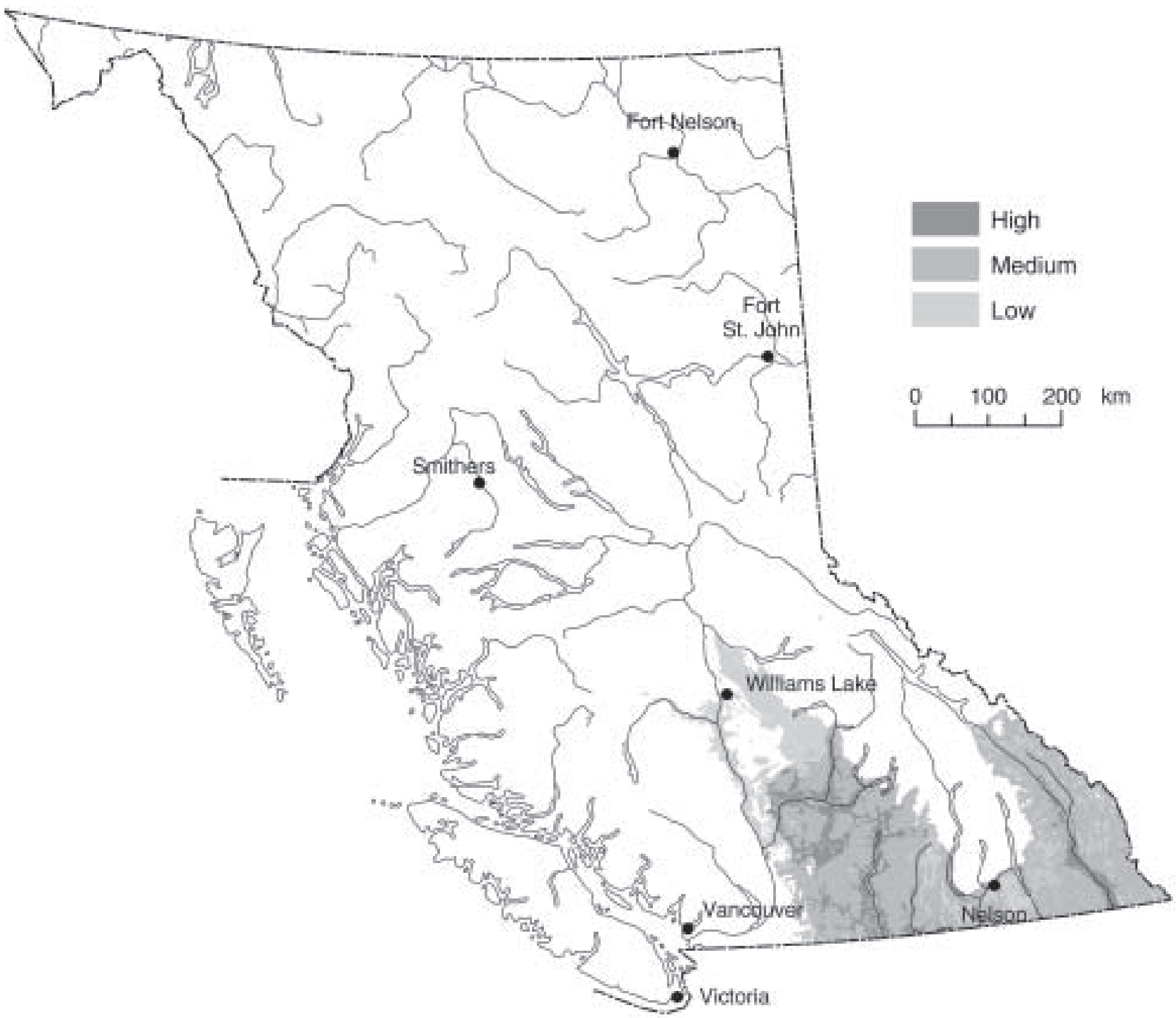
Forest regions and districts

Southern Interior: 100 Mile House, Arrow Boundary, Cascades, Central Cariboo, Chilcotin (extreme east-central only), Columbia (southeast only), Headwaters (south only), Kamloops, Kootenay Lake (south only), Okanagan Shuswap, Quesnel (extreme south-central only), Rocky Mountain

Coast: Chilliwack (extreme east only)

1 Draft account for Volume 1 prepared by L. Gyug.

Badger
(Taxidea taxus)



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: CAB, CAP, CHP (lowest elevations only), FRB

SIM: COC, EKT, EPM, FLV, MCR, SCM, SFH, SHH (extreme south only), SPK

SOI: HOR, NOB, NOH, NTU, OKR, PAR, SOB, SOH, STU, THB

Biogeoclimatic units

AT

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

ESSF: dc1, dc2, dcp, dk, dkp, mw, mwp, wc1, wc4, wcp, wm, wmp, xc, xcp

ICH: dw, mk1, mk2, mk3, mw1, mw2, mw3, xw

IDF: dk1, dk2, dk3, dm1, dm2, mw, mw1, mw2, un, xh1, xh2, xm, xw, xw2

MS: dk, dm1, dm2, un, xk

PP: dh1, dh2, xh1, xh2

SBPS: mk

SBS: dw1, dw2, mc1, mm, un

Broad ecosystem units

Southern Interior Forest: AC, DF, DL, DP, EF, IG, IH, IS, PP, RB, RD, SD

Central and Northern Forest: LP, SF, SL

Subalpine Parkland and Krummholz: FP, WB

Shrub and Herb Dominated: AB, BS, MS, SS

Non-forested Subalpine and Alpine: AG, AM, AT, SG, SM

Sparsely Vegetated: UV

Urban and Agricultural: CF, MI, OV, RM, TC, TR, UR

Elevation

Badger occurrence is usually greatest near valley bottoms but at least some populations make regular use of all elevations, including the alpine. Minimum elevations are 300–800 m, depending on the region, while the maximum elevation is about 2800 m.

Life History

Diet and foraging behaviour

Badgers are adapted to capturing fossorial prey, which is their primary diet in most locations (Lampe 1982; Salt 1976). However, badgers supplement their diet with a wide variety of mammals, birds, eggs, reptiles, amphibians, invertebrates, and plants (Messick 1987). Fecal and stomach samples have included Columbian Ground Squirrels, Yellow-bellied Marmots, Northern Pocket Gophers, Red-backed Voles, Deer Mice, Great-Basin Pocket Gopher, ungulates, insects, sparrows, Common Loon, leporid, sucker, salmonid, Yellow-Bellied Racer, Western Rattlesnake, Long-Toed Salamander, frog or toad, and unidentified remains (Newhouse and Kinley 2002; H. Davis, Artemis Wildlife Consultants, unpubl. data; C. Hoodicoff, Univ. Victoria, unpubl. data; D. Nagorsen, formerly Royal B.C. Mus., pers. comm.; N. Newhouse, Sylvan Consulting Ltd., unpubl. data).

Dens function as sites for resting, food storage, and parturition, and as central nodes from which foraging is based. In Utah, Lindzey (1978) found that only 15% of all dens used by badgers were dug immediately before their use and some dens were reused numerous times by the same badger. Newhouse (1999) noted that 60% of radio-locations were in reused burrows, and also documented different badgers using the same burrow at different times. Maternal dens differ from those used for diurnal resting in that they are more structurally complex with larger soil mounds at the entrance (Lindzey 1976). A high degree of individual and interannual variation in winter torpor has also been noted, with some individuals active throughout most of the winter and others remaining in one burrow for up to 98 days (Newhouse 1997).

Reproduction

Badgers are promiscuous, with breeding occurring in late July and August (Messick and Hornocker 1981). Implantation is delayed until February, with parturition occurring in late March or early April. Litter sizes range from one to five kits (Lindzey 1982). Litter sizes among radio-tagged females in the East Kootenay and Thompson-Okanagan have varied from zero to three, recorded 6–10 weeks post-partum, although members of the public have reported local litters of up to four (Newhouse and Kinley 2002; Weir and Hoodicoff 2002; N. Newhouse, Sylvan Consulting Ltd., unpubl. data).

Home range and movement

As of 2000, mean home ranges in the East Kootenay were 51 km^2 for females and 450 km^2 for males, based on the minimum convex polygon (MCP) method. Another subsample of badgers recently radio-tagged at the southern end of the East Kootenay appears to have considerably smaller ranges, but data are not yet complete. Mean home ranges in the Thompson-Okanagan region are similar to those in the East Kootenay (Weir and Hoodicoff 2002). Home ranges in British Columbia are much larger than those found in Idaho, Wyoming, and Illinois (2–44 km^2 based on MCP; Messick and Hornocker 1981; Minta 1993; Warner and Ver Steeg 1995).

Juvenile dispersal generally occurs in June through August, but cases of dispersal not occurring until the age of 1 year have been recorded (N. Newhouse, unpubl. data).

Habitat

Structural stage

For forested habitat types in which older structural stages are characterized by closed-canopy forest, structural stage is critical. In such cases, prey abundance can sometimes be very high in structural stages 0 and 1, but typically diminishes rapidly after that.

For open-canopied and non-forested habitat types, the importance of grassland structural stages varies according to local prey base. In areas where Columbian Ground Squirrels are present, vegetative structure may play a relatively insignificant role. However, where ground squirrels are not present, badgers are more reliant on microtine rodents (mice and voles). At these sites, mid- to late-seral, highly structured grasslands are important habitat features for badger prey.

Important habitats and habitat features

In British Columbia most badger activity is at low elevations in dry regions (BG, PP, IDF) within native or non-native grasslands, open forests of Douglas-fir or ponderosa pine, and disturbed sites such as roadsides and agricultural fields. However, badgers have also been documented using cutblocks, burns, early-seral forests of several species composition, other open sites in the ICH, MS, ESSF biogeoclimatic zones and parts of the SBPS and SBS and occasionally the AT (Apps et al. 2002; Weir and Hoodicoff 2002). Newhouse and Kinley (2000) documented individual male badgers regularly travelling between the IDF and the AT biogeoclimatic zones. Badgers are also adaptable by region and by season to a wide variety of food sources. Badgers appear to be relatively tolerant of human presence, as evidenced by their use of golf courses, abandoned buildings, and roadsides (Newhouse 1999), although there are presumably upper limits to the level of habitat alteration, number of movement barriers, or amount of direct human disturbance that badgers will tolerate.

Burrowing and foraging

Badger burrow and hunting sites are typically within sites dominated by grass, forbs, or low shrubs, either in non-forest, open forest, or very young forest. Badgers are typically found in or near colonies of prey species, such as Columbian Ground Squirrels or Yellow-Bellied Marmots. Ground squirrels appear to slightly favour sites with a preponderance of forbs relative to grass and shrubs. However, without these species, badgers may rely on more evenly dispersed microtine rodents.

A variety of soil types are used, but the most common types are moderately coarse-textured Brunisols with low to moderate (<35%) coarse fragment content, originating from glaciofluvial and glaciolacustrine parent material. Where available, Chernozems are probably also selected. Badgers that occur in areas with predominantly morainal deposits (e.g., ESSF, MS forests) may be limited to using disturbed soils (e.g., overburden, road fill) or small areas with glaciofluvial deposits in these areas. Although badgers sometimes burrow along disturbed road rights-of-way, the high mortality risk associated with such locations probably outweighs any habitat value there. Distance from other mortality or harassment risks such as dogs are another important habitat feature. Because badgers maintain and use several burrows over a large home range, identifying a burrow as "active" or "inactive" is difficult. Burrows are readily reused by both badgers and other species (e.g., Burrowing Owl).

Conservation and Management

Status

The Badger is on the provincial *Red List* in British Columbia. In Canada, it is listed as *Endangered* (COSEWIC 2002). (See Summary of ABI status in BC and adjacent jurisdictions at bottom of page.)

Trends

Population trends

The most recent estimate for badger numbers in the province is <200 breeding adults (Adams et al. 2002). This is considerably lower than an earlier estimate of 300–1000 (Rahme et al. 1995). It is not clear whether this difference is due to recent population declines or simply a lack of information with which to make the earlier estimate. Pelt records do indicate a much larger population historically, with 200–350 pelts reported annually from British Columbia in 5 years within the 1920s, and this presumably represents only a portion of the total kill (Adams et al. 2002). In addition, there are examples of badgers disappearing (or nearly so) from relatively large areas in the recent past, such as the apparent near extirpation of badgers from the upper Columbia Valley in the past decade. However, even within areas of relatively healthy badger populations, numbers likely oscillate somewhat with changes in prey densities. Thus, the medium- to long-term trend in badger numbers has been downward, with the short-term trend unknown.

In southeast British Columbia, the average annual mortality was 23% among adults and 45% among juveniles (<1 yr), with causes of mortality among study animals including roadkill, probable predation by cougar, train kill, old age, predation by bobcat, and unknown. Trapping and shooting also resulted in the death of untagged animals (Newhouse and Kinley 2002).

Habitat trends

Throughout the regions of British Columbia that were historically dominated by grassland, shrub-steppe, and open forest, habitat has been lost over the past century due to forest encroachment and in-growth (as defined by Kirby and Campbell 1999). In some places, the pace of such losses may have slowed somewhat in recent years with the initiation of habitat restoration burns. Within more densely forested areas, some habitat has been created temporarily through logging (particularly where new forests have been slow to regrow). However, in areas with moderate to short historic fire-return intervals, gains from forest harvesting have probably been outpaced by the prevention of forest fires and the replanting of trees after burns. Post-harvesting habitat is generally short lived due to current stocking densities and "free-to-grow" requirements. Habitat has also been lost to human settlement, highways, intensive agriculture, gravel/sand pits, hydroelectric reservoirs, and the elimination of ground squirrel colonies. Thus, both the short- and long-term trends in habitat have been downward.

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

AB	BC	CA	ID	MT	OR	WA	Canada	Global
S4	S1	S4	S5	S4	S4	S5[a]	N4	G5[b]

a Badgers will soon be under review in Washington where wildlife managers have significant concerns over its status, especially close to the British Columbia border (H. Allen, pers. comm.).

b There is no global ranking for the Taxidea taxus jeffersonii subspecies. This rank reflects the global rank for the entire Taxidea taxus species.

Threats

Several threats exist to badgers and their habitat (Table 1). Some of these are historical and likely led to the initial decline in badger numbers across the province but have since been at least partially abated. Other threats continue or are increasing.

Population threats

A large proportion of known death of instrumented badgers results from highway mortality. Their vulnerability to roadkill is due to several factors:

- Badgers prefer open valley bottom habitats, where highways are most often constructed.
- Large home ranges (especially males) may increase the frequency of encounters with highways.
- Disturbed soils adjacent to highways are ideal digging substrates for both badgers and their prey.
- Prey densities may be higher near highways because rights-of-way are maintained in early successional, grassy stages.
- Badgers' fearless behaviour, typical of most mustelids, leaves them vulnerable to road kills.
- Badgers are most active at night, when drivers will have the most difficulty seeing a relatively small, low-to-the-ground animal.
- Badgers may use roadside ditches and right-of-ways as extensive linear movement corridors.

Extermination of prey species such as ground squirrels, marmots, and pocket gophers may reduce food available to badgers. Secondary effects from consuming poisoned prey may also have harmful results on badgers. Habitat degradation due to poor range practices has also likely led to reductions in prey species with subsequent effects on badger population levels.

Badgers are killed by landowners who either directly fear them or consider them nuisance animals whose diggings may damage machinery or pose a threat to livestock.

The observed low reproductive output in British Columbia may inhibit badgers' ability to recover from lowered population levels. Banci and Proulx

Table 1. List of probable continuing and historic threats to badger populations and habitat in British Columbia ranked by relative impact (predominant or contributing), spatial distribution of the threat (widespread or local), temporal impacts (chronic, episodic, or ephemeral), and degree to which the threat has been reduced. (Source: Adams et al. 2002).

Threat	Impact	Spatial	Temporal	Continuing
Trapping	predominant	widespread	episodic	yes
Persecution	contributing [a]	widespread	chronic	partially
Urban development	predominant	widespread	episodic	increasing
Cultivation	contributing	widespread	chronic	no
Viniculture & orchards	contributing	local	chronic	no
Forest in-growth & encroachment	contributing	widespread	chronic	partially
Reservoir flooding	contributing [b]	local	chronic	no
Highway mortality	predominant	widespread	chronic	increasing
Extermination of prey	contributing	widespread	episodic	no
Secondary poisoning via prey	contributing	local	ephemeral	partially

a Degree of persecution is unknown. Impact is potentially substantial at a local level.

b Across all of British Columbia, reservoir flooding has likely had limited impact on population numbers. However at a local level (e.g., Lake Koocanusa in southern Rocky Mountain Trench), impacts are likely predominant.

(1999) classified the badger as a low resiliency species in British Columbia (i.e., with a low capability to recover from a reduction in numbers). They attribute the low resiliency to the fact that badger populations have a relatively low reproductive rate, extensive dispersal movements, and high human-caused mortality other than trapping. Human-caused mortality should be kept to a minimum (i.e., <10%) (Banci and Proulx 1999).

Habitat threats

There are several threats to badger habitat, including:

- highway construction
- urban development
- cultivation agriculture
- viniculture and orchard development
- forest in-growth and encroachment
- gravel and sand pits
- reservoir flooding
- poor range practices
- unfettered motorized access to grassland and open-forest ecosystems

Many of these threats present semi-permeable barriers to badgers. They readily cross highways; are known to swim across reservoirs; and will use cultivated fields, orchards, and ginseng farms. However, all of these represent varying degrees of habitat degradation, often as a result of reduced prey availability and increased mortality risk.

An important aspect regarding badger habitat loss is that impacts are exacerbated by negative human attitudes toward badgers. Badgers have been sighted at golf courses, ginseng farms, mine sites, ski hills; and within urban areas. However, humans tend to be intolerant (sometimes fearful) of badgers and either exterminate them directly or remove their prey.

Legal Protection and Habitat Conservation

Badgers have been protected from trapping and hunting under the provincial *Wildlife Act*. However, under Section 26 of the *Wildlife Act*, any species not listed as threatened or endangered and deemed to be a menace to domestic animals or birds may be killed by the property owner. Although red-listed by the B.C. Conservation Data Centre, badgers are not formally listed as threatened or endangered under the *Wildlife Act*.

Most prey species, including Columbian Ground Squirrel, Yellow-bellied Marmot, Northern Pocket Gopher, *Peromyscus* spp., and arvicolid rodents (voles) are protected on Crown land. However all are listed under Schedule B of the designation and exemption regulations of the *Wildlife Act* and may be legally killed on private land to protect property.

Protected areas currently provide little conservation value. In the East Kootenay region, protected areas represent 15% of the area available, but only 3% of probable badger habitat (Apps et al. 2002). Conversely, private lands represent 9% of the study area, but 35% of probable habitat (Apps et al. 2002). Despite new protected areas in the Okanagan region, a similar situation exists there. Further, badger home ranges are larger than most protected areas with probable badger habitat.

Large protected areas with suitable badger habitat include Kootenay National Park, Kikomun Creek Provincial Park, Lac du Bois Grasslands Provincial Park, Okanagan Mountain Provincial Park, White Lake Grasslands Provincial Park, and South Okanagan Grasslands Provincial Park. Outside of these parks, no significant habitat conservation actions have been taken specifically for badgers although badgers have been identified as part of the rationale for acquisition of conservation lands by non-profit organizations, and for restoring habitat within landscapes historically dominated by open habitats.

A functioning *jeffersonii* badger Recovery Team is in place under provincial jurisdiction with the B.C. Ministry of Water, Land and Air Protection as the lead agency. A draft recovery strategy (Adams et al. 2002) is under review and actions toward increasing badger populations in British Columbia are under way.

The Wildlife Habitat Feature designation under the results based code may be sufficient to protect and maintain badger burrows, especially maternal dens, provided that a 20-m radius (or one tree length, whichever is less) around the burrow is kept free of machinery impacts and soil disturbance. Characteristics or evidence of a maternal den include larger than average burrow (lots of dirt and signs of repeated use such as tracks, fresh digging), repeated sightings of adult badger within a small area, sighting of badger kits, and documented historic use. Burrows may also be protected on cutblocks using wildlife tree retention areas.

Livestock grazing practices on Crown rangelands should adhere to prescribed range use plans as administered by the Ministry of Forests under the results based code.

Identified Wildlife Provisions

Sustainable resources management and planning recommendations

The highest quality badger habitats occur in Natural Disturbance Type 4 (NDT4). Sites are characterized by:

- frequent, stand-maintaining fires
- generally open grassland or sparsely treed areas
- high densities of prey populations
- Brunisol and Chernozem soil types with fine sandy loam structure (generally friable soils without large rocks).

The focus of the following recommendations and measures are based on management in these areas. However, badgers in British Columbia are known to use NDT3 sites that have not been restocked, often following logging operations or severe fires. These NDT3 sites may represent a significant portion of the provincial badger population but are much more difficult to manage under current fire suppression, restocking, and Free-to-Grow requirements.

- ❖ Maintain areas of high habitat value for badgers.
- ❖ Maximize connectivity between areas of higher habitat value by minimizing urbanization and conversion of agricultural land to residential, industrial, or other developments.
- ❖ Maintain seral stage and structure on all habitats to support prey base.
- ❖ Maintain lowest possible road densities.
- ❖ Continue/increase restoration activities that reduce forest in-growth and encroachment.
- ❖ Reduce re-stocking rates in NDT4 zones (no planting wherever possible).
- ❖ Create and maintain a range of successional and structural stages of grassland and open forest ecosystems with structure and cover attractive to ground squirrels and other prey species.
- ❖ Leave larger, older trees to provide more ecological stability.

Wildlife habitat area

Goal

Protect critical habitat such as concentrations of burrow sites, especially maternal dens, and concentrations of prey species or friable soil habitat.

Feature

Establish WHAs in areas identified as critical badger habitat (e.g., concentration of burrows, abundant prey sources, and localized preferred friable soil types including moderately coarse-textured Brunisols originating from glaciofluvial and glaciolacustrine parent material) by the Regional Recovery Action Groups established by the National Recovery Team.

Size

Generally 2–100 ha, depending on site characteristics such as badger population density, soil types, number of burrows, and frequency of use.

Design

Design WHAs to include known burrows and/or prey concentrations and areas of suitable habitat. Use soil or geologic boundaries wherever possible.

General wildlife measures

Goals

1. Maintain important habitat features including sufficient structure/litter to provide hiding cover, open- or non-forested land, grasslands in a range of seral stages, friable soils, and prey.

2. Control forest encroachment and in-growth.
3. Manage livestock grazing to maintain suitable habitat for prey species (Columbian Ground Squirrel, Yellow-bellied Marmot, microtine rodents).
4. Minimize disturbance during the breeding season.

Measures

Access

- Do not develop any new road access.
- Restrict access to active maternal areas between 1 May and 15 August. Active areas may be identified by observed sightings of family groups (>1 badger) or other means (e.g., radio-telemetry). Active closures need only be in place for the current season.
- Close all established roads after resource extraction is completed.

Harvesting and silviculture

- Harvest as required to support ecological restoration. Reduce stocking densities (<75 stems/ha; target of 20 stems/ha) and free-to-grow requirements.
- Leave a selection of live and dead trees to maintain site ecology.

Pesticides

- Do not use pesticides.

Range

- Do not place livestock attractants in WHA.
- Manage livestock grazing to ensure proper conditions (seral and structural stages) for prey species. Conditions will vary depending on the prey species present.

Additional Management Considerations

Where appropriate, apply restoration treatments to maintain/create grassland and open forest conditions suitable as badger habitat.

Where feasible, maintain disturbed, early seral NDT3 sites as badger habitat by delaying and/or reducing restocking.

Encourage private land stewardship.

Protect prey species. Do not use rodenticides.

Off-road vehicle use (e.g., ATVs) should be restricted in areas of high badger use.

Information Needs

1. Predator–prey interactions including ecological requirements of various prey species, importance of Columbian Ground Squirrels as prey; implications of range/forest management strategies on prey species.
2. Distribution and abundance of badgers beyond Thompson and East Kootenay regions.
3. Contribution of NDT3 and alpine sites to provincial badger population, habitat supply, and connectivity.

Cross References

Bighorn Sheep, Burrowing Owl, "Columbian" Sharp-tailed Grouse, Grasshopper Sparrow, Long-billed Curlew, Racer, Sage Thrasher, "Sagebrush" Brewer's Sparrow, Sonora Skipper, Sooty Hairstreak, Western Rattlesnake, White-headed Woodpecker

antelope-brush–bluebunch wheatgrass, Douglas-fir–snowberry–balsamroot, ponderosa pine–bluebunch wheatgrass–silky lupine

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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).

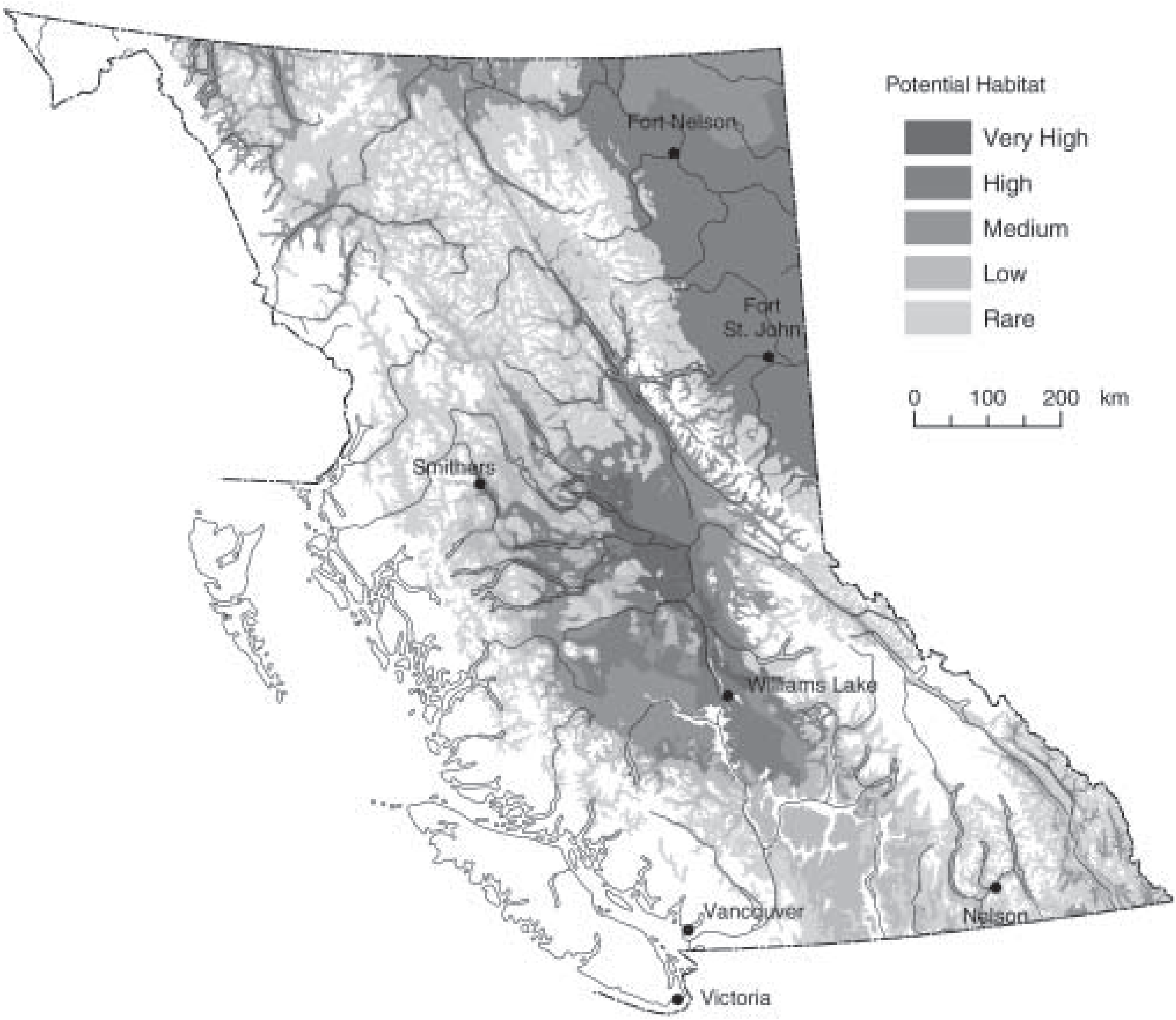
The distribution of fishers in North America has probably been considerably reduced since pre-European contact (ca. 1600; Proulx et al. 2003). The current distribution of fishers has declined primarily in areas south of the Great Lakes region, but has also diminished in some areas of southeastern Ontario 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 Mountain ranges of the southern interior and in the Columbia and Rocky Mountain ranges south of Kinbasket Reservoir.

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.

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 $\geq$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 (<–5ºC), 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 –15ºC (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 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).

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

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 km² of forested land has been harvested in the four forest regions that support fisher populations in the province. Of this 213 000 km², 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 km² 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 km²) and, of these, only 35 are large enough to encompass the mean home range size of a male fisher (i.e., 137 km²).

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.

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.

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)

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.

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Wolverine

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Grizzly Bear

Ursus arctos

Original prepared by Les Gyug,
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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	Grizzly Bear population density: 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

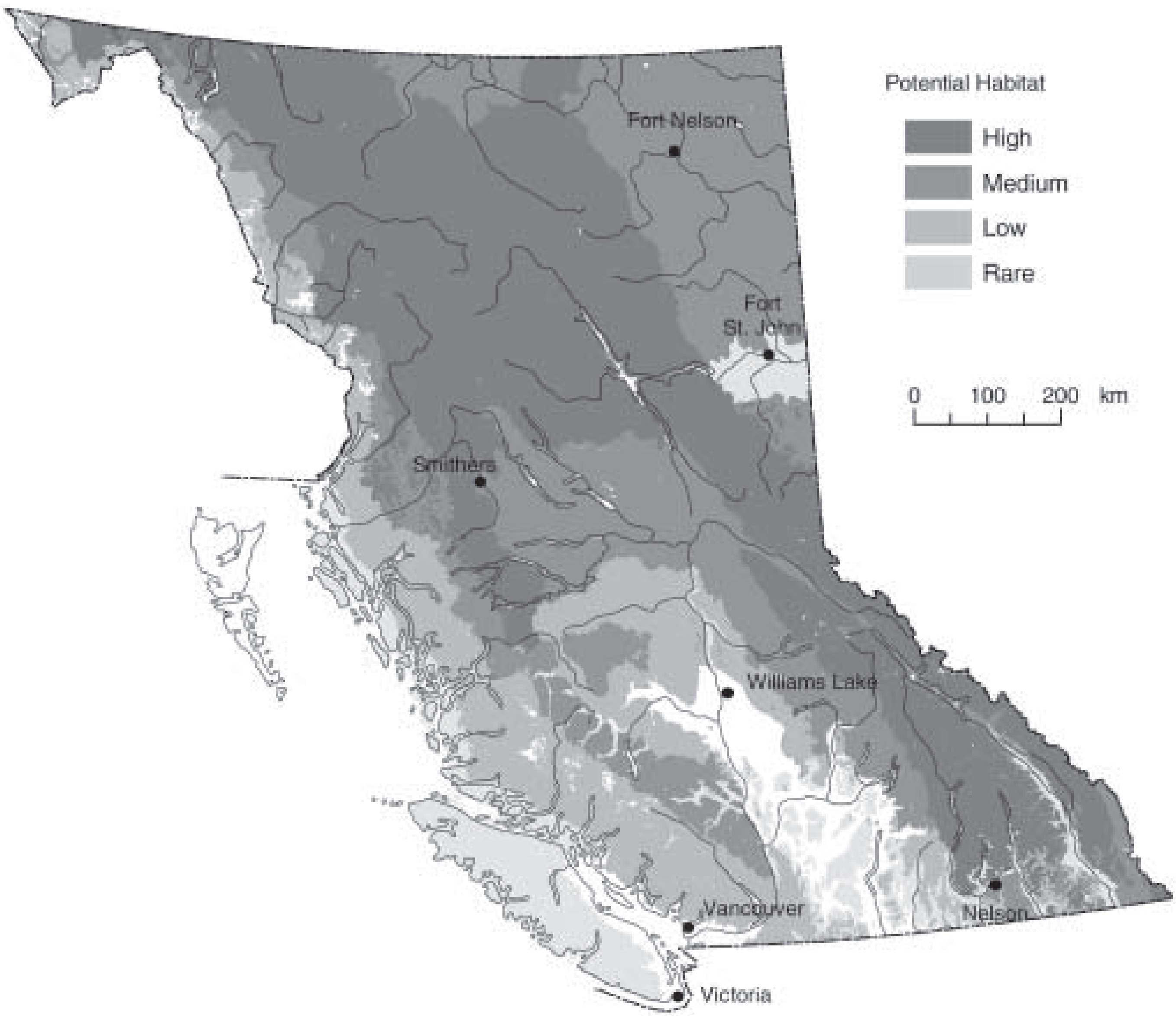
Wolverines occur in all terrestrial ecoprovinces, except for the Georgia Depression Ecoprovince.

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.

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?		

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.

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 km², females: 405 km² [Lofroth 2001]; northern Columbia Mountains, males: 1005 km², females: 311 km² [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.

Cross References

Fisher, Caribou

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Vancouver Island Marmot

Marmota vancouverensis

Original[1] prepared by Andrew A. Bryant

Species Information

Taxonomy

The Vancouver Island Marmot, *Marmota vancouverensis* (Swarth 1911), is endemic to Vancouver Island and is the only member of the genus *Marmota* that occurs there (Nagorsen 1987). Five other species of marmot occur in North America: the Woodchuck, *M. monax;* Hoary Marmot, *M. caligata;* Yellow-bellied Marmot, *M. flaviventris;* Olympic Marmot, *M. olympus;* and Brower's Marmot, *M. browerii*). Worldwide, 14 species are recognized (Barash 1989).

Marmota vancouverensis was described from 12 specimens shot on Douglas Peak and Mount McQuillan in central Vancouver Island in 1910 (Swarth 1912). *Marmota vancouverensis* is considered a "true" species on the basis of karyotype (Rausch and Rausch 1971), cranial-morphometric characteristics (Hoffman et al. 1979), and reproductive isolation from Hoary (*M. caligata*) and Olympic (*M. olympus*) marmots on the North American mainland (Nagorsen 1987). *Marmota vancouverensis* differs from the closely related Hoary and Olympic marmots in colour (Hoffman et al. 1979) and behaviour (Heard 1977). Recently published DNA phylogenies suggest relatively recent divergence in the three species (Kruckenhauser et al. 1999; Steppan et al. 1999).

Description

Fur colour is diagnostic. Vancouver Island marmots have a rich chocolate-brown coat with contrasting patches of white fur on the nose, chin, forehead, and chest. Pups (young-of-the-year) have uniformly dark, almost black, coats. As summer progresses the fur fades to a more rusty, rufous colour. Unlike most mammals, Vancouver Island Marmots apparently do not complete their molt every year. For this reason yearlings are typically a uniform faded rusty colour in June and 2 year olds have dark fur. Older animals can take on a decidedly mottled appearance, with patches of old, faded fur contrasting with new, dark fur.

Marmots have large, beaver-like incisors, sharp claws, and very powerful shoulder and leg muscles. Adults typically measure 65–70 cm from nose to tip of the tail. Weights show large seasonal variation. An adult female that weighs 3 kg when she emerges from hibernation in late April can weigh 4.5–5.5 kg by the onset of hibernation in mid-September. Adult males can be even larger, reaching weights of up to 7 kg. Marmots generally lose about one-third of their body mass during winter hibernation.

Distribution

Global

The Vancouver Island Marmot is one of only five mammal species considered endemic to Canada (Wilson and Reeder 1993).

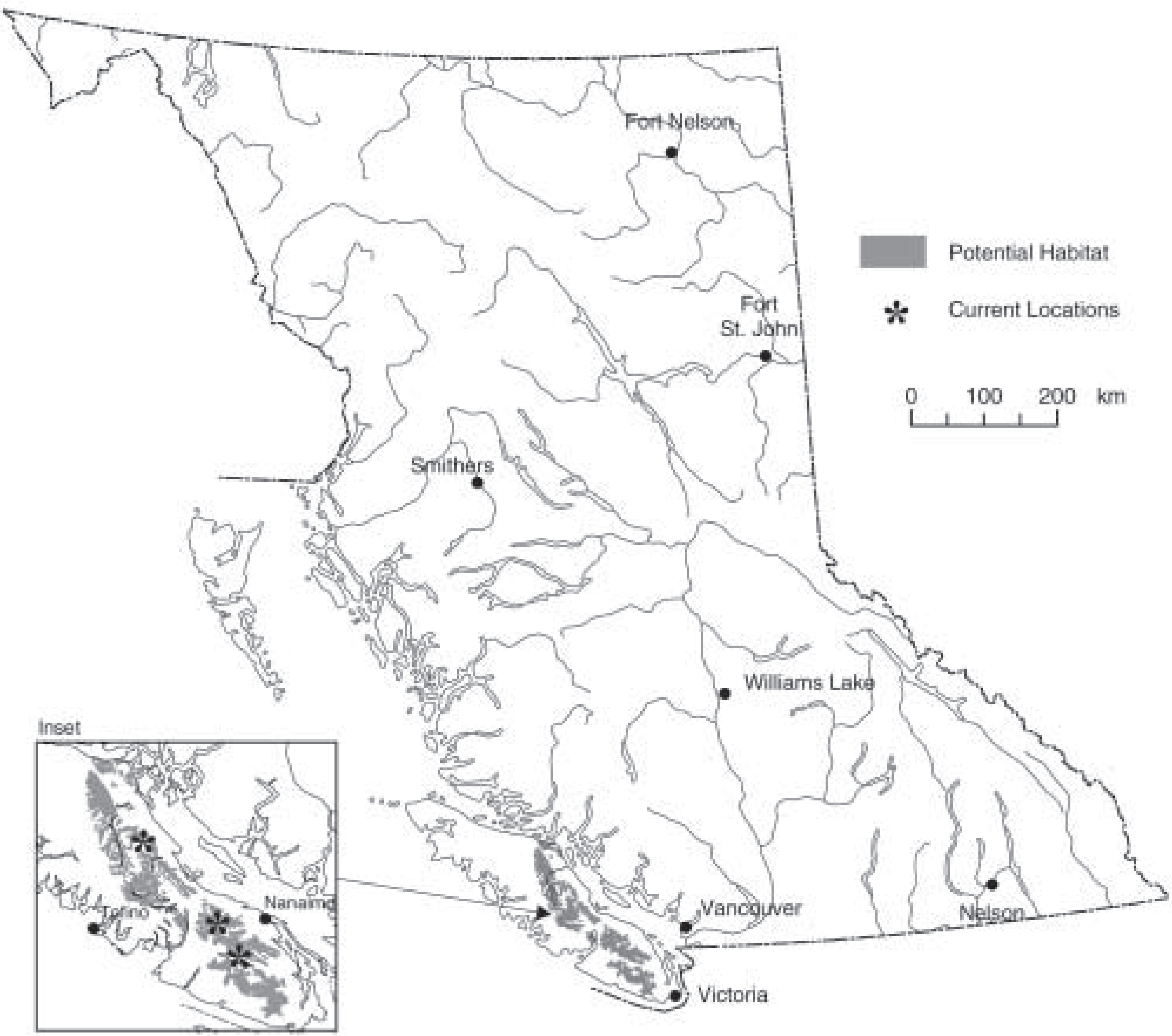
British Columbia

The distribution is now highly restricted on Vancouver Island. Most of the few remaining marmot colonies occur in south-central Vancouver Island at the headwaters of the adjacent drainages of the Nanaimo, Chemainus, Nitinat, Cameron, and Cowichan rivers. One small isolated colony occurs on Mount Washington in east-central Vancouver Island. The recent historical range (from 1864 to 1969) was apparently considerably broader, including records from at least 25 mountains on the leeward spine of Vancouver Island (Bryant and Janz 1996). In addition there are five additional known prehistoric location records (Nagorsen et al. 1996).

1 Volume 1 account prepared by B. Forbes and L. Hartman.

Vancouver Island Marmot

(Marmota vancouverensis)



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.

Forest region and districts

Coast: Campbell River, South Island

Ecoprovinces and ecosections

GED: LIM

Biogeoclimatic units

AT:

CWH: mm2

MH: mm1, mmp1

Broad ecosystem units

AV, FR, SM, TA

Elevation

800–1600 m (natural colonies); 700–1200 m (clearcuts)

Life History

Diet and foraging behaviour

Vancouver Island marmots are herbivorous. Martell and Milko (1986) used fecal samples from three natural subalpine colonies to identify food plants. They concluded that marmots depend on oatgrass (*Danthonia intermedia*) and sedges (*Carex* spp.) in early spring, and shift to forbs (especially *Lupinus latifolius* and *Eriophyllum lanatum*) in summer and fall. Spreading phlox (*Phlox diffusa*) is apparently an important food item in early summer. Similar work has not been conducted at other colonies; however, known food plants at clearcut sites include grasses, *Anaphalis margariticea*, *Fragaria* spp., *Epilobium angustifolium*, and *Lupinus latifolius* (Bryant, unpubl. data).

Typical Vancouver Island Marmot behaviour involves spending much of the day resting on boulders, logs, or stumps. Relatively little time is spent feeding. Marmots are more likely to be seen in early morning or late afternoon than during the middle of the day.

Reproduction

Vancouver Island Marmots are slow to achieve sexual maturity. Most males and females do not breed until 4 years old, although two females are known to have bred when 2 years old. In most cases there is a non-reproductive interval of at least 1 year between litters. Mating occurs within several weeks of emergence in the spring. Gestation is approximately 31 days. Most litters are three or four pups; litters of two, five and six occur infrequently. Pups are born blind and hairless and remain underground for approximately 1 month. Young have been observed above ground as early as 22 June but the bulk of litters emerge from 28 June through 7 July (Bryant 1998).

Site fidelity

Marmot pups and adults predictably use the same burrows and adjacent meadows and cliffs from year to year. Natal and hibernation burrows are often reused in consecutive years, as are escape burrows and "lookout" boulders or stumps (Bryant 1998). This consistent use allows easy detection of marmots, particularly in clearcuts where mud-stains on stumps are diagnostic. Yearlings sometimes hibernate away from the mother and 2 year olds and adult males commonly do. New burrows and lookout spots are a common feature of new or expanding colonies. Transplanted marmots quickly found and used abandoned burrows (Bryant et al., in press), and immigrant marmots will commonly use the same burrows and lookout spots as residents (Bryant, unpubl. data).

Home range

Heard (1977) documented home ranges of several hectares for individual adult marmots at one colony. Subsequent radio-telemetry generally corroborates these results but suggests that larger movements are occasionally made, particularly by yearlings and adult males. Marmots commonly shift their areas of use between early spring/late fall and summer periods. In natural colonies several habitat patches may be used. In clearcuts, marmots are often seen travelling along logging roads; daily movements of 500–1000 m are not uncommon (Bryant 1998, unpubl. data).

Movements and dispersal

A substantial fraction of subadult marmots disperse, apparently when 2 or 3 years old. Seven records of tagged and/or radio-telemetered subadults indicate movements greater than 10 km are common. One 2-year-old male moved 27 km within a month before being captured. Records of solitary marmots in low elevation habitats also suggest dispersal capability of 20–50 km (Bryant and Janz 1996).

Habitat

Structural stage

1: non-vegetated/sparse
2: herb
3a: low shrub

Important habitats and habitat features

Vancouver Island marmots require three essential habitat features: (1) grasses and forbs to eat, (2) colluvial soil structure for construction of overnight and overwintering burrows, and (3) microclimatic conditions that permit summer foraging, thermoregulation, and successful hibernation. Habitat scarcity is the fundamental reason for the rarity of *M. vancouverensis* (Bryant and Janz 1996).

Milko (1984) studied vegetation at three natural subalpine meadows and identified six major communities (*Phlox*-moss, *Anaphalis-Aster*, *Ribes-Heuchera, Pteridium aquilinum*, *Senecio-Veratrum* and *Vaccinium-Carex*). He concluded that such meadows are maintained by avalanches or snow-creep. Some natural meadows may be created by wildfires (Mount Whymper, Hooper North). Vancouver Island Marmots also inhabit clearcuts resulting from forestry, meadows created by ski-run development (Mount Washington and Green Mountain), and mine tailings (Mount Washington).

Bryant and Janz (1996) used average abundance (1972–1995) data to describe habitats used by marmots. They reported that most (81%) marmots were found between 1000 and 1400 m in elevation. Colonies in logged habitats were generally lower (median = 990 m; range = 730–1140 m) than natural subalpine meadows (median = 1240 m; range = 1040–1450 m). Most marmots were found on south- to west-facing slopes (74%). Most colonizations of clearcuts occurred within 10 years of logging (median = 8.5 years; range = 1–15 years) and within 1 km of natural colonies (median = 0.82 km; range = 0.4–4.5 km). Only a small fraction (<2%) of logged sites above 700 m elevation was eventually colonized by marmots. Maximum occupancy at logged sites is 21 years, but most (83%) animals inhabited clearcuts from 5–15 years after harvest (Bryant, unpubl. data). All marmot colonies in clearcuts are apparently now extinct.

Burrows

Vancouver Island marmots construct burrows in which to hibernate, bear young, hide from predators, and avoid environmental extremes. Burrows (including hibernacula) are commonly reused in multiple years by the same individuals (Bryant 1990; unpubl. data). One excavated burrow was >4 m in length with the sleeping chamber more than 1 m underground (Bryant et al., in press).

Escape burrows (used to avoid predators) may be a shallow excavation under a rock or tree root. Burrows used overnight or as birthing chambers are more elaborate, and often feature multiple entrances. As with escape burrows, they are typically constructed underneath a boulder or tree root system, which presumably offers supporting structure. Hibernacula are presumably deep enough that marmots can be underneath the frost layer. Work on alpine marmots (*M. marmota*) suggests that a critical feature of hibernacula may be its ability to maintain stable ambient temperatures close to 5°C (Arnold 1990; Arnold et al. 1991).

Burrow entrances are typically 30–45 cm in diameter and generally located on the downhill side of boulders or, in clearcut habitats, below stumps. Burrows used as hibernation or birth sites will almost always have some dirt mounded on the low side of the burrow entrance. Lounging spots are identifiable by mud stains on rocks or stumps.

Conservation and Management

Status

The Vancouver Island Marmot is on the provincial *Red List* in British Columbia. It is designated as *Endangered* in Canada (COSEWIC 2002).

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

BC	Canada	Global
S1	N1	G1

Trends

Population trends

The Vancouver Island marmot is one of the rarest mammals in North America. The September 2001 population numbered fewer than 30 animals in the wild, distributed among five mountains. An additional 47 animals are in captivity.

Recent decades have seen a drastic reduction in occupied range and numbers (Bryant and Janz 1996). A short-term expansion occurred as marmots colonized clearcuts in the Nanaimo Lakes region during the 1980s. Populations expanded to a peak of 300–350 animals in 1984 and have declined drastically since then. Much of the decline was due to distinct "episodes" of high mortality at particular colonies (Bryant 2000). Per-capita birth rates have remained stable but death rates have increased. The spatial and temporal pattern of "crashes" is consistent with a hypothesis of predation and disease (Bryant 1998).

Black-tailed deer abundance declined dramatically from the mid-1970s through the late-1990s. Current populations are about 40% of the long-term average. Predation by cougar and wolf is largely responsible for the deer declines and circumstantial evidence suggests that predator-effort upon marmots has likely increased, especially in clearcut habitats.

Habitat trends

Milko (1984) suggested that vegetation changes have reduced habitat availability in recent decades (a view supported by Nagorsen et al. 1996). Under this interpretation, sites formerly occupied by marmots have changed in some qualitative way, and the species is confined to a shrinking geographic region in which suitable climatic and vegetation conditions are found. Several possible mechanisms have been suggested, including invasion of subalpine meadows by trees or *Pteridium* ferns, altered fire regime (Milko 1984), and changing food-plant availability (Martell and Milko 1986).

The evidence remains ambiguous. Invasion of subalpine meadows by trees has been documented for several areas in the Olympic (Fonda and Bliss 1969; Schreiner and Burger 1994) and Cascade mountains (Franklin et al. 1971). However, dendrochronological work at historic and extant colonies has produced surprising results (Laroque 1998; unpubl. data). In Strathcona Provincial Park, where marmots apparently disappeared some 10–30 years ago, most trees are more than 300 years of age, and there is little evidence of forest succession. Paradoxically, some of the highest-quality habitats within the present core area of distribution show considerable evidence of tree invasion within the past 50 years, probably as a result of post-fire regeneration (i.e., the Green-Gemini-Haley-Butler ridge system).

Previous speculation about the impact of dogs, ski-hill development, and all-terrain vehicles (Dearden and Hall 1983) has been discredited (Bryant 1998).

Forestry activities have changed the landscape dramatically in recent decades, particularly in the Nanaimo Lakes region (Bryant 1998). There was little forest harvesting prior to 1956 and much of what occurred was concentrated along valley bottoms. This pattern continued through the 1960s. Harvest rates increased during the 1970s, particularly at higher elevations. By 1976 over 75% of the annual harvest occurred above 700 m in elevation. At least 60% of all forests classified as mature were harvested in a 25-year period. Road development took place at a similar pace and increased five-fold in density. Potential clearcut marmot habitat was first created during the late 1960s and large amounts (>10 000 ha) became available during the 1970s.

Threats

Population threats

Ultimately the wild population is so small and fragmented that recovery is probably impossible without active human intervention in the form of captive breeding combined with reintroduction (Janz et al. 2000).

A major cause of mortality is predation. The number of potential predators is relatively small compared with other marmot species, with the only confirmed species being wolves (*Canis lupus*), cougars (*Puma concolor*), and golden eagles (*Aquila chrysaetos*). It is likely that bald eagles (*Haliaeetus leucocephalus*) and other diurnal raptors may occasionally take marmots, especially pups. Black bears are not known to prey upon marmots.

Habitat threats

Forestry activities continue adjacent to recently occupied marmot habitats, although the proportion of young clearcuts (potential marmot habitat) has declined significantly in recent years.

Death during hibernation has been confirmed only once although circumstantial evidence suggests this may occur often, especially in clearcuts. There is as yet no empirical evidence for a specific disease organism, although spatial and temporal patterns of mortality are consistent with a disease hypothesis (Bryant 2000).

Possible vegetation dynamics resulting from global warming remain impossible to predict. It may become necessary in the future to manipulate habitats to retain suitability for Vancouver Island Marmots.

Legal Protection and Habitat Conservation

Under the provincial *Wildlife Act*, the Vancouver Island Marmot is protected from killing, wounding, hunting and trapping, taking, and transporting including importing and exporting. It is listed as Endangered under the B.C. *Wildlife Act*.

The only currently occupied site on Crown land is partially protected within the Green Mountain Critical Wildlife Management Area (300 ha) and Haley Lake Ecological Reserve (120 ha).

Two currently occupied sites occur within private managed forest land. For a species at risk to be considered for special management under the Private Managed Forest Land regulations it must be designated as Identified Wildlife.

One currently occupied site occurs on private land.

Coarse filter provisions of the results based code are not sufficient to protect the habitats of this species.

Identified Wildlife Provisions

Wildlife habitat area

Goal

Maintain suitable habitat.

Feature

Establish WHAs at known colonies, reintroduction sites.

Size

Typically between 5 and 100 ha but will ultimately depend on the extent of the colony, or suitable habitat.

Design

The WHA should include a core area delineated by the outer perimeter of the colony and a 50–200 m management zone. The width of the management zone must be sufficient to maintain the micro-climatic regime of the core area.

General wildlife measures

Goals

1. Protect burrows and denning animals.
2. Ensure integrity of burrow systems.
3. Maintain soil and drainage characteristics suitable for burrowing.

Measures

Access

- Do not construct roads or landings. Consult MWLAP when road maintenance, deactivation, or rehabilitation activities are required to ensure species requirements are adequately addressed.

Harvesting and silviculture

- Do not harvest or salvage in core area.
- Single tree or group selection systems may be determined to be appropriate in the management zone.
- Where timber harvesting with ground-based equipment is approved, it should only be conducted with low ground pressure equipment, to avoid damaging burrows.
- Do not use mechanical site preparation techniques that will damage burrows.

Pesticides

- Do not use pesticides.

Information Needs

1. Identification and mapping of suitable reintroduction sites.

Cross References

"Vancouver Island" White-tailed Ptarmigan

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Pacific Water Shrew

Sorex bendirii

Original[1] prepared by Pontus Lindgren

Species Information

Taxonomy

Shrews belong to the Soricidae family, of which there are 13 species in Canada and nine species in British Columbia. The Pacific Water Shrew (*Sorex bendirii*), also referred to as the Marsh Shrew (Pattie 1973; Maser and Franklin 1974; Whitaker and Maser 1976; McComb et al. 1993) and Bendire's Shrew (Cowan and Guiguet 1973; Banfield 1974), has three subspecies, of which only *S. bendirii bendirii* is found in British Columbia.

Description

The Pacific Water Shrew is the largest shrew in the province (Nagorsen 1996) and the largest species of the *Sorex* genus in North America (Maser 1998). Nagorsen (1996) states that this shrew has an average length of 154 mm, of which 70 mm is tail, and weighs an average of 13.2 g. It has velvety dark chocolate brown fur that is only slightly paler on its ventral surface than its dorsal surface. The Pacific Water Shrew molts; however, the summer pelage is very similar in colour to the winter pelage (Banfield 1974). The tail is unicoloured and, like the body, is also dark brown. Adapted for its semi-aquatic lifestyle, it has a row of stiff fringe hairs on the toes of its hind feet. While submerged, this shrew maintains its body temperature with an insulating layer of air trapped within its fur, giving the shrew a silvery appearance while in the water (Calder 1969; Nagorsen 1996). In addition to being able to dive, air bubbles trapped beneath the feet provide enough buoyancy to enable this shrew to run on the surface of the water for up to 5 seconds. The Pacific Water Shrew is active during all hours of the day and throughout the year (Maser 1998).

The Common Water Shrew (*S. palustris*) is similar to the Pacific Water Shrew in several ways; it too is a large shrew, inhabits the Lower Mainland, lives close to water, has fringe hairs on its hind feet, can dive, and can run for short distances on top of water. However, within British Columbia, these shrews are often separated by elevation; the Common Water Shrew is usually found within habitats above 850 m while the Pacific Water Shrew typically inhabits areas below 850 m (Nagorsen 1996). Where these species do occur together, a Common Water Shrew can be distinguished by its bicoloured body and tail (dark above and pale below) which differs from the solid dark colouration of the Pacific Water Shrew.

Distribution

Global

The Pacific Water Shrew is found within the coastal lowlands of the Pacific Northwest, from northern California to southern British Columbia (Nagorsen 1996).

British Columbia

Within British Columbia, the Pacific Water Shrew is restricted to the extreme southwest corner, occupying the Lower Fraser Valley. It has been observed as far east as the Chilliwack River and Agassiz and as far north as the north shore of Burrard Inlet (Nagorsen 1996).

Forest regions and districts

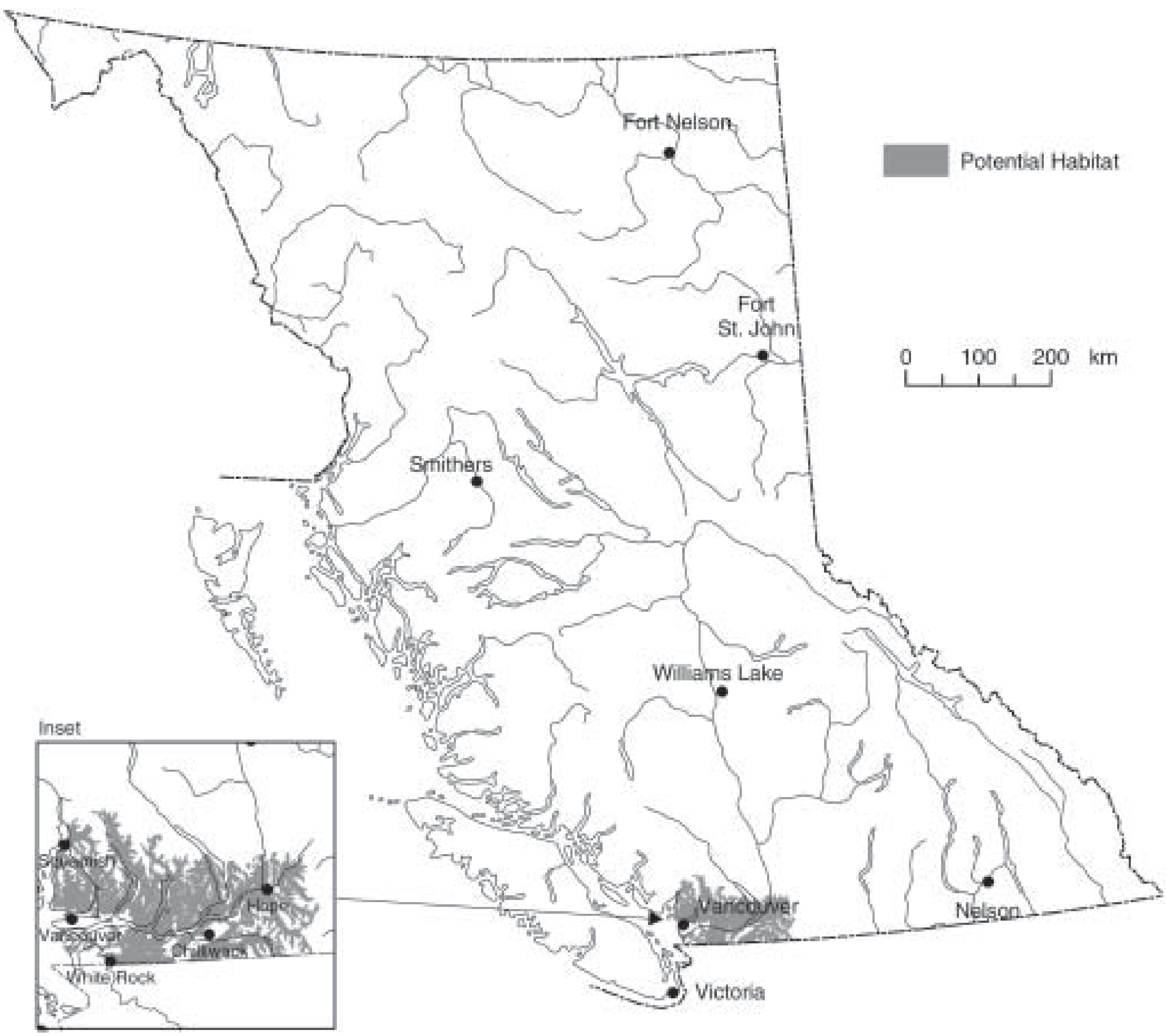
Coast: Chilliwack, Squamish

Ecoprovinces and ecosections

COM: EPR, SPR
GED: FRL

1 Volume 1 account prepared by L. Darling and K. Paige.

Pacific Water Shrew
(Sorex bendirii)



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

CDF: mm
CWH: dm, ds1, ms1, vm1, xm1

Broad ecosystem units

CD, CH, CR, CW, FR, RS, WL

Elevation

Up to 850 m but is generally believed to inhabit areas below 600 m (Nagorsen 1996)

Life History

Diet and foraging behaviour

All shrews are insectivorous. Whitaker and Maser (1976) reported the Pacific Water Shrew as the most specialized feeder of the five species of shrews studied in western Oregon, with 25% of stomach contents consisting of aquatic prey. Unidentified insect larvae, slugs, and snails, Ephemeroptera naiads, unidentified invertebrates, and earthworms were the foods most frequently consumed by this shrew. Pattie (1969) observed that captive shrews immobilize their prey with several rapid bites along the length of the body. Prey animals appear to be located by sound and by exploring the forest floor and rotten logs with their sensitive vibrissae (whiskers) and flexible snout. These tactile senses also appear to be used when locating prey animals under water. Dives for prey can last up to several minutes (Pattie 1969). Although prey will be seized underwater, food is always consumed on land.

Reproduction

Very little is known about the breeding biology of the Pacific Water Shrew and no studies have been conducted in British Columbia. In other parts of its range, young are born in March with an average litter size of three or four (Nagorsen 1996) and a gestation period of about 3 weeks (Beneski and Stinson 1987). These shrews likely do not become sexually mature until they have overwintered; however, females may mature during their first summer. The Pacific Water Shrew is an early breeder, with pregnant females captured as early as February (Beneski and Stinson 1987). A pungent odour originating from scent glands located on the flanks of males may function as a form of communication between sexes during the breeding season (Maser 1998). Shrews do not survive their second winter and may not survive their first (Nagorsen 1996). Pacific Water Shrews are assumed to survive only one overwinter period and have an average life expectancy of 18 months (Nagorsen 1996).

Home range

Very little is known about the home range size of the Pacific Water Shrew as removal methods used to sample this animal preclude such estimates. Harris (1984) reports a home range size of 1.09 ha; however, no sources for this estimate are provided.

Although a few Pacific Water Shrews have been captured considerable distances from water, probably related to juvenile dispersal (Maser and Franklin 1974), this shrew's affinity for slow-moving streams and marshes is well documented (Pattie 1973; Maser and Franklin 1974; Whitaker and Maser 1976; McComb et al. 1993; Zuleta and Galindo-Leal 1994; Nagorsen 1996; Maser 1998). In addition, both McComb et al. (1993) and Zuleta and Galindo-Leal (1994) report that capture rates are inversely related to distance from streams, and that most Pacific Water Shrews were found within 50 and 25 m of streams, respectively.

Movements and dispersal

Because of the removal methods used to sample the Pacific Water Shrew, very little can be said about the movements of this shrew. Young are assumed to disperse to suitable habitat after leaving the nest (Maser 1998).

Habitat

Structural stage

4: pole/sapling
5: young forest
6: mature forest
7: old forest

Important habitats and habitat features

Literature on habitat use by the Pacific Water Shrew is limited to only a few studies, most of which were conducted in Oregon and Washington. Two studies in Oregon report this shrew to be more abundant within mature and old forests (Corn and Bury 1991; Gilbert and Allwine 1991). Other studies in Washington describe this shrew to be equally, or more abundant, within young forests (Aubrey et al. 1991; West 1991). In a recent study conducted within the Lower Mainland, Zuleta and Galindo-Leal (1994) found three Pacific Water Shrews within widely separated habitats, ranging from deciduous to coniferous dominated sites with moderate to high canopy closure. It appears as though moist, coastal forests that border streams and skunk-cabbage marshes with an abundance of shrubs and coarse woody debris and extensive canopy closure are more important features than age of the forest (Nagorsen 1996). Likewise stream size may not be important but speed of water movement is likely important.

This semi-aquatic insectivore (25% of diet is aquatic invertebrates) requires access to slow-moving creeks and/or wetlands to forage. In addition to the aquatic food source, this shrew readily consumes terrestrial invertebrates found throughout the forest floor, especially within a well-developed litter layer and decomposed coarse woody debris. Forested riparian habitats typically provide both a well-developed forest floor as well as an abundant supply of coarse woody debris, making this habitat preferred foraging habitat for several species of insectivores (Nagorsen 1996).

Conservation and Management

Status

The Pacific Water Shrew is on the provincial *Red List* in British Columbia. It is considered *Threatened* in Canada (COSEWIC 2002).

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

BC	WA	OR	CA	Canada	Global
S1S2	S5?	S4	S3S4	N1N2	G4

Trends

Population trends

Data on population trends of the Pacific Water Shrew are limited because of its rarity and the removal methods used for sampling this species. Although this species has probably never been abundant within any part of its global range, typically making up <1% of all small mammal captures (Aubrey et al. 1991; Corn and Bury 1991; Gilbert and Allwine 1991; West 1991), in British Columbia, fewer individuals have been documented recently than a century ago (Zuleta and Galindo-Leal 1994). Over the past 40 years, only 15 specimens have been collected and only eight extant occurrences have been identified, although more probably exist (Nagorsen 1996; CDC 2001). Because of the well-documented rarity of this shrew and the rapid degradation of critical riparian habitat resulting from urban sprawl and forestry operations throughout the Lower Mainland, the Pacific Water Shrew is undoubtedly experiencing a decline in population size within British Columbia (Galindo-Leal and Runciman 1994).

Habitat trends

Human developments, particularly urban and agricultural developments, have reduced or isolated much of the suitable riparian habitat for this shrew. During the past century, the aggregate channel length of small rivers and streams in Vancouver has been reduced from 120 to 20 km (Galindo-Leal and Runciman 1994). Approximately 15% of the streams in the Lower Fraser Valley have been lost and 71 % are considered threatened or endangered (Fisheries and Oceans Canada 1998). Additional habitat has likely been lost to industrial forest removal, although no studies have quantitatively assessed this type of development.

Threats

Population threats

Pacific Water Shrews are found in naturally low numbers (Aubrey et al. 1991; Corn and Bury 1991; Gilbert and Allwine 1991; West 1991), are habitat specialists (Nagorsen 1996), and within British Columbia, are found at their most northerly distribution (Zuleta and Galindo-Leal 1994). Consequently, this shrew is particularly vulnerable to the loss or isolation of its preferred riparian habitat. An indirect human-caused threat to the population may be increased predation by domestic cats. The impact of the increase in coyotes over the range of this species is not known.

Habitat threats

Urban and agricultural developments pose the most significant threat to the habitat and survival of the Pacific Water Shrew in British Columbia. The limited distribution of this shrew in British Columbia coincides with the largest urban centre in the province (Lower Mainland). The dissection of the Lower Mainland by roads, highways, and power lines has created a fragmented landscape of isolated habitat patches, which may not be large enough to support a viable population of Pacific Water Shrew (Galindo-Leal and Runciman 1994). Even when patches appear to be large enough, edge effects may render the habitat unsuitable for a habitat specialist like the Pacific Water Shrew. Examples of edge effects particularly detrimental to the habitat of this shrew are loss of canopy closure resulting in decreased security cover (Galindo-Leal and Runciman 1994; Nagorsen 1996); increased human-related disturbance, which can penetrate up to 70 m from an edge (Matlack 1993); and increased predation by domestic cats on small animals, of which 80% of captures are shrews (Fitzgerald 1988). Although some studies indicate that this shrew may be able to cope with edge effects (e.g., Zuleta and Galindo-Leal [1994] captured this shrew within isolated, small habitats, and one, 20 m from a busy public street), no studies have addressed the long-term consequences of edge effects on this species.

Forest harvesting has received little attention with respect to Pacific Water Shrew because most of this species range coincides with urban areas, not Crown land. However, industrial forest removal potentially threatens Pacific Water Shrew habitat in Canada because Pacific Water Shrews have been captured in several locations on or near Crown land (Galindo-Leal and Runciman 1994). These locations include the Chilliwack River Valley (four occurrences), Sumas Mountain (eight occurrences), and several watersheds located north of the Lower Mainland and Fraser River (Coquitlam River area, one occurrence; Seymour River area, four occurrences; Alouette River area, one occurrence).

Water quality is also of concern. Because this shrew spends a considerable amount of time foraging for aquatic invertebrates (Pattie 1969; Whitaker and Maser 1976), changes in water quality caused by agricultural runoff, residential septic fields, erosion, and industrial waste can have detrimental effects on its food source as well as the habitat of the Pacific Water Shrew (Galindo-Leal and Runciman 1994).

Legal Protection and Habitat Conservation

The Pacific Water Shrew is protected, in that it cannot be killed, collected, or held in captivity without special permits, under the provincial *Wildlife Act.*

Several occurrences are protected within regional and provincial parks including Mount Seymour Provincial Park (3508 ha), Cultus Lake Provincial Park (656 ha), Aldergrove Lake Regional Park (250 ha), and Pacific Spirit Regional Park (763 ha).

The results based code recommendations for biodiversity and riparian areas may conserve several beneficial attributes of Pacific Water Shrew habitat where implemented. Where landscape level planning can address maintenance of landscape connectivity, particularly along natural features such as streams and rivers, or can address natural vegetative species composition and requirements for coarse woody debris retention, then the recommendations may partially address this species requirements.

Riparian management recommendations may in some cases partially address the requirements of this species. Current riparian management recommendations for streams and wetlands vary depending on the size and classification of the aquatic feature. General recommendations include minimizing windthrow risk; maintaining wildlife trees; and conserving stream channel shape, bank stability, water quality, as well as guidelines for minimizing detrimental effects of range, roads, and culverts. Where these recommendations are applied they may contribute to the maintenance of this species' habitat.

Protected areas or special resource management zones created for other species overlapping in distribution with the Pacific Water Shrew (i.e., Spotted Owl, tall bugbane, Coastal Giant Salamander) may afford additional protection.

Although these habitat provisions provide several beneficial recommendations for the habitats of the Pacific Water Shrew, these provisions are not sufficient to ensure the conservation of this rare taxon. In addition the range of this species overlaps with private land.

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

Landscape level planning within the Chilliwack and Squamish forest districts should promote connectivity among remnant patches of suitable low elevation riparian habitat by restoring forest habitat along watercourses and wetlands. Whenever possible, large buffer widths around riparian areas should be maintained to compensate for the fragmentation that is occurring.

Wildlife habitat area

Goal

Protect current and historical habitat of the Pacific Water Shrew.

Feature

Establish WHAs at current or historical sites where suitable habitat still exists.

Size

Generally between 5 and 45 ha but ultimately depends on the area of suitable habitat.

Design

It is recommended that the WHA extend the entire length of the stream or wetland and include at a 30 m core area and a 45 m management zone on each side of the stream or around wetland/wetland complex. Measurements of slope distance should be consistent with the *Riparian Management Area Guidebook*. Where slopes exceed 60%, the WHA should extend to the top of the inner gorge

The WHA should include suitable riparian and aquatic habitats. Wetlands, streams, or other suitable riparian habitats (e.g., Skunk-Cabbage marshes) within 1 km should also be included wherever possible to increase the effectiveness of the WHA. Because of the linear shape of the species home range, the management zone is necessary to minimize potential detrimental edge effects which tend to be more pronounced within long thin habitats.

General wildlife measures

Goals

1. Maintain hydrological regime.
2. Maintain water quality and physical integrity of riparian habitat.
3. Maintain or promote microclimate and structural elements known to be preferred by this species (i.e., good ground cover of evergreen shrubs, large amount of coarse woody debris, abundance of fine litter, and moderate to high levels of canopy closure from coniferous, deciduous, or mixedwood forests).
4. Minimize edge effects.

Measures

Access

- Do not construct roads unless there is no other practical option.

Harvesting and silviculture

- Do not harvest or salvage within the core area.

- Use partial-harvesting systems in the management zone that maintain 70% basal area. Partial harvesting within the management zone should promote natural microclimate and structural elements such as multi-layered canopies, wildlife trees, and coarse woody debris.
- Restrict activities that may alter the vegetation, hydrology, stream structure, or soils, particularly the upper soil layers.

Pesticides

- Do not use pesticides.

Recreation

- Do not establish recreational trails or sites within a WHA.

Additional Management Considerations

When operating immediately adjacent to WHAs, consider the following recommendations:

- apply as many of the silviculture practices required within the WHA management zone, particularly practices that minimize edge effects and promote the retention of the forest litter layer, coarse woody debris, and wildlife trees (future coarse woody debris);
- minimize impacts of forest activities by harvesting one side of a stream at a time;
- extend green-up specifications within riparian and nearby habitats to allow this area to better recover prior to harvesting adjacent areas;
- employ partial cutting systems to reduce edge effects near riparian areas; and
- incorporate larger riparian buffers.

Because of the rapid urban development that coincides with the distribution the Pacific Water Shrew in British Columbia, much of this shrew's habitat has been destroyed or fragmented (Galindo-Leal and Runciman 1994; Zuleta and Galindo-Leal 1994; Nagorsen 1996). It is important to consider this species within urban planning and stewardship programs.

Information Needs

1. Using live-trapping methods, determine basic demographic parameters (i.e., home range size, movement patterns, ability to recolonize areas) and a better understanding of habitat preferences and limitations are needed.
2. Effects of habitat fragmentation on this shrew, and investigating the impact of domestic cat predation.

Cross References

Bull Trout, Coastal Giant Salamander, Coastal Tailed Frog, Keen's Long-eared Myotis, Marbled Murrelet, Sandhill Crane, tall bugbane

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"Vancouver Island" Common Water Shrew

Sorex palustris brooksi

Original[1] prepared by Pontus Lindgren and Vanessa Craig

Species Information

Taxonomy

Shrews belong to the Soricidae family, of which there are 13 species in Canada and nine species in British Columbia. Although there is some debate as to the taxonomy of this species, there are currently nine recognized subspecies, two of which are found in British Columbia (Cowan and Guiguet 1973; Nagorsen 1996). The mainland subspecies (*S. palustris navigator)* is found throughout the mainland of the province except for low-lying areas of the Fraser River Valley. The Vancouver Island subspecies (*S. palustris brooksi)* is restricted to Vancouver Island (Anderson 1934).

Literature on the Vancouver Island subspecies of the Common Water Shrew is extremely limited. Much of the information presented in this account is from research on other subspecies, usually *S. palustris palustris*, which are referred to hereafter simply as Common Water Shrews.

Description

The Common Water Shrew is a large shrew, surpassed in size only by the Pacific Water Shrew (Nagorsen 1996; Maser 1998). It has an average length of 152 mm, of which 75 mm is tail, and weighs an average of 10.6 g (Nagorsen 1996). The body is distinctly bicoloured; its dorsal surface has black glossy fur and the ventral surface is silvery white, sometimes a diffuse brown. Similarly, the tail is dark above and whitish below (Anderson 1934; Banfield 1974; Nagorsen 1996). Several adaptations distinguish this shrew from its non-aquatic relatives including long digits on its hind feet that are rimmed with a margin of stiff fringe hairs. The front feet also have these specialized hairs.

The Common Water Shrew has specialized fur that both repels water and traps an insulating layer of air when under water (Calder 1969; Beneski and Stinson 1987). This layer of trapped air reduces heat loss by 50% and gives the shrew a silvery, fish-like appearance when underwater (Calder 1969). In addition to being able to sustain dives of up to 47 seconds, air bubbles trapped beneath the feet of this shrew provide enough buoyancy to enable it to run on the surface of even turbulent water for several seconds (Beneski and Stinson 1987).

Although the Pacific Water Shrew (*S. bendirii*) is similar to the Common Water Shrew in its appearance and behaviour, its range does not overlap with that of the Vancouver Island Common Water Shrew.

Distribution

Global

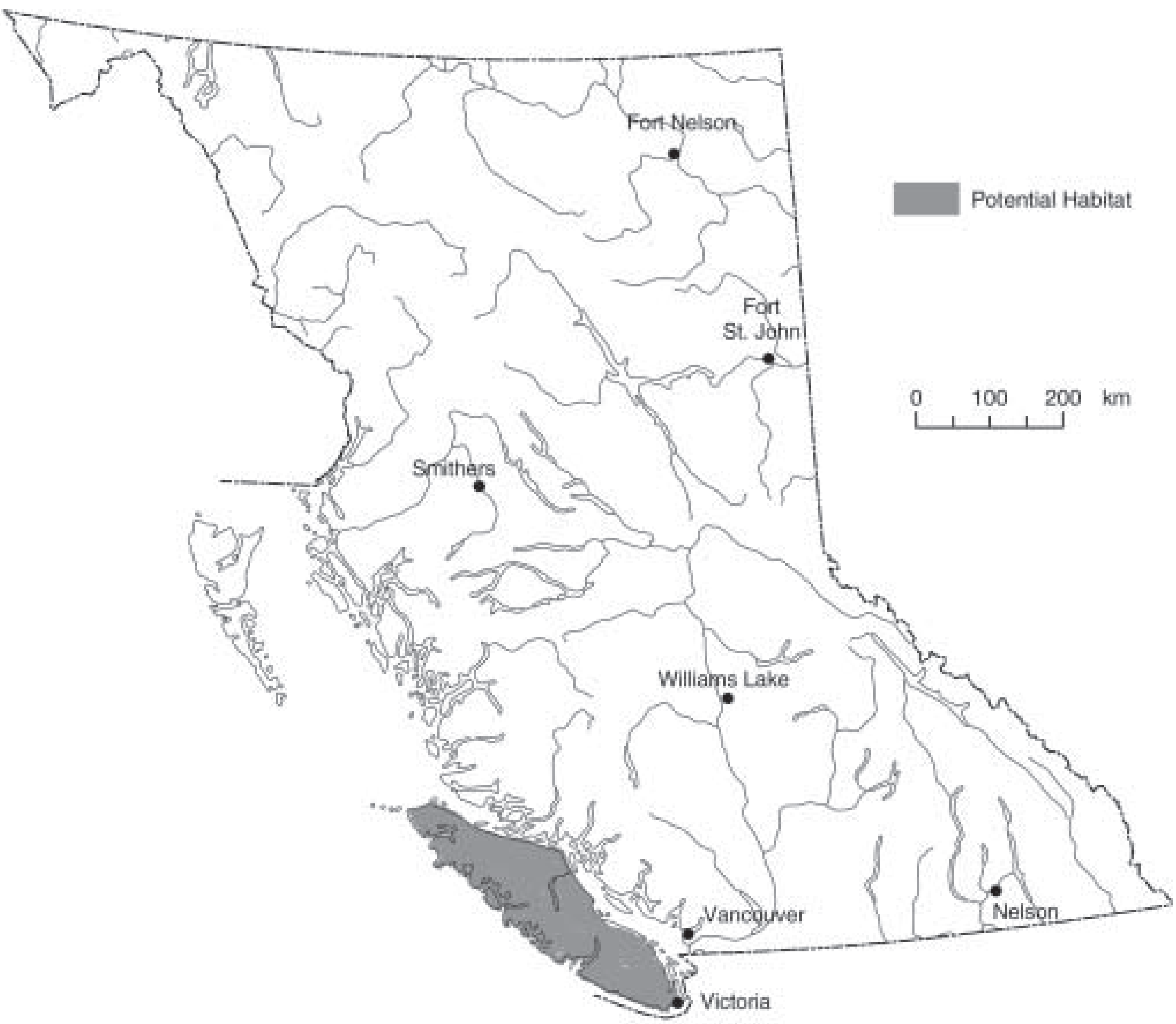
The Common Water Shrew is a widespread species found throughout much of Canada, southwestern Alaska, and cooler mountainous areas of the United States (Beneski and Stinson 1987). The Vancouver Island subspecies is restricted to Vancouver Island. This taxon is the only island population of Common Water Shrew on the entire Pacific Coast of America (Nagorsen 1996).

British Columbia

Although the Vancouver Island subspecies is assumed to be found throughout much of Vancouver Island (Nagorsen 1996), it is known from very few specimens. There are currently 67 known records from 38 locations on Vancouver Island (Craig 2002). It has been documented as far north as Quatse River

1 Draft account for Volume 1 prepared by L. Darling.

Common Water Shrew - subspecies *brooksi*
(Sorex palustris brooksi)



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.

near Port Hardy (north end of the island), along the east coast at Quinsam River (near Campbell River), as far inland as Robertson Creek and the Lowry Lake area (near Port Alberni), along the west coast at Lost Shoe Creek near Ucluelet, and as far south as Veitch Creek near Victoria (Cowan and Guiguet 1973; Waye 1997; CDC 2001).

The following distribution information represents the known and potential range of the Common Water Shrew on Vancouver Island. Sites from which Common Water Shrews have not been recorded, but where it is possible they occur based on the range of the closely related subspecies from the mainland (Stevens 1995; Nagorsen 1996), are presented in brackets.

Forest region and districts

Coast: Campbell River, North Island, South Island

Ecoprovinces and ecosections

COM: NIM, NWL, WIM

GED: LIM, NAL, SGI

Biogeoclimatic units

CDF: mm

CWH: dm(?),[2] mm1, mm2, vm1, vm2, vh1, xm1, xm2

MH: mm1(?)

Broad ecosystem units

CD, CH, CW, FR, (CB, CG, CR, DA, GO, MF, WL)

Elevation

30–558 m but possible between 0 and 2400 m

Life History

Diet and foraging behaviour

No diet studies have been conducted on the Vancouver Island Common Water Shrew. All shrews are insectivorous, primarily feeding on insects and other invertebrates. Whitaker and French (1984) report that the diet of the Common Water Shrew consists mainly of insect larvae, spiders, slugs, snails, and flies. Beneski and Stinson (1987) note that slugs and earthworms comprise 50% of this shrew's diet. The importance of an aquatic food source is indicated by the frequent occurrence of aquatic invertebrates, small fish (up to 8 cm in length), fish eggs, and Pacific Giant Salamander larvae found in the stomachs of this shrew (Conaway 1952; Sorenson 1962; Banfield 1974; Nagorsen 1996; Maser 1998). Its varied diet suggests that it may be an opportunistic forager (Buckner and Ray 1968).

Prey appear to be located by sound and by exploring the forest floor and rotten logs with their sensitive vibrissae (whiskers) and flexible snout, although the importance of the vibrissae has been questioned (Sorenson 1962). These tactile senses also appear to be used when locating prey under water (Svihala 1934; Nagorsen 1996). The Common Water Shrew is semi-aquatic and is a skilled swimmer that readily enters streams in search of food (Maser 1998). The ability to echolocate has also been suggested (Sorenson 1962; Gould et al. 1964); however, how this shrew uses this sense is not well understood (Nagorsen 1996). Shrews immobilize their prey with several rapid bites along the length of the body. Although prey may be seized underwater, food is always consumed on land. The Common Water Shrew feeds every 10 minutes and consumes its own weight in food every 24 hours (Conaway 1952; Sorenson 1962; Beneski and Stinson 1987). When food is plentiful, this shrew has been observed to cache extra food, often within hollow logs (Banfield 1974; Beneski and Stinson 1987; Nagorsen 1996).

Reproduction

Very little is known about the breeding biology of the Common Water Shrew and no studies have been conducted in British Columbia. Common Water Shrews mature in their first winter. A pungent odour originating from scent glands located on the flanks of males may function as a form of communication between sexes during the breeding season (Svihala 1934; Sorenson 1962). Nagorsen (1996) reports that female Common Water Shrews in British Columbia are mature (pregnant or caring for young) from May

2 (?) Indicates possible occurrence but has not been confirmed.

to September. Common Water Shrews have two or three litters, averaging six young, before dying prior to their second winter (Beneski and Stinson 1987; Nagorsen 1996). Shrews can live up to 18 months but most probably do not survive their first winter.

Site fidelity

Not much is known but this species likely maintains established home ranges.

Home range

Not known. Because Common Water Shrews on Vancouver Island have been captured almost exclusively at the land/water interface, their home range is likely a long, linear strip along the water's edge.

Movements and dispersal

No information exists on the movement patterns of the Vancouver Island subspecies (Nagorsen 1996). Most movements are likely concentrated near or within the banks of the stream it inhabits. This assumption is made because of the trap success observed immediately next to streams and creeks, often under stream bank overhangs (Conaway 1952; Nagorsen 1996; Waye 1997; Hartman 2002). Hartman (2002) reports that capture rates more than doubled after pitfalls were placed at the water's edge, instead of 1 m away. Conaway (1952) reported that the farthest a Common Water Shrew was captured from water was 18 cm. Although this shrew is active during all hours of the day throughout the year, it is more active at night and is observed to have two periods of hyperactivity: just before dawn and just after dusk (Conaway 1952; Nagorsen 1996; Maser 1998). Its movement has been described further as consisting of repeating cycles of 30 minutes of activity, followed by 60 minutes of rest (Sorenson 1962; Beneski and Stinson 1987).

Habitat

Structural stage

Proximity to suitable aquatic habitat appears to be more important than structural stage of the surrounding habitat (Steven and Lofts 1988). Common water shrews occur in riparian habitat within all vegetated structural stages (stages 1b to 7), as long as the riparian habitat is intact. Vancouver Island Common Water Shrews have been captured along riparian corridors in young forests (age classes 1 and 2) through to older forest (age class 7; Craig 2002). If the riparian corridor is harvested, then water shrews likely will not be present until the water quality and riparian zone recovers (likely structural stages 3–7).

Important habitats and habitat features

Aquatic

Vancouver Island Common Water Shrews appear to be very closely associated with aquatic habitat and up to 50% of a Common Water Shrew's diet is made up of aquatic animals and invertebrates (Conaway 1952; Sorenson 1962; Banfield 1974). Although the Common Water Shrew has been found using a variety of aquatic habitats, it is considered to be particularly productive within the banks of swift flowing, high elevation, cool streams with an abundance of rocks and boulders within and around the stream (Svihala 1934; Conaway 1952; Beneski and Stinson 1987; Nagorsen 1996; Pagels et al. 1998). Previous research in the United States emphasized high elevation sites (up to 2900 m; Conaway 1952) These types of habitats have been preferentially sampled in the past (Conaway 1952). Shrew captures have also been reported from small seepages and intermittent streams (Kinsella 1967).

The Vancouver Island Common Water Shrew has been captured in a wide variety of waterways, ranging from 1.2 to 26 m wide, next to still pools of water and slow-flowing waterways as well as swift-flowing streams, along both permanent and intermittent watercourses (Craig 2002). Most of the sites sampled for this shrew on Vancouver Island have been <10 m wide, low gradient, low elevation watercourses;. The majority of captures were along streams with a gravel or cobble substrate; unsuccessful sampling sites often had a bedrock substrate (Craig 2002). At this time, any riparian habitat, whether it borders a marsh, pond, lake, or slow- or fast-moving stream should be considered potential habitat for this shrew.

Terrestrial

In addition to aquatic food sources, this shrew readily consumes terrestrial invertebrates found throughout the forest floor, especially within litter and decomposed coarse woody debris and hollow logs (Whitaker and French 1984; Beneski and Stinson 1987; Nagorsen 1996; Maser 1998). This shrew appears to prefer complex riparian habitat with overhanging vegetation, undercut banks with exposed tree roots and crevices, and in-stream coarse woody debris (Conaway 1952; Craig 2002). Nests that have been found were very close to water and most were under or in logs (Nagorsen 1996).

Nagorsen (1996) notes that Common Water Shrews have been found inhabiting low elevation forest, open wetlands, and high alpine habitat, and Buckner and Ray (1968) report this shrew in bog habitat. Craig (2002) reports Vancouver Island Common Water Shrews from young forests. Most sites surveyed for the Vancouver Island subspecies of the Common Water Shrew have been low elevation; the highest elevation capture site was 558 m. Because of the wide range of habitats this shrew has been documented within, all vegetated structural and seral stages with an intact riparian zone should be considered potential habitat (Conaway 1952; Beneski and Stinson 1987; Nagorsen 1996).

Conservation and Management

Status

The Vancouver Island Common Water Shrew 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	Canada	Global
S2	N2	G5T2

Trends

Population trends

Believed to be declining due to habitat loss on southeast Vancouver Island (CDC 2001; Craig 2002). There are no details regarding population trends (Nagorsen 1996) because of its rarity, and the removal methods that have been used to sample this species. The B.C. Conservation Data Centre has mapped 17 occurrences (CDC 2001). In total, there are 67 records from 38 locations. Most of the known records are along the east coast of Vancouver Island (Craig 2002). There are considerable data from field studies and fossil records that suggest that this species is rare even within ideal habitats (Svihala 1934; Beneski and Stinson 1987; Nagorsen 1996; Waye 1997).

Habitat trends

Urban development and forestry practices occurring within riparian habitats throughout Vancouver Island are undoubtedly degrading and reducing the amount of preferred habitat (CDC 2001). In the last 20 years, four of the 16 identified watershed groups on Vancouver Island had up to 30% of their riparian habitat (30 m on either side of a stream >200 m long) clearcut logged and an additional 10 watersheds had up to 20% of riparian habitat logged (MELP 1999). Reid et al. (1998) reported that 93% of 14 second-order streams and 165 watersheds they examined along the east coast of Vancouver Island showed changes in the riparian zone associated with upstream forest harvesting or urbanization.

Forests cover 91% of Vancouver Island and the results based code (RBC) applies to approximately two-thirds of the forested land (Government of B.C. 2000). While S1, S2, and S3 streams and other water bodies are buffered from forestry activity by the RBC, smaller and/or non-fish bearing streams are not protected, even though these streams potentially provide important habitat for Common Water Shrews.

The human population of Vancouver Island is concentrated in the south and along the east coast. Between 1991 and 1997 the population increased by

19%, and is expected to increase by a similar amount over 1997 levels by 2012 (Government of B.C. 2000). Increasing population density will be associated with increasing road density, industrialization, and general urbanization, all of which have the potential to degrade, fragment, or remove Vancouver Island Common Water Shrew habitat.

Threats

Population threats

Rarity and a restricted distribution make this subspecies vulnerable to environmental change and extinction.

Habitat threats

Hartman (2002) noted that several recent and historical capture sites are now encircled by, or crossed by roads, potentially reducing the suitability of the habitat for the Vancouver Island Common Water Shrew.

The primary threat to habitat of the Vancouver Island Common Water Shrew is loss, fragmentation, and degradation, due to urban development along the east coast and on southern Vancouver Island, as well as forest practices that affect riparian habitat and water quality (CDC 2001).

Water quality influences the abundance and diversity of aquatic invertebrates and other aquatic food sources which are essential for water shrews (Svihala 1934; Conaway 1952; Sorenson 1962; Banfield 1974; Cairns and Pratt 1993; Nagorsen 1996; Vuori and Joensuu 1996). Changes in water quality can be caused by changes in riparian vegetation, erosion, siltation, or removal of the riparian zone by forest harvesting, or in more urban areas, water contamination from residential stormwater, industrial waste, or runoff of pesticides or chemicals. All of these factors can have detrimental effects on the food source and habitat of the Common Water Shrew.

Fragmentation of riparian habitat on Vancouver Island will likely be an increasing threat to this subspecies. The close association of this shrew with intact riparian zones suggests that its ability to move among fragmented riparian zones might be limited. This subspecies has not been reported more than 1 m from the water's edge, and the majority of sightings and captures have been at the water's edge (Craig 2002). The current distribution of this shrew on Vancouver Island will likely decrease if its ability to recolonize areas (essential for gene flow in the population) is restricted.

Even within relatively large tracts of undeveloped riparian habitat, edge effects may render the habitat unsuitable for a habitat specialist like the Common Water Shrew. Examples of edge effects that are particularly detrimental include loss of canopy closure resulting in decreased security (Nagorsen 1996) or changes in water quality (Noel et al. 1986); increased disturbance which can penetrate up to 70 m from an edge (Matlack 1993); and, in urban areas, increased predation by domestic cats on small animals, of which 80% of captures are shrews (Fitzgerald 1988).

Legal Protection and Habitat Conservation

The Common Water Shrew is protected, in that it cannot be killed, collected, or held in captivity without special permits, under the provincial *Wildlife Act*.

There are records of this subspecies from protected areas on Vancouver Island, but because of the sparse data the proportion of the population that is protected is unknown. Records show that this shrew occurs in Goldstream Provincial Park (388 ha), the Greater Victoria Water District adjacent to the park, Pacific Rim National Park (155 km^2), Miracle Beach Provincial Park (137 ha), Veitch Regional Park and Niagara Catchment, Dudley Marsh, and possibly Marble River Provincial Park (1512 ha). Approximately 13% of the land base of Vancouver Island is in protected areas of which 32% is in the Mountain Hemlock and Alpine Tundra biogeoclimatic zones (Government of B.C. 2000) where no water shrews have been reported to date. An additional (unknown) amount of habitat is protected in regional parks and private land managed for conservation purposes.

The results based code recommendations for landscape level planning and riparian management may conserve several beneficial attributes of Water Shrew habitat, if implemented. Where landscape level planning can address maintenance of landscape connectivity, particularly along natural features such as streams and rivers, or can address natural vegetative species composition and requirements for coarse woody debris retention, then the recommendations may partially address this species' requirements. However, these aspects are only opportunistically being applied.

Riparian management recommendations may in some cases partially address the requirements of this species. Current riparian management recommendations for streams and wetlands vary depending on the size and classification of the aquatic feature. General recommendations include minimizing windthrow risk; maintaining wildlife trees; and conserving stream channel shape, bank stability, and water quality; as well as guidelines for minimizing detrimental effects of range, roads, and culverts. Where these recommendations are applied they may contribute to the maintenance of this species' habitat.

Although these habitat provisions provide several beneficial recommendations for the habitats of the Vancouver Island Common Water Shrew, these provisions are not sufficient to ensure the conservation of this rare taxon. Urban planning and stewardship programs will be an important component of this subspecies recovery. In addition the range of this species overlaps with private land or private managed forest land. For the Vancouver Island Common Water Shrew to be addressed within the Private Managed Forest Land regulations it must be designated as Identified Wildlife.

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

Strategic or landscape level planning should promote connectivity among remnant patches of suitable riparian habitat by restoring forest habitat along watercourses and wetlands, especially within the South Island Forest District. Whenever possible, large buffer widths around riparian areas should be maintained to compensate for the fragmentation that is occurring.

Wildlife habitat area

Goal

Protect current and historical habitat of the Vancouver Island Common Water Shrew.

Feature

Establish WHAs at current or historical occurrences where suitable habitat still exists. Emphasis should be placed on protecting areas with intact riparian areas (undisturbed watercourses) of varying classes (including wetlands) to protect a diversity of habitat.

Size

Generally between 5 and 45 ha but will ultimately depend on the size of the water feature, area of suitable habitat, and potential threats to riparian habitats and water quality. In more urban areas (along the east coast and southern Vancouver Island), WHAs should be larger to minimize edge effects and contamination of waterways.

Design

The WHA should include suitable riparian and aquatic habitats, extend the entire length of the stream or wetland, and encompass as many tributaries or wetlands within 1 km as possible. The WHAs should encompass a minimum of 1 linear km of riparian habitat. In areas with greater threats (i.e., more urbanized areas), WHAs should include a 30 m core area and a 45 m management zone on each side of the stream or around wetland/wetland complexes. In other areas, the WHA design should be based on the size and type of the aquatic feature. Wetlands should have a minimum 20 m core area and a 30 m management zone. Larger streams (S1) should have a 50 m core area and 20 m management zone on either side of the stream. Mid-sized streams (S2, S3, S5) streams should have a minimum 30 m core area and a 30 m management zone on either side of the stream, and smaller streams (S4, S6) should have a minimum 20 m core area and 30 m management zone on either side of the stream.

Measurements of slope distance should be consistent with the *Riparian Management Area Guidebook*. Where slopes exceed 60%, the WHA should extend to the top of the inner gorge.

General wildlife measures

Goals

1. Maintain hydrological regime.
2. Maintain water quality and physical integrity of riparian habitat.
3. Maintain or promote natural microclimatic conditions and structural elements known to be preferred by this species, such as stream bank stability, abundance of rocks and boulders within and around stream, good ground cover, coarse woody debris, and litter layer.
4. Minimize edge effects and windthrow.

Measures

Access

- Do not construct roads.

Harvesting and silviculture

- Do not harvest or salvage within core areas or riparian reserve areas.
- Use partial-harvesting systems within the management zone that maintain 70% basal area. Partial harvesting within the management zone should promote natural microclimate and maintain wildlife trees and coarse woody debris.
- Restrict activities that may alter the vegetation, hydrology, stream structure, or soils, particularly the upper soil layers.

Pesticides

- Do not use pesticides.

Recreation

- Do not establish recreational trails, structures, or sites within WHA.

Additional Management Considerations

When operating immediately adjacent to WHAs, minimize disturbance to soil, water quality of occupied streams, litter layer and ground cover.

It is recommended that additional WHAs be established around nearby (interconnected) streams or wetlands to protect an entire subpopulation.

Because of the urban development occurring on Vancouver Island, particularly in the south and along the east coast, a significant portion of the habitat for this shrew is threatened. It is important to consider this species within urban planning and stewardship programs.

Information Needs

1. Taxonomy. Existing preserved specimens should be sufficient to perform the modern systematic research into the taxonomy of this subspecies.
2. Distribution and basic demographic parameters including home range size, movement patterns, and ability to recolonize areas are needed. Live-trapping methods should be used during future investigations into this and other rare shrew species (Craig 2002; T. Sullivan, pers. comm.).
3. Preferred habitat attributes and the effects of habitat fragmentation. Many potentially suitable habitat types such as wetlands, high elevation, and/or high gradient streams have not been surveyed for water shrews on Vancouver Island. Future survey work should investigate and only use non-lethal methods of assessing their presence, such as faecal samples obtained in bait tubes (Churchfield et al. 2000) or track plates (Ellenbroeck 1980).

Cross References

Douglas-fir/Alaska onion grass, Keen's Long-eared Myotis, Marbled Murrelet, "Queen Charlotte" Goshawk, Scouler's corydalis

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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 interrelated 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

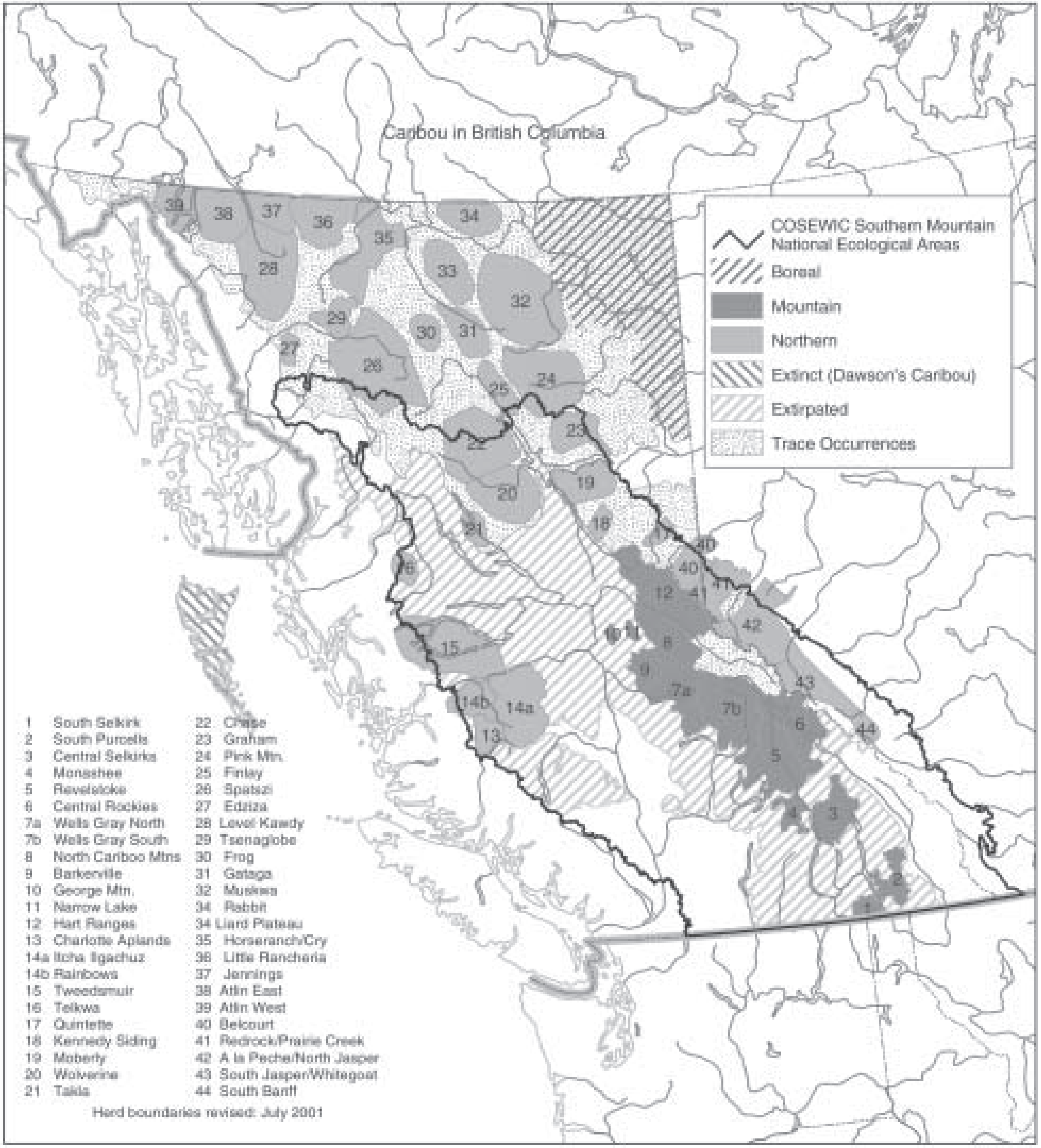
Global

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

Ecotype	Status			
	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 meta-population 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. Meta-population 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 north-eastern 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 coordinated 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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Plants

Scouler's Corydalis

Corydalis scouleri

Adapted by Sharon Hartwell and Kathy Paige[1]

Species Information

Taxonomy

Scouler's corydalis is in the *Fumariaceae* (fumitory or bleeding-heart) family. It is one of five *Corydalis* species indigenous to Canada, four of which occur in British Columbia. There are no recognized infraspecific taxa.

Description

Scouler's corydalis is a tall (0.6–1.2 m) perennial herb with thick rhizomes. Stems are upright, hollow, and may be simple or somewhat branched. The large, blue-green, deciduous leaves, usually three in number, arise from near or above the middle of the stem and are much dissected (tri- to quadripinnate). The inflorescence is a terminal or axillary raceme of 15–35 showy, rosy-pink, spurred flowers. Individual flowers are relatively small (~2.5 cm long) and bilaterally symmetrical. The fruits are pod-like capsules (10–15 mm long), containing small (4 mm) shiny black seeds. The plant is summer dormant, and foliage dies back completely after seed set. See Douglas et al. (1999, 2002) for complete description and illustrations and Pojar and MacKinnon (1994) for colour photograph.

Distribution

Global

Scouler's corydalis is limited to the Pacific Northwest, where it occurs west of the Cascades, from northwestern Oregon northward through the Olympic Peninsula to southwestern Vancouver Island (Douglas and Jamison 2000, 2001). It is frequent to common in Oregon and Washington (>100 extant populations), but rare in British Columbia (~22 extant populations).

British Columbia

In British Columbia, this species is restricted to extreme southwestern Vancouver Island. It is found in the Nitinat River valley, the northeast shore of Nitinat Lake, the Klanawa River valley, the Kissinger Lake area, immediately west of Cowichan Lake, and Heather Lake.

Forest region and district

Coast: South Island

Ecoprovinces and ecosections

COM: WIM
GED: LIM

Biogeoclimatic units

CWH: vm1

Broad ecosystem units

FR, SR

Elevation

5– ~200 m (Douglas and Jamison 2000, 2001)

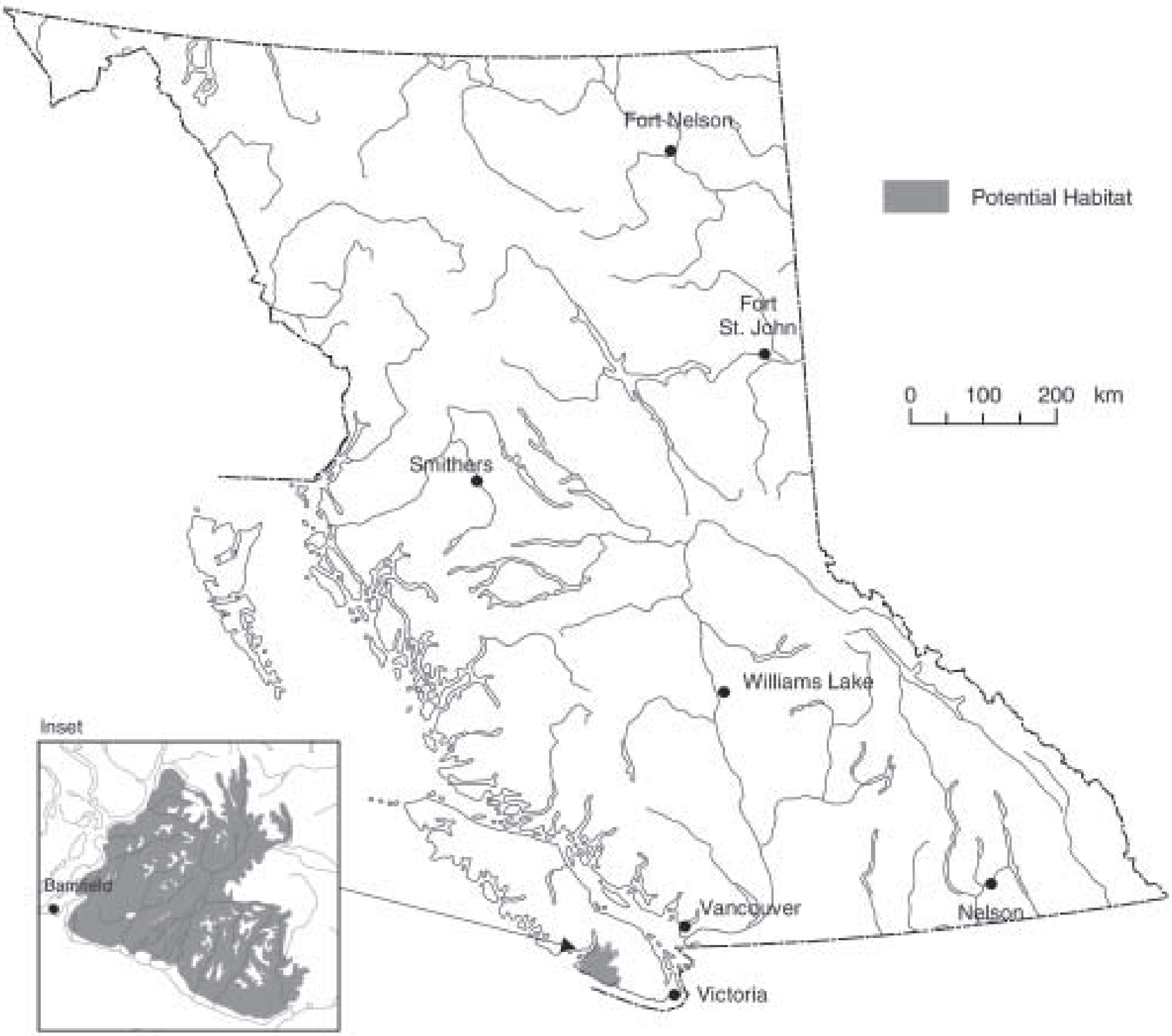
Life History

Reproduction

Scouler's corydalis is a perennial, herbaceous understorey plant with thick rhizomes. It reproduces well vegetatively, generating annual stems apically from the rhizome. This vegetative growth can result in extensive single clones with numerous stems, which may cover tens of square metres (Douglas and

1 Account largely adapted from Douglas and Jamison 2000.

Scouler's Corydalis
(Corydalis scouleri)



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.

Jamison 2001). Single leaves are produced on each stem until the plants reach sexual maturity, after 4 or more years.

In British Columbia, flowering occurs in May and June. A raceme typically produces 15–20 flowers, each with two multi-seeded carpels. There is the potential for considerable seed set, but Hitchcock et al. (1969) note that only the terminal flower of the raceme may develop, which would limit seed production. A number of pollinators visit the species. Self-fertilization is also a possibility (Ownbey 1947), but Ryberg's observations of cultivated specimens lead him to speculate that Scouler's corydalis is probably self-sterile (1960).

Dispersal

The ripe seed capsule explodes elastically when disturbed, spreading seeds a considerable distance. Seeds are also typically dispersed by ants (D. Fraser, pers. comm.); however, the seeds are also short lived and readily dry out. Periodic flooding may facilitate dispersal of both rhizome fragments and seeds (Douglas and Jamison 2000, 2001).

Habitat

Structural stage

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

Important habitats and habitat features

In British Columbia, Scouler's corydalis grows in cool, moist, shady habitats adjacent to watercourses, which vary in size from moderately large rivers (Nitinat and Klanawa) to small tributary streams (Jasper Creek, Vernon Creek) and roadside ditches draining into streams (Old Nitinat Campsite). The fine silts and sediments of floodplains and alluvial flats and river benches are prime habitat, but the plant also grows where silty soil is combined with coarser floodplain material or river-smoothed rocks on stream banks, river terraces, islands, and bottomlands. Known sites occur on slopes ranging from 0 to 45%. Aspects include west, southwest, and north to northeast.

The preferred cool, moist, and moderately shady habitat is usually found in deciduous or mixed forests. Occurs in young and older dominant red alder (*Alnus rubra*) stands, but is also found in mixed conifer stands with mature big-leaf maple (*Acer macrophyllu*m) and Sitka spruce (*Picea sitchensis*), as well as red alder, western redcedar (*Thuja plicata*), and western hemlock (*Tsuga heterophylla*). Understorey associates include western swordfern (*Polystichum munitum*), salmonberry (*Rubus spectabilis*), red elderberry (*Sambucus racemosa*), devil's-club (*Oplopanax horridus*), palmate-leaved coltsfoot (*Petasites palmatus*), and stink currant (*Ribes bracteosum*) (Douglas and Jamison 2000, 2001). These plant communities are typically found in areas of high precipitation, with a nitrogen-rich moder and mull humus (Douglas and Jamison 2000, 2001).

At least two of the Nitinat River populations occur in older forest (one in a *Tsuga heterophylla/Acer macrophyllum* stand, and one in a *Picea sitchensis* stand). The remaining sites range from young to mature forest.

Although all of the known populations in British Columbia occur adjacent to watercourses, Diaz and Mellen (1996) classify Scouler's corydalis as a facultative, rather than obligate, wetland species. The plant can be cultivated in shady or woodland situations and is grown by gardeners in Europe (Ownbey 1947) and the Pacific Northwest, where it is sold by nurseries specializing in native plants.

Conservation and Management

Status

Scouler's corydalis is on the provincial *Blue 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)

BC	WA	OR	Canada	Global
S3	S?	S?	N3	G4

Trends

Population trends

Population trends are not possible to determine due to the lack of information for the few existing historical records. The 22 extant populations in British Columbia are restricted to two major watersheds on southwestern Vancouver Island (Klanawa, Nitinat, and immediately east of the Nitinat near Cowichan Lake). These populations range in size from one stem to 100 000 stems growing over a 6-ha area.

Habitat trends

Not known. Scouler's corydalis occurs on southwest Vancouver Island, an extensively logged area with a widespread network of logging roads providing widespread access. In addition, southwest Vancouver Island is used extensively for recreational activities.

Recreational activity has also had an impact on the riparian habitat of southwest Vancouver Island. Forestry recreation sites tend to be situated on lakeshores and riverbanks, and there are several along the Nitinat River, including Nitinat Provincial Park. Nitinat Lake is a popular windsurfing destination, and the campsite at the mouth of the Caycuse River receives heavy use. A moderate-sized population of Scouler's corydalis (ca. 500 stems) exists close to this site.

Threats

Population threats

Scouler's corydalis propagates very successfully by rhizomatous growth, but appears to have low sexual reproductive success and possibly has limited seed dispersal (Douglas and Jamison 2000, 2001; D. Fraser pers. comm.). These characteristics, combined with the limited number of populations in the province, may well have resulted in a lack of genetic heterogeneity. If this is true, the long-term survival of the species in British Columbia could be at risk due to factors such as disease.

Habitat threats

Forest management practices including road building and maintenance, may be a potential threat to habitat for Scouler's corydalis. Logging occurring too close to rivers and streams may damage individuals, alter suitable habitat by removing shade cover, or cause downstream erosion or flooding which could result in alteration or loss of habitat. Road maintenance and stream crossing developments may have an impact. However, new road and bridge construction and forest harvesting will be limited in known sites of Scouler's corydalis (Beese, pers. comm.; Ferguson pers. comm.)

Recreational activity may also be a threat. Along the Nitinat River, logging roads and their associated bridges provide direct access to more than half the known populations of Scouler's corydalis. The summer dormancy of the species makes it difficult to detect. Repetitive or continuous recreational activity such as camping in the same site where Scouler's corydalis is found may potentially affect populations.

Large scale or severe flooding of the Nitinat River could result in loss or alteration of habitat, although it might also assist in dispersing seeds and rhizomes. An examination of the historic patterns of flooding in these watersheds could yield insight to population distribution and density. Where there are small populations, natural flooding and resultant erosion may threaten their continued existence.

Forest succession will lead to changes in forest structure which will eventually shade out the corydalis.

Legal Protection and Habitat Conservation

There is currently no legislation that specifically protects Scouler's corydalis in British Columbia. One population occurs within an ecological reserve and is protected from human disturbance.

The riparian management recommendations under the results based code will be the most important component in protecting this species, because the majority of known populations are adjacent to rivers and creeks of significant size. A number of populations are on private land (e.g., Caycuse River sites on the Nitinat downstream from the fish hatchery, and sites west of Cowichan Lake, near Kissinger Lake).

Identified Wildlife Provisions

Wildlife habitat area

Goal

Maintain populations and provide adequate habitat for populations to persist.

Feature

Establish WHAs at known populations.

Size

WHAs for this species will typically be <10 ha. The WHA size will ultimately depend on the extent of the individual population and suitable habitat as well as surrounding conditions, which will determine the size of the management zone.

Design

The WHA should include a core area and management zone. The core area should be defined by the perimeter of the population. Most of the known populations have been mapped. Most are <1 ha although one population occurs over several hectares. The management zone will normally be approximately 50 m but may extend up to 250 m depending on site-specific characteristics, but should be large enough to preserve the ambient conditions and be windfirm. In some cases a wider management zone may be required on the upslope side of the population to maintain hydrological conditions.

General wildlife measures

Goals

1. Prevent direct mortality from road or stream crossing construction or maintenance activities.
2. Maintain core area as suitable habitat to allow population to persist.
3. Maintain microclimatic conditions (i.e., light conditions, soil moisture).
4. Avoid creating large canopy gaps.
5. Maintain hydrological conditions of core area.
6. Maintain important habitat features (e.g., dominant overstorey tree species, such as *Alnus rubra, Acer macrophyllum,* and *Picea sitchensis*).

Measures

Access

- Do not construct access structures (roads, trails, or stream crossings) in the core area.
- Avoid developing access structures in the management zone, particularly upslope of the core area.
- Where roads are determined to be necessary or already exist within WHA, ensure road maintenance activities do not damage or kill plants and use methods to prevent the spread of invasive species.

Harvesting and silviculture

- Do not harvest within core area except for treatments aimed at maintaining or improving stand characteristics for Scouler's corydalis.
- Use partial harvesting systems in the management zone that maintain ~60% basal stem area. Remove 40% basal steam area in small openings.
- Do not salvage unless it can be done without disturbing important structural elements (e.g., dominant overstorey trees).

Pesticides

- Do not use pesticides.

Recreation

- Do not develop recreational trails, facilities, or structures within the core area.

Information Needs

1. Baseline biological and ecological information for British Columbia.
2. Genetic research on Scouler's corydalis populations in British Columbia (e.g., genetic diversity, heterogeneity).
3. Long-term response of populations of Scouler's corydalis to human and natural occurrences to different activities.

Cross References

Marbled Murrelet, "Queen Charlotte" Goshawk, "Vancouver Island" Common Water Shrew

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Tall Bugbane

Cimicifuga elata

Original prepared by Jenifer L. Penny

Species Information

Taxonomy

Tall bugbane is in the Ranunculaceae (buttercup) family. It is one of six *Cimicifuga* species in North America. There are no recognized infraspecific taxa. The taxonomy of the *Cimicifuga* genus is currently under review and may be included under the genu *Actaea*, in which case tall bugbane would be referred to as *Actaea elata*.

Description

Perennial, large-leafed understorey plant that stands 1–2 m tall. Stems are branched above and leaves are bi-ternate with 9–17, cordate to ovate, often palmate leaflets, which are usually three-lobed. This species has a dark, tuberous, horizontal rhizome. The inflorescence is a simple to compound raceme with 50–900 small, white, closely crowded flowers. Individual flowers are radially symmetrical and apetalous, and sepals are white or pinkish, falling off at once. Fruits are follicles, 9–12 mm long, subsessile, appearing singly in the upper flowers, but in two's, and rarely, three's on the lower raceme. Follicles each contain approximately 10 red to purple-brown seeds.

Distribution

Global

Occurs from extreme southwestern British Columbia south to southwestern Oregon. It is rare throughout its entire range in the Pacific Northwest, but is particularly rare in British Columbia.

British Columbia

Only known from 10 sites near Chilliwack, British Columbia.

Forest region and district

Coast: Chilliwack

Ecoprovince and ecosection

COM: EPR, NWC

Biogeoclimatic units

CWH: dm, ms1

Broad ecosystem units

CD, FR

Elevation

300–1300 m

Life History

Reproduction

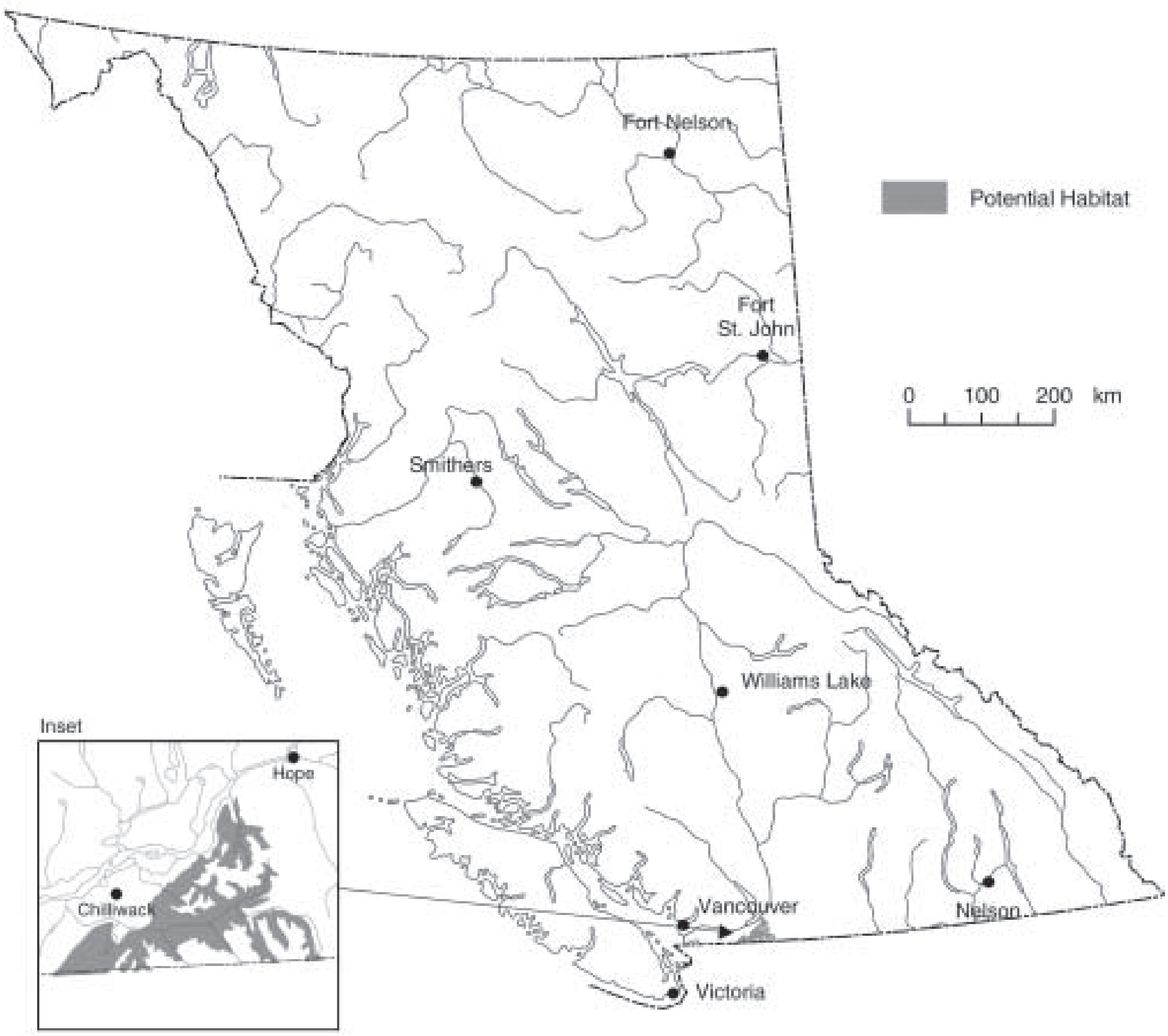
Tall bugbane is a herbaceous long-lived perennial understorey plant. Young plants emerge in the spring, produce buds in late spring, and flower mid-June to August. In experiments, Kaye and Kirkland (1994) showed that seeds required cold-stratification for germination and that percentage germination was low. In growth experiments on tall bugbane using ample light, plants grew to reproductive size in 3 years (USDA For. Serv., USDI BLM, and U.S. Army Corps of Engineers 1996). Under less ideal conditions, time to reproductive size could be up to 6 years.

Dispersal

Seeds are heavy, have no special dispersal mechanism, and are dispersed within a few metres of the parent plant (Kaye and Kirkland 1994; Wentworth 1996).

Tall Bugbane

(Cimicifuga elata)



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.

Habitat

Structural stages

1–3: non-vegetated to tall shrub (<15 yr)
4–6: pole/sapling to mature forest (70–150 yr)

Important habitats and habitat features

In British Columbia, this species grows in shady, moist, mature (70–150 yr) western redcedar forest, commonly in *Thuja plicata-Polystichum munitum-Achlys triphylla* communities. This species is nearly always associated with bigleaf maple (*Acer macrophyllum*). In Washington and Oregon, it generally requires a hardwood component in the canopy, subsurface moisture (often provided by creeks or rivers), and occurs on northerly slopes (Kaye and Kirkland 1994). In British Columbia, it has been found on road-cuts, in clearcuts, and in mature forests with strong deciduous components. Plants have also been observed in deciduous stands. Kaye and Kirkland (1999) describe tall bugbane as "light flexible" rather than old growth dependent and shade restricted (Collins et al. 1985).

The deciduous component of mixed forest is important in maintaining optimal light conditions for this species. Deciduous trees species that occur with tall bugbane include bigleaf maple (*Acer macrophyllum*), vine maple (*A. circinatum*), and Douglas maple (*A. glabrum* var. *douglasii*). Bigleaf maple is the most important as it occupies the forest canopy, increasing forest floor light during the spring. Natural canopy gaps provide the opportunity for flowering and establishment of progeny.

In British Columbia, known sites occur on 15–35° slopes with north, southwest, and south aspects. In southern populations (Oregon and Washington), this species nearly always occurs on northern slopes from east to west aspects. This may be an important distinction between northern and southern populations but needs to be confirmed.

Conservation and Management

Status

The tall bugbane is on the provincial *Red List* in British Columbia. It is considered *Endangered* in Canada (COSEWIC 2002).

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

BC	WA	OR	Canada	Global
S1	S2	S2	N2	G2

Trends

Population trends

No long-term studies on population trends have ever been undertaken in British Columbia. However, two of the 10 populations in the Chilliwack River Valley (one of which has not been observed since 1957) appear to have been reduced due to extensive logging at the sites. One population was lost due to the development of a helicopter landing pad. All of the populations are small and sporadically distributed (Penny and Douglas 1999). The southern populations in Oregon tended to be larger (i.e., several hundred to several thousand plants) and have larger and more reproductive plants than northern populations (Kaye 2000). In British Columbia, the largest population is 63 plants (Penny and Douglas 1999).

Habitat trends

The forests of the Pacific Northwest have become increasingly fragmented due to past logging practices. A high proportion of the mature to old forest in the Chilliwack forest district have been converted to young forest, disturbing natural conditions for tall bugbane. Initially, plants respond favourably after logging (clearcuts), but there are several risks to its continued persistence following the initial disturbance.

Threats

Population threats

Populations are small, and sporadically distributed over the landscape. Small populations are susceptible to low genetic diversity and imminent extirpation. In addition, tall bugbane is relatively much less attractive to pollinators than other flowering plants, and therefore, receives less visits, and has less reproductive success. Further limiting this species is the lack of a specialized seed dispersal mechanism. Due to this species' reproductive limitations, colonization into new sites or recolonization into former sites may be limited.

Habitat threats

The main threats to this species are forest harvesting, road construction, and lack of reproductive potential and recruitment (Penny and Douglas 1999; Kaye 2000). This species has been found in both mature forest and clearcuts, but it likely naturally grows in mature to old forest with canopy gaps (Kaye and Kirkland 1994). Clearcuts can provide the necessary conditions for seedling establishment, but the early stages of forest growth may overcome the plants due to intense competition. Thus, although tall bugbane responds favourably to removal of the forest canopy (Kaye and Kirkland 1999), the longer term impacts are unknown.

Plants may also grow on road cuts due to the favourable conditions for seedling germination but these plants may be threatened by roadside maintenance activities such as mowing and spraying which could kill adult plants, reduce seed production, or cause mortality of new seedlings (Kaye and Kirkland 1999).

Tall bugbane has reproductive limitations that make colonization into new sites difficult. It is relatively much less attractive to pollinators than other flowering plants, and lacks any effective seed dispersal mechanism.

Other potential threats include competition with invasive species.

Legal Protection and Habitat Conservation

There is currently no legislation that specifically protects tall bugbane in British Columbia. None of the populations are found in protected areas. However, one population on Vedder Mountain is partially protected within a small wildlife tree retention area and a visual landscape reserve.

Old growth management areas are unlikely to be located in the appropriate locations to meet the needs of this species. Riparian reserves will likewise not be important in protecting this species. This species does not typically grow along watercourses.

Identified Wildlife Provisions

Wildlife habitat area

Goal

Maintain the population and provide adequate space for population to persist as well as maintain a seed source for colonization or recolonization into nearby suitable habitat.

Feature

Establish WHAs at known or historical populations. A population is considered to be a cluster of individuals that are likely interbreeding, that is, they are not separated by any barrier that would restrict reproduction. Large distances could be a barrier, so populations are generally defined by polygons with a radius of no more than 500 m.

Size

Typically between 20 and 40 ha but will depend on site-specific conditions such as size of the population and area covered by population.

Design

The WHA should include a core area and a management zone. The core area is defined using the perimeter of the population plus a 30–50 m band surrounding the population. The management zone should be 150–200 m depending on site-specific characteristics but should be large enough to preserve the ambient conditions and be windfirm. In some cases a wider management zone may be required on the upslope side of the population to maintain hydrological conditions.

General wildlife measure

Goals

1. Prevent direct mortality from road construction or maintenance activities.
2. Maintain core area as suitable habitat to allow population stability or growth.
3. Maintain microclimatic conditions (i.e., light conditions, soil moisture).
4. Minimize introduction and spread of invasive species.
5. Maintain the diverse stand structural components (e.g., Acer spp., canopy gaps).
6. Maintain an open canopy.
7. Maintain hydrological characteristics of core area.

Measures

Access

- Do not construct roads, trails, or stream crossings, particularly upslope of the population.
- Rehabilitate temporary access structures where possible.
- Where roads are determined to be necessary or already exist within WHA, ensure road maintenance practices do not damage or kill plants (i.e., do not mow plants) and use methods to prevent spread of invasive species (i.e, use control measures and seed with native species).

Harvesting and silviculture

- Do not harvest within core area except for treatments aimed at maintaining or improving stand characteristics for this species.
- Use partial harvesting systems in the management zone that maintain 60% basal stem area. Remove 40% basal stem area in small openings with a minimum of only a few crowns per gap.
- Retain *Acer* species, particularly *Acer macrophyllum*. Retain at least 20–30% from inventory distribution.
- Do not salvage unless it can be done without disturbing important structural elements (e.g., *Acer* species).
- Include deciduous species specifically *Acer* species, in the Free Growing standards.
- Use stand tending activities to promote canopy gaps around identified individuals of tall bugbane.

Pesticides

- Do not use pesticides.

Recreation

- Do not develop recreational trails, facilities, or structures within core area.

Additional Management Considerations

Avoid seeding with non-native species within the stand in which the WHA is found.

Avoid foliar or broadcast spraying of herbicides within the stand in which the WHA is found.

Promote persistence of deciduous species, in particular *Acer*, during stand tending activities.

Information Needs

1. Baseline biological and ecological data on tall bugbane in British Columbia.
2. Response of populations of tall bugbane to different logging treatments (i.e., population structure, inflorescence production, and average reproductive plant size) following treatments (done on more southerly populations, but not on Canadian populations).
3. Long-term viability of tall bugbane in managed forests in British Columbia.

Cross References

Coastal Tailed Frog, Marbled Murrelet, Pacific Water Shrew

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Plant Communities

Douglas-fir/Alaska Oniongrass

Pseudotsuga menziesii/Melica subulata

Original[1] prepared by J. Pojar

Plant Community Information

Description

Forests of this community have an open canopy of Douglas-fir (*Pseudotsuga menziesii*), often with Garry oak (*Quercus garryana*). Although this plant community has several manifestations, depending on disturbance and successional stage and chance, it usually includes both Douglas-fir and Garry oak as dominant or frequent trees. Hairy honeysuckle (*Lonicera hispidula*) is usually present in the sparse shrub layer. The herb layer is dominated by Alaska oniongrass (*Melica subulata*), with long-stoloned sedge (*Carex inops*), blue wildrye (*Elymus glaucus*), Pacific sanicle (*Sanicula crassicaulis*), big-leaved sandwort (*Moehringia macrophylla*), broad-leaved shootingstar (*Dodecatheon hendersonii*), nodding trisetum (*Trisetum canescens* var. *cernuum*), and cleavers (*Galium aparine*). Electrified cat's-tail moss (*Rhytidiadelphus triquetrus*) is the dominant moss. See Roemer (1972) and Green and Klinka (1994).

These communities occur on dry warm sites, typically on southerly aspects over inactive colluvial and sometimes morainal parent materials, at low elevations in the southern Strait of Georgia area. Soils are shallow, mostly sandy loamy, often with moderate coarse fragments, and are classified as Sombric Brunisols. Soil moisture is rated as very dry and the soil nutrient regime is rich to very rich.

Distribution

Global

Originally this plant community was scattered and localized in the driest warmest portions of the Pacific coastal formation of western North America, especially in the Strait of Georgia–Puget Sound area of British Columbia/Washington and in the Willamette Valley of Oregon. It is considered to be extirpated from Washington State.

British Columbia

This community is restricted to low elevations along southeast Vancouver Island from Bowser to Victoria, and on the Gulf Islands south of Hornby and Lasqueti islands.

Forest region and districts

Coast: South Island, Sunshine Coast (Lasqueti Island)

Ecoprovince and ecosections

GED: NAL, SGI, SOG

Biogeoclimatic unit

CDF: mm/03

Broad ecosystem units

CD, GO

Elevation

0–150 m

Plant Community Characteristics

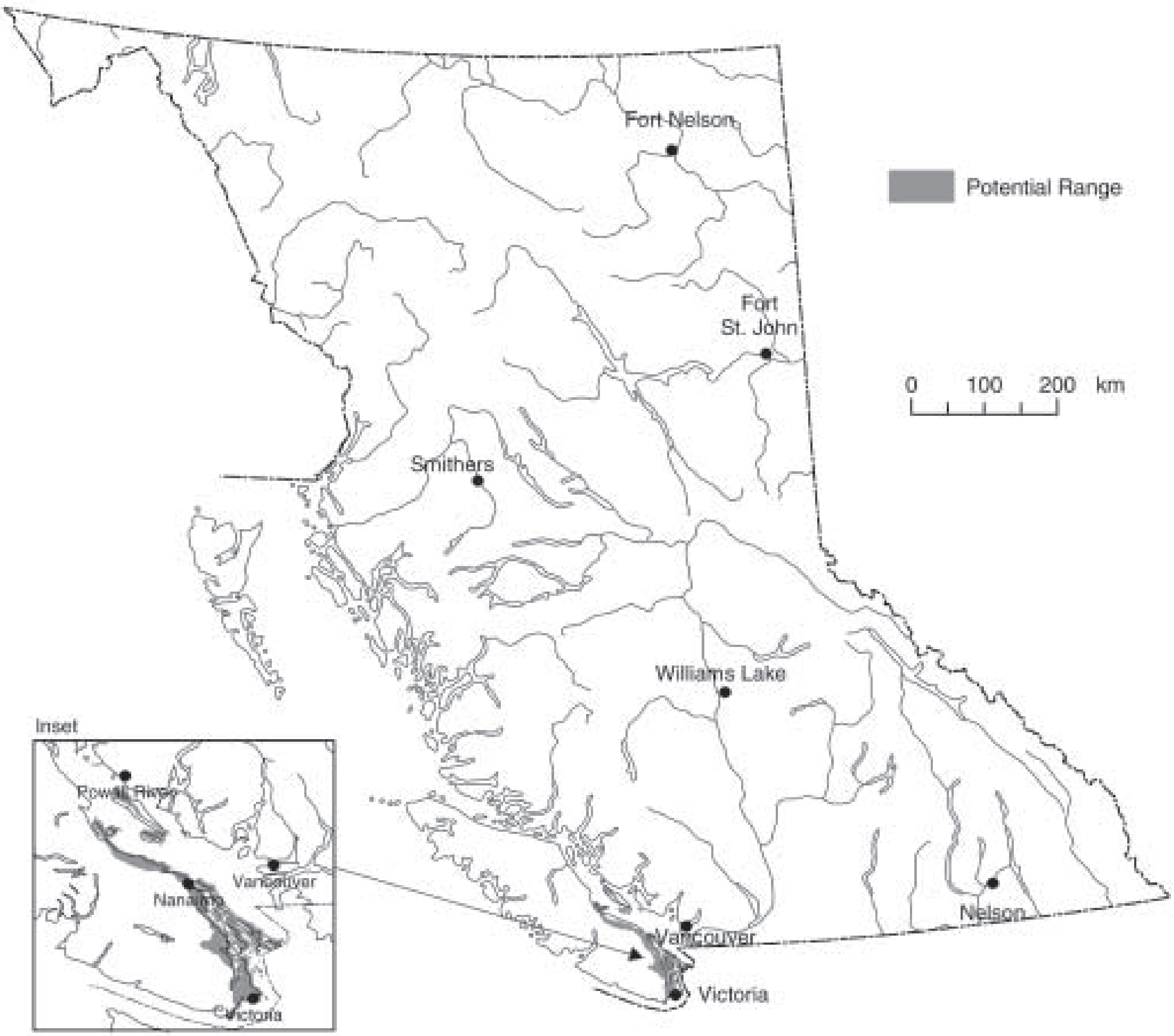
Structural stage

3–7

1 Volume 1 account prepared by S. Flynn and C. Cadrin.

Douglas-fir / Alaska Oniongrass

(Pseudotsuga menziesii / Melica subulata)



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

Most likely a variant of frequent stand-maintaining fires (NDT4) (W.R. Erickson, pers. comm.). Infrequent stand-initiating events (NDT2) appear to have been the norm for this landscape (MOF and MELP 1995), primarily medium to high intensity but relatively small crown fires (perhaps every 150–200 years and 5–50 ha, on average), and occasionally windthrow. However, local surface fires, due to First Nations and post-contact burning as well as natural causes, were more frequent but were smaller and usually not stand replacing. These fires helped maintain the open canopy, mixed nature, and understorey diversity of these forests. Individual or small groups of trees also suffer direct mortality due to root rots and defoliating insects and occasional severe drought, or indirect mortality via predisposition of attacked trees to blowdown. Possibly periodic mortality of Douglas-fir on sites rather extreme for the species allows the drought-tolerant but shade-intolerant Garry oak to persist. Roemer (2000) suggests that outbreaks of western oak looper (*Lambdina fiscellaria somniaria*) attack Douglas-fir as well as Garry oak and Douglas-fir bark beetle (*Dendroctonus ponderosae*) could be responsible for some of the Douglas-fir mortality. Garry oak seems to be able to largely survive the looper outbreaks, and so can persist in the stand even without fire.

Fragility

Very fragile. Soils often are shallow around rock ridges and outcrops, so can be susceptible to degradation due to soil compaction and erosion. These ecosystems recover rather slowly after stand-destroying disturbances, due to droughty soils, invasion by exotic species like Scotch broom (*Cytisus scoparius*), gorse (*Ulex europaeus*), and spurge-laurel (*Daphne laureola*), and prolonged recruitment of structural elements such as standing dead trees, large old live trees, and large downed logs. Moisture stress can delay forest regeneration and slow recovery after disturbance. These mixed forests are very susceptible to invasive species, especially after logging or roadbuilding or any disturbance that exposes mineral soil.

Conservation and Management

Status

The Douglas-fir/Alaska oniongrass plant community is on the provincial *Red List* in British Columbia. It is ranked S1 in British Columbia. Its global rank is unknown.

Trends

Almost gone. Less than 1% and possibly <0.5% of the entire CDF zone remains in mature or old forest condition in British Columbia. This community has a very restricted range and, historically, occurred infrequently and mostly in small patches in the natural landscape. Intact remnants of this community are all small fragments, including those in protected areas. Most of what little remains outside of protected areas occurs on private land. Few, if any, high quality occurrences are left.

Threats

The CDFmm is a very small biogeoclimatic subzone with a high density of humans and long history of disturbance by humans, including extensive clearing and settlement. This plant community is naturally small and local in extent, but the localities are highly prized for upscale residences on favourable, scenic aspects, as well as small-scale logging and has been depleted to near-extirpation in British Columbia. Originally fragmentary and insular, it is even more so now.

Other threats include small but intensive agriculture, fire suppression, invasive species, recreation (especially mountain bikes, dirt bikes, all-terrain vehicles), grazing and browsing by domestic livestock (sheep and goats in particular), and deer (native and introduced, as on Sidney Island), and probably climate change.

Legal Protection and Habitat Conservation

There is no legal protection for plant communities except for those occurring within protected areas and parks.

Approximately 3% (6700 ha) of the entire CDFmm is in protected areas but little of this is mature or old forest. There are several known occurrences within protected areas or parks (e.g., John Dean Provincial Park in North Saanich and Thetis Lake Regional Park in Victoria); however, many occur in active recreational areas and/or are fragmented by trails and subject to soil degradation and invasive species.

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

It is recommended to:

- ❖ 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
- ❖ maximize connectivity between occurrences and within occurrences fragmented by development.

Wildlife habitat areas

Goals

Maintain or recover known occurrences.

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. All remaining occurrences >3 ha in any structural stage and in a relatively natural state should be designated as WHAs. As a lower priority, WHAs could be established within younger forests belonging to the same plant community. When choosing candidate areas for recovery, choose (in order of priority):

- the oldest, most structurally complex secondary forests available, ideally stands containing a component of veteran Douglas-fir and Garry oak;
- communities that are relatively lightly damaged —especially due to grazing/browsing—and can be expected to recover to a more natural state;
- communities that could become part of a network of reserve areas; and
- communities that are 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. Remaining occurrences are typically <20 ha.

Design

A WHA should include the entire occurrence of the community and ±60 m (approximately two tree heights) surrounding the occurrence. Boundaries should be designed to minimize edge effects and to the extent possible, be delineated along windfirm boundaries. This community tends to be adapted to strong winds.

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) (Roemer 1972; Meidinger and Pojar 1991; Green and Klinka 1994; Erickson 1996).
2. Maintain an open forest canopy or a range form very open to closed, but maintain a sparse shrub cover.
3. Prevent physical disturbance, especially of the soil.
4. Maintain or enhance old forest structure (at least some large old trees, range of tree sizes, large snags, down logs, canopy depth and roughness, multiple vegetation strata, horizontal patchiness of understorey) (Spies 1998).
5. Maintain regeneration and recruitment of Garry oak.
6. Minimize introduction and spread of invasive species.

Measures

Access

- Do not develop roads or trails.

Harvesting and silviculture

- Do not harvest or salvage.
- Do not conduct any silvicultural practices, other than those prescribed fire or restoration activities that fulfil the management goals and are approved by the statutory decision maker.

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 a WHA, particularly during road development and maintenance and development of recreational trails or facilities.

Restrict recreational use (i.e., dirt bikes, mountain bikes, and other off-road vehicles).

Implement silvicultural and prescribed burning to reduce conifer ingress, fuel accumulations, and shade-tolerant understorey vegetation. Prescribed burning must be planned and implemented carefully and may be difficult to implement.

Information Needs

1. Further inventory and confirmation of classification to clarify the extent of this community.
2. Mapping and assessment of the quality and integrity of remaining occurrences.
3. Assessment of the effectiveness of conservation efforts for this community.

Cross References

Douglas-fir/dull Oregon-grape, Keen's Long-Eared Myotis, Lewis's Woodpecker, "Queen Charlotte" Goshawk

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Douglas-fir/Dull Oregon-grape

Pseudotsuga menziesii/Mahonia nervosa

Original prepared by J. Pojar, S. Flynn, and C. Cadrin

Plant Community Information

Description

Old forests of this community are moderately open to closed stands of Douglas-fir (*Pseudotsuga menziesii*), with some grand fir (*Abies grandis*) and western redcedar (*Thuja plicata*). The last two tree species are more shade tolerant, but Douglas-fir can also regenerate in these stands, especially in small canopy gaps resulting from the death of trees. The moderate to dense shrub layer is dominated by dull Oregon-grape (*Mahonia nervosa*), salal (*Gaultheria shallon*), oceanspray (*Holodiscus discolor*), and trailing blackberry (*Rubus ursinus*). The herb layer is sparse but broad-leaved starflower (*Trientalis borealis* ssp. *latifolia*), sword fern (*Polystichum munitum*), and bracken fern (*Pteridium aquilinum*) are usually present. The well-developed moss layer is dominated by Oregon beaked moss (*Kindbergia oregana*) with electrified cat's-tail moss (*Rhytidiadelphus triquetrus*) and step moss (*Hylocomium splendens*) (Green and Klinka 1994).

This community occurs on middle slopes, on all aspects, at low elevations in the relatively dry and warm Strait of Georgia of coastal British Columbia. Parent materials are mostly morainal, occasionally colluvial or marine. Soils are mostly sandy loams with some gravelly, sandy, and silty loams, and are classified typically as Orthic Dystric Brunisols. Sites have a moderately dry moisture regime (relative within subzone) and a very poor to medium nutrient regime.

Distribution

Global

Originally these forests were widespread in the drier warmer portions of the Pacific coastal formation of western North America, from northwestern United States to southwestern British Columbia.

British Columbia

This community is restricted to low elevations along southeast Vancouver Island from Bowser to Victoria, the Gulf Islands south of Cortes Island, a narrow strip along the Sunshine Coast between Powell River and Lund, and near Halfmoon Bay, and on the Fraser River delta.

Forest region and districts

Coast: Chilliwack, South Island, Sunshine Coast

Ecoprovince and ecosections

GED: FRL, GEL, NAL, SGI, SOG

Biogeoclimatic unit

CDF: mm/01

Broad ecosystem unit

CD

Elevation

0–200 m

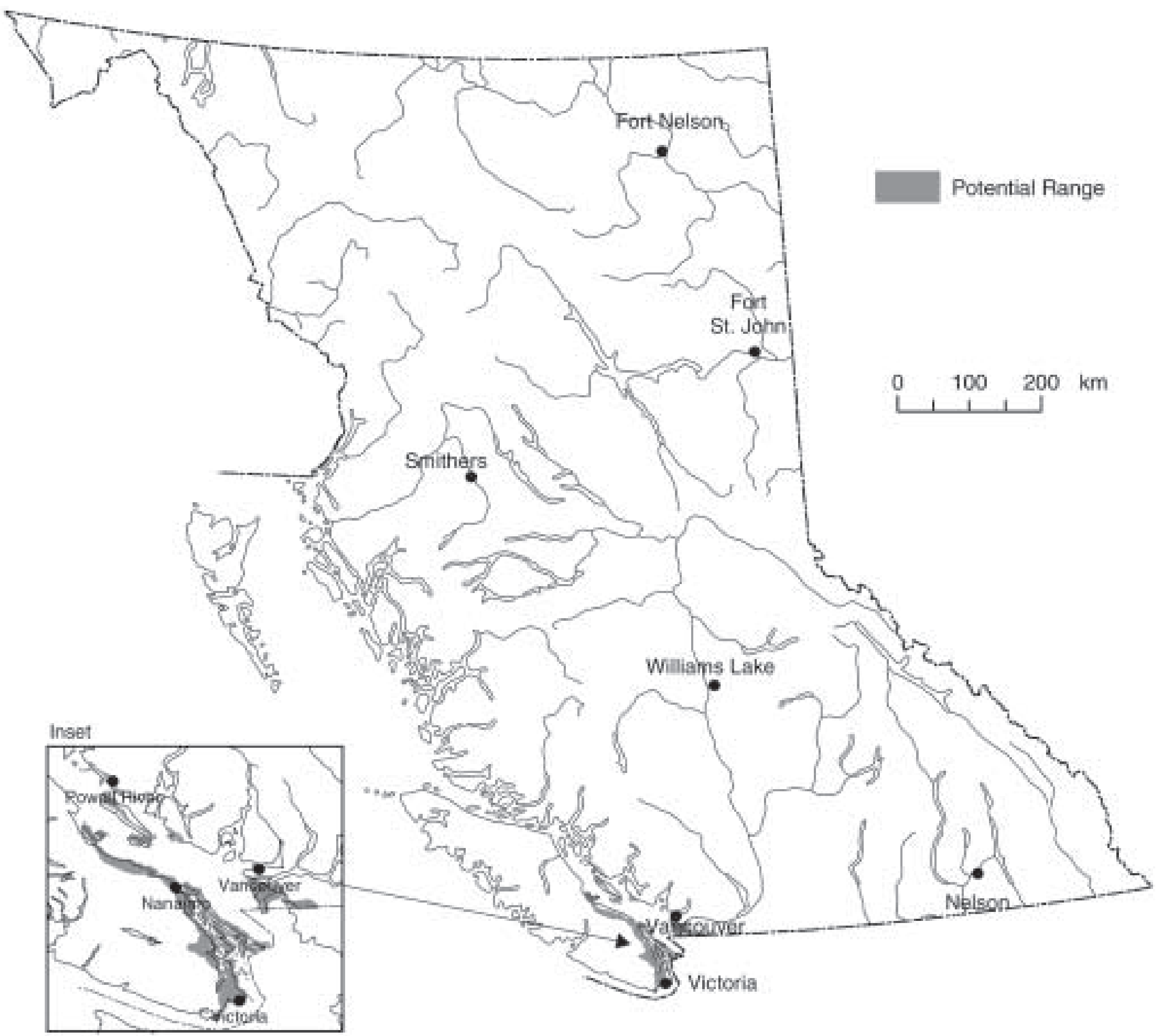
Plant Community Characteristics

Structural stage

5: more structurally complex stands, usually >80 years
6: mature forest
7: old forest

Douglas-fir / Dull Oregon-grape

(Pseudotsuga menziesii / Mahonia nervosa)



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

Infrequent stand-initiating events (NDT2) (MOF and MELP 1995), primarily medium to high intensity but relatively small crown fires (perhaps every 150–200 years and 5–50 ha, on average) and occasionally windthrow. Individual or small groups of trees suffer direct mortality due to root rots, bark beetles, or indirect mortality via predisposition of attacked trees to blowdown. Locally, surface fires, due to aboriginal and post-contact burning as well as natural causes, were more frequent (perhaps every [20–] 50–100 years; see Brown and Hebda 1999) but were smaller and usually not stand replacing. These small surface fires likely contributed to the maintenance of a moderately open forest canopy and contributed to Douglas-fir regeneration. Gap dynamics prevail in old forests.

Fragility

Moderately fragile. At some sites, soils may be rather shallow around rock ridges and outcrops, so can be susceptible to degradation due to soil erosion and nutrient losses. These ecosystems may recover relatively quickly after stand-destroying disturbances, provided biological legacies such as standing dead trees, large old live trees, and large downed logs persist on site and there has been no damage or displacement of soil materials. Periodic summer drought could delay forest regeneration and slow recovery after disturbance. These forests are very susceptible to the introduction and spread of invasive species, especially after clearcut logging. Stands adjacent to urban or farm areas are susceptible to invasion by introduced garden species such as English ivy (*Hedera helix*), spurge-laurel (*Daphne laureola*), Scotch broom (*Cytisus scoparius*), and gorse (*Ulex europaeus*).

Conservation and Management

Status

The Douglas-fir/dull Oregon-grape plant community is on the provincial *Red List* in British Columbia. In British Columbia this community is ranked S2. Its global status is unknown; however, two similar plant communities in Washington and Oregon are ranked G3 and G2G3.

Trends

Almost gone. Less than 1% (possibly <0.5%) of the entire CDF zone remains in mature or old forest condition in British Columbia. These forests have been heavily logged virtually everywhere and sizeable areas were cleared for agriculture and human settlement. Approximately 30% of the original forest land in the CDF zone in British Columbia is currently non-forested developed land. The remaining secondary forests in both British Columbia and the U.S. Pacific Northwest have largely been industrialized and are managed on short rotations. Consequently, very little of this kind of coastal old growth is left in the world, and virtually all of it is in fragments.

Old remnants of this community are all small fragments (<40 ha) including those in protected areas. Most of what little remains outside of protected areas occurs on private land, and will continue to be lost to urban development and forest harvesting (as recently on Denman Island). Saltspring Island still has a few significant areas of old forest of this community on private and Crown lands (T.L. Fleming, pers. comm.).

Threats

Threats include urban and semi-rural development, small-scale but intensive agriculture, forest harvesting, livestock (sheep and goats) grazing, ungulate browsing (on Sidney Island), the introduction and spread of invasive species (e.g., daphne laurel, Scotch broom in early seral stages), and probably climate change.

Legal Protection and Habitat Conservation

There is no legal protection for plant communities except for those within protected areas and parks.

About 3% (~6700 ha) of the entire CDFmm subzone occurs in protected areas, of which little is mature or old forest. There are 27 small, mature, or old occurrences of this plant community in or partly within protected areas including John Dean, Goldstream, Gowlland Tod, South Otter Bay, Prevost Island, Tumbo Island, Ruckle, South Texada, Jedediah, and Sargeant Bay provincial parks, and Woodley Range, Mount Tuam, Mount Maxwell, Saturna, and Lasqueti ecological reserves. Thetis Lake, Mill Hill, and Francis-King regional parks on Saanich Peninsula, and Mill Farm Regional Park on Saltspring Island all support occurrences in older forest stages (T.L. Fleming, pers. comm.) as do Rocky Point/William Head and parts of Mary Hill (Dep. National Defense lands), and parts of Royal Roads (A. Ceska, pers. comm.).

Even within protected areas, much of the forest is secondary forest (i.e., logged from the mid-1800s on). Ecological integrity of all occurrences has been compromised by the unnatural ecosystem dynamics resulting from decades of fire prevention and suppression, from attrition of native species, from the introduction and spread of invasive species, and in many cases from grazing and browsing by domestic stock (sheep and goats in particular). These changes are exacerbated by the insular nature of the remnant older forests.

The *Forest Practices Code* guidelines for riparian management areas would not apply to this community. In addition, it is uncertain whether old growth management areas (OGMAs) will protect known occurrences because little old forest remains (<1%) within the CDF zone and current policy requires OGMAs to be selected from the non-timber harvesting land base wherever possible.

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

This plant community was originally the matrix community type for the CDFmm. It was the most common and widespread community type of the subzone and may have covered as much as 135 000 ha. Today most of the remaining occurrences within the CDF are younger secondary forests. It is recommended to:

- ❖ 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;
- ❖ maximize connectivity of old forest within the CDFmm; and
- ❖ wherever possible, protect remaining occurrences through the placement of old growth management areas.

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 or mature (structural stage 6 or 7) occurrences of this community that are in a relatively natural state and included within a larger area of younger forest. As a lower priority, establish WHAs within regenerating younger forests belonging to the same plant community, to recover community to climax condition. Select areas that are (in order of priority):

- the oldest, most structurally complex secondary forests available, ideally stands containing some old residual conifers;

- relatively lightly damaged and can be expected to recover to a more natural state;
- adjacent to occurrences of other natural plant communities;
- part of a network of reserve areas; and
- in areas where the forest community has been severely depleted.

Size

The size of the WHA should be based on the extent of the plant community occurrence including areas of younger stands where adjacent which will maximize the long-term viability of the plant community at a site. WHAs will be ~50 ha when in relatively pure composition, or where recovery is the main objective. However, WHAs may be larger (~200 ha) when the understorey community or tree layer has a patchy distribution or when the community occurs in complexes with other at-risk plant communities.

Design

The WHA should include the entire occurrence of the community plus a minimum of 80 m within adjacent natural area, or more at some sections if a barrier (e.g., road, agricultural area, developed area) is encountered at other sections of the boundaries. Boundaries should be designed to minimize edge effects and to the extent possible, be windfirm.

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 Roemer 1972; Meidinger and Pojar 1991; Green and Klinka 1994).
2. Maintain or enhance old forest structure (i.e., some 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 the ecological functions and processes of the plant community.
4. Maintain interior forest conditions and minimize edge effects.
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 windfirm boundaries.
- 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 a WHA, particularly during adjacent road development and maintenance.

Prevent or eliminate livestock grazing.

Restrict recreational use (i.e., dirt bikes, mountain bikes, and other off-road vehicles).

Reduce fuel accumulations and shade-tolerant understorey vegetation through controlled prescribed fire (where practical), manual or mechanical removal, which may or may not be combined with piling and burning.

Information Needs

1. Further inventory and confirmation of classification to clarify the extent of this community.
2. Mapping and assessment of the quality of remaining occurrences.
3. Identification of candidate forests for recruitment.

Cross References

Lewis's Woodpecker, "Interior" Western Screech-Owl, Keen's Long-eared Myotis, Red-Legged Frog

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Western Hemlock–Douglas-fir/Electrified Cat's-tail Moss

Tsuga heterophylla–Pseudotsuga menziesii/Rhytidiadelphus triquetrus

Original prepared by J. Pojar, S. Flynn, and C. Cadrin

Plant Community Information

Description

This forest community has a canopy composed primarily of western hemlock (*Tsuga heterophylla*) and Douglas-fir (*Pseudotsuga menziesii*), with a lesser component of western redcedar (*Thuja plicata*). The shrub layer is rather sparse and not vigorous, with low cover of falsebox (*Paxistima myrsinites*), red huckleberry (*Vaccinium parvifolium*), black huckleberry (*Vaccinium membranaceum*), baldhip rose (*Rosa gymnocarpa*), and sometimes dull Oregon-grape (*Mahonia nervosa*). Twinflower (*Linnaea borealis*), queen's cup (*Clintonia uniflora*), and prince's pine (*Chimaphila umbellata*) dominate the moderately diverse herb layer. Other common herbs include rattlesnake-plantain (*Goodyera oblongifolia*), pink wintergreen (*Pyrola asarifolia*), one-sided wintergreen (*Orthilia secunda*), sword fern (*Polystichum munitum*), and bracken fern (*Pteridium aquilinum*). The moss layer is dominated by step moss (*Hylocomium splendens*), pipecleaner moss (*Rhytidiopsis robusta*), electrified cat's-tail moss (*Rhytidiadelphus triquetrus*), and red-stemmed feathermoss (*Pleurozium schreberi*). See Green and Klinka (1994).

Zonal sites in the CWHds1. These forests occur mostly on middle slopes and higher terraces, on a variety of surficial deposits and on moderately well-drained soils with a range of textures, but tending to coarse-loamy rather than fine-loamy. Sites have medium to poor nutrient regime and fresh to somewhat dry soil moisture (relative within subzone).

Distribution

Global

Unknown.

British Columbia

In British Columbia, this community occurs in the drainages of the lower Fraser River east and north of Chilliwack, and in the eastern portion of the Coast/Cascade Mountains from upper Harrison Lake to the Homathko River. It also occurs in submaritime and subcontinental areas north of the head of Knight Inlet, especially in the lower Klinaklini, Bella Coola, Talchako, and Dean valleys.

Forest regions and districts

Coast: Chilliwack, North Island, Squamish, Sunshine Coast

Southern Interior: Cascades, Chilcotin

Ecoprovinces and ecosections

CEI: WCR

COM: CPR, EPR, NPR, SPR

SOI: LPR

Biogeoclimatic unit

CWH: ds1/01, ds2/01

Broad ecosystem unit

CW

Elevation

Near sea level to 650 m

Plant Community Characteristics

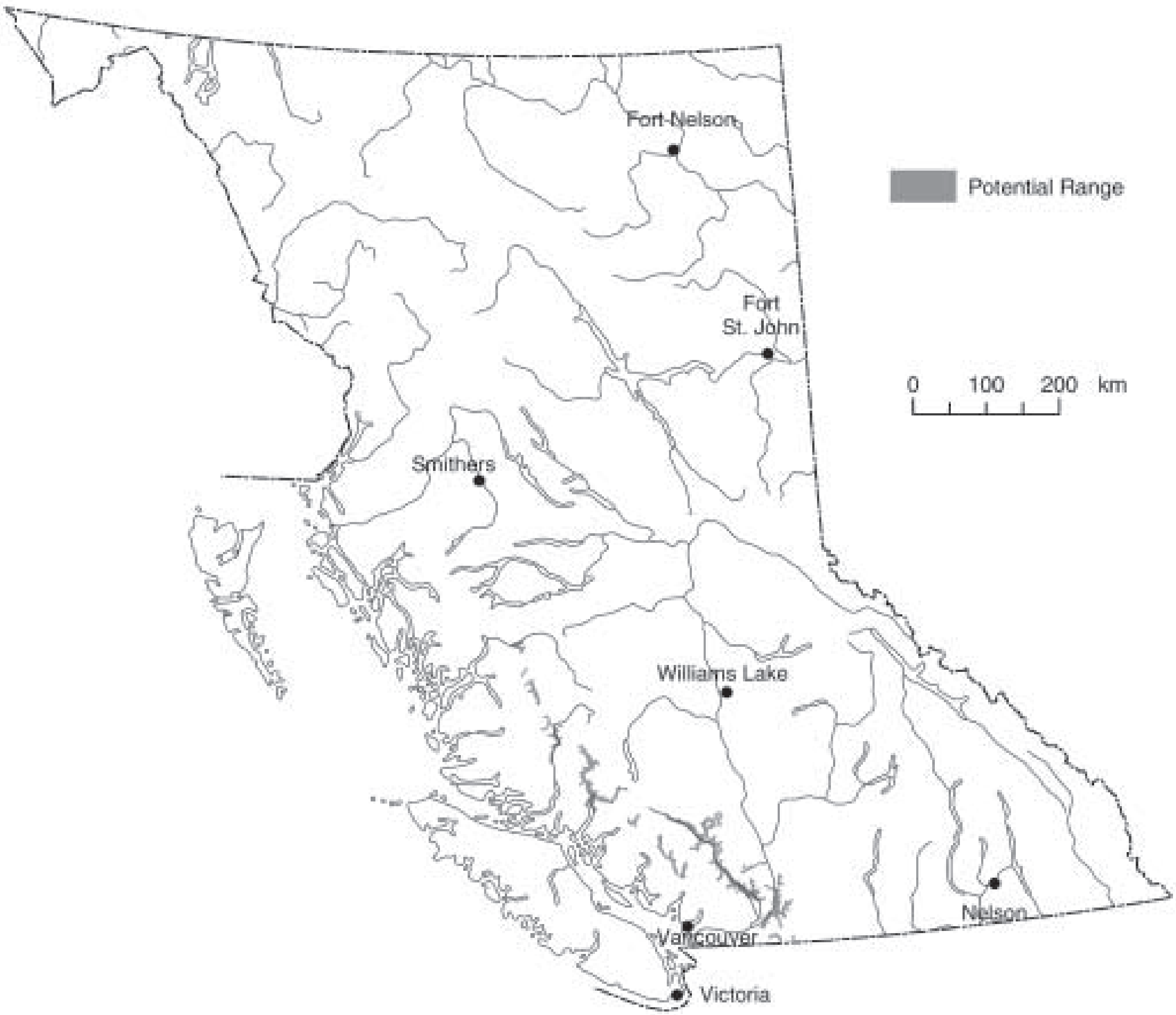
Structural stage

6: mature forest

7: old forest

Western Hemlock - Douglas-fir / Electrified Cat's-tail Moss

(Tsuga heterophylla - Pseudotsuga menziesii / Rhytidiadelphus triquetrus)



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

Infrequent stand-initiating events (NDT2) (MOF and MELP 1995), primarily wildfire (perhaps every 200–300 years, on average) and windthrow, sometimes snow avalanches and landslides. Occasional direct mortality of individual or small groups of trees due to defoliating insects and root rots, or indirect mortality via predisposition of attacked trees to blowdown (see Pojar et al. 1999). Gap dynamics prevail in old forests.

Fragility

Low to moderate. Soils typically are deep, somewhat coarse-textured with a medium to poor nutrient regime. This plant community sometimes occurs on unstable landforms, and could be susceptible to mass movements, especially those triggered by forestry activity such as road building. It should also recover relatively quickly after stand-destroying disturbances, provided biological legacies such as snags and large downed logs persist on site. However, the transitional (i.e., between coast and interior) nature of the climate is reflected in periodic climatic extremes (summer drought, cold air ponding, outflow winter winds, heavy snows). The climatic factors can delay forest regeneration and could slow recovery after disturbance.

Conservation and Management

Status

The western hemlock–Douglas-fir/electrified cat's-tail moss plant community is on the provincial *Red List* in British Columbia. It is ranked S2 in British Columbia. Its global status is unknown.

Trends

Exact calculations of the areal extent of this once predominant forest system are difficult to project. By definition, the zonal forest type of each biogeo-climatic subzone is the expression of the dominant landscape and climatic conditions and frequently represents the largest area, proportionally, of all ecosystems within the subzone. However, this plant community has been heavily logged over much of its range, and continues to be logged. Urban and agricultural developments have also impacted this plant community. Timber harvesting of remaining patches of old and mature forest will continue, as will localized urban development. Large old or mature, high quality occurrences are now rare.

Threats

Primarily threatened by forest harvesting and the resulting loss and fragmentation of sizeable, old, high quality occurrences. Agricultural, rural, and urban development (Fraser Valley, Pemberton Valley, Bella Coola Valley) have also reduced the occurrence of this plant community.

The greatly diminished connectivity of old forest in the CWHds is a serious issue in the valleys, especially at the lower elevations typically occupied by this subzone. Most of the remaining patches of old growth outside of parks are fragments in a matrix of younger second growth.

Legal Protection and Habitat Conservation

There is no legal protection for plant communities except for those within protected areas and parks.

Known sites occur within several provincial parks including Tweedsmuir (especially along middle Dean River and on east side of Talchako River), Homathko, Mehatl, Chilliwack Lake, Skagit Valley, Garibaldi, and Birkenhead Lake.

Riparian management area guidelines are unlikely to be relevant for most occurrences of this plant community. Old growth management areas could address, at least in part, some occurrences provided old forest objectives cannot be met in the non-timber harvesting land base.

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

This matrix forest community used to be widespread, forming the predominant forest matrix throughout much of its range. It is recommended to:

❖ maximize connectivity of old forest within the CWHds1;

❖ maintain or recover at least 20 large 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

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 of this community and include within a matrix of younger stands if necessary to attain a 40 ha minimum size that and mature (structural stage 6) occurrences >100 ha that are in a relatively natural state. As a lower priority, establish WHAs up to 100 ha within regenerating younger forests containing the same plant community, to recover community to climax condition. Select areas that are (in order of priority):

- the oldest, most structurally complex secondary forests available, ideally stands containing some old residual conifers;
- relatively lightly damaged and can be expected to recover to a more natural state;
- part of a network of reserve areas (e.g., adjacent or linked to other WHAs or to OGMAs or to riparian reserves);
- in areas where the forest community has been severely depleted; 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 a minimum of 40 ha.

Design

The WHA should include the entire occurrence of the community plus ±100 m (approximately two tree heights) surrounding the community. Boundaries should be designed to minimize edge effects and be windfirm.

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 Green and Klinka 1994).
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 forest-interior conditions.
4. Prevent physical disturbance, especially of the soil.
5. Minimize introduction and spread of non-native 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 a WHA, particularly during road development and maintenance.

Information Needs

1. Further inventory and confirmation of classification to clarify the extent of this community.
2. Mapping of present-day occurrences and assessment of structural stage and successional dynamics of the occurrences.
3. Identification of the most optimal networks to link this and other listed communities in the CWHds1.

Cross References

Spotted Owl

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.

Green, R.N. and K. Klinka. 1994. A field guide to site identification and interpretation for the Vancouver Forest Region. B.C. Min. For., Victoria, B.C. Land Manage. Handb. No. 28.

Pojar, J., C. Rowan, A. MacKinnon, D. Coates, and P. LePage. 1999. Silvicultural options in the Central Coast. Land Use Coordination Office, Victoria, B.C. Unpubl. report.

Spies, T.A. 1998. Forest structure: a key to the ecosystem. Northwest Sci. 72:34–39.

Western Redcedar–Douglas-fir/Devil's-club

Thuja plicata–Pseudotsuga menziesii/Oplopanax horridus

Original prepared by J. Pojar, S. Flynn, and C. Cadrin

Plant Community Information

Description

This forest community is dominated by western redcedar (*Thuja plicata*) and western hemlock (*Tsuga heterophylla*), often accompanied by Douglas-fir (*Pseudotsuga menziesii*) and (in the central coast) Sitka spruce (*Picea sitchensis*). Devil's-club (*Oplopanax horridus*) characterizes the rather sparse shrub layer. The herb layer is dominated by queen's cup (*Clintonia uniflora*), lady fern (*Athyrium filix-femina*), spiny wood fern (*Dryopteris expansa*), rosy twistedstalk (*Streptopus roseus*), and oak fern (*Gymnocarpium dryopteris latifolia*). Step moss (*Hylocomium splendens*), electrified cat's-tail moss (*Rhytidiadelphus triquetrus*), coastal leafy moss (*Plagiomnium insigne*), and lanky moss (*Rhytidiadelphus loreus*) are common mosses. See Green and Klinka (1994).

These forests occur at low elevations; on lower or level slope positions; and on fluvial, colluvial, and sometimes morainal deposits. Soils are moderately well drained but often exhibit seepage, and are loamy or sandy, frequently with many coarse fragments. Sites are moist to very moist (relative within subzone), and nutrient conditions are rich to very rich.

Distribution

Global

Unknown.

British Columbia

In British Columbia, this community occurs in the drainages of the lower Fraser River east and north of Chilliwack and in the eastern portion of the Coast/Cascade Mountains from upper Harrison Lake to the Homathko River. It also occurs in submaritime and subcontinental areas north of the head of Knight Inlet, especially in the lower Klinaklini, Bella Coola, Talchako, and Dean valleys.

Forest regions and districts

Coast: Chilliwack, North Island, Squamish, Sunshine Coast

Southern Interior: Cascades, Chilcotin

Ecoprovinces and ecosections

CEI: WCR

COM: CPR, EPR, NPR, SPR

SOI: LPR

Biogeoclimatic unit

CWH: ds1/07

Broad ecosystem unit

CW

Elevation

Near sea level to 650 m

Plant Community Characteristics

Structural stage

6: mature forest

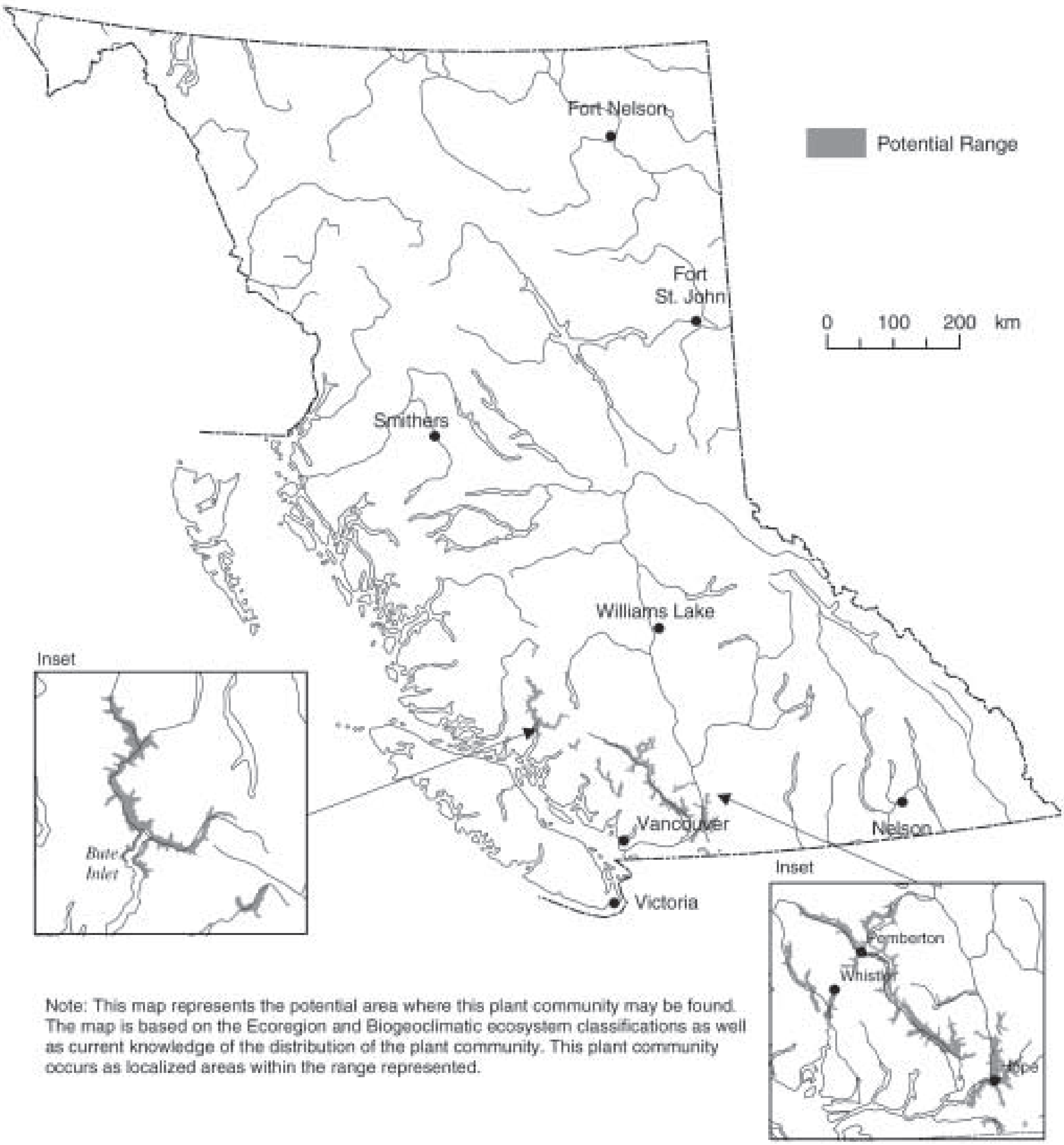
7: old forest

Natural disturbance regime

Infrequent stand-initiating events (NDT2) (MOF and MELP 1995), primarily wildfire (perhaps every 200–300 years, on average) and windthrow, sometimes snow avalanches and landslides. Occasional

Western Redcedar - Douglas-fir / Devil's-club

(Thuja Plicata - Pseudotsuga menziesii / Oplopanax horridus)



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.

direct mortality of individual or small groups of trees due to defoliating insects and root rots, or indirect mortality via predisposition of attacked trees to blowdown (see Pojar et al. 1999). Gap dynamics prevail in old forests.

Fragility

Low to moderate. Soils typically are deep, somewhat coarse-textured, moist and nutrient-rich. Therefore, these sites are less susceptible to degradation due to soil compaction, erosion, and nutrient losses and should recover relatively quickly after stand-destroying disturbances provided biological legacies such as snags and large downed logs persist on site. However, the transitional (i.e., between coast and interior) nature of the climate is reflected in periodic climatic extremes (summer drought, cold air ponding, outflow winter winds, heavy snows). The climatic factors can delay forest regeneration and could slow recovery after disturbance.

Conservation and Management

Status

The western redcedar–Douglas-fir/devil's-club plant community is on the provincial *Red List* in British Columbia. It is ranked S1S2 in British Columbia. Its global status is unknown.

Trends

The CWHds is a medium-sized subzone with a long history (by B.C. standards) of disturbance by humans. Many forest sites are productive and used to have an abundance of old growth Douglas-fir; thus, timber harvesting has been extensive. This community used to be rather widespread as small patches distributed across a localized area. It has been heavily logged over much of its range, and continues to be logged. Urban and agricultural developments have also impacted this plant community. Timber harvesting of remaining patches of old forest on these productive sites will continue, as will localized developments for other land uses.

Threats

Naturally small and patchy occurrences continue to be threatened by forest management and the resulting loss of high quality mature and old forests and also because of the history of disturbance of these forests and the areas surrounding them. Agriculture, rural, and urban development (Fraser Valley, Pemberton Valley, Bella Coola Valley) have also impacted this plant community.

The greatly diminished connectivity of old forest in the CWHds is a serious issue, especially at the lower elevations typically occupied by this subzone. Most of the remaining patches of old forest outside of parks are patches in a matrix of second growth.

Legal Protection and Habitat Conservation

There is no legal protection for plant communities except for those within protected areas and parks.

Known sites occur within the following provincial parks: Tweedsmuir (especially along middle Dean River and on east side of Talchako River), Homathko, Mehatl, Chilliwack Lake, Skagit Valley, Garibaldi, and possibly Birkenhead Lake.

The *Forest and Range Practices Act* riparian guidelines would most likely not apply to this plant community. Old growth management areas (OGMAs) could address, at least in part, some occurrences provided old forest objectives could not be met in the non-timber harvesting land base.

Identified Wildlife Provisions

Sustainable resources management and planning recommendations

- 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.
- Maximize connectivity of old forest within the CWHds1.
- Wherever possible, protect remaining occurrences through the placement of OGMAs.

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 (structural stage 7) occurrences of this community within a younger stand if necessary to attain a minimum size of 10 ha and mature (structural stage 6) occurrences between 5 and 50 ha that are in a relatively natural state. As a lower priority, establish WHAs within regenerating younger forests belonging to the same plant community, to recover community to climax condition. Select areas that are (in order of priority):

- the oldest, most structurally complex secondary forests available, ideally stands containing some old residual conifers;
- relatively lightly damaged and can be expected to recover to a more natural state;
- part of a network of reserve areas;
- in areas where the forest community has been severely depleted; 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. Boundaries should be designed to minimize edge effects and to the extent possible, be windfirm.

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 Green and Klinka 1994).
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 a diversity of natural disturbance regimes.
4. Allow for the processes of litter accumulation, renewal, and microbiotic crust development.
5. Maintain forest-interior conditions.
6. Prevent physical disturbance, especially of the soil.
7. 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 a WHA, particularly during road development and maintenance.

Eventually it will be necessary to intervene in the WHA when large veteran Douglas-fir and Sitka spruce die and are not naturally replaced (both species are shade-intolerant on such sites). The intervention could take the form of fill-planting in a natural gap sufficiently large that full light conditions would occur in part of the opening, or suitable openings could be created through small-group selection logging.

Information Needs

1. Further inventory and confirmation of classification to clarify the extent of this community.
2. Mapping of present-day occurrences and assessment of structural stage and successional dynamics of the occurrences.
3. Identification of the most optimal networks to link this and other listed communities in the CWHds.

Cross References

Grizzly Bear, Spotted Owl

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.

Green, R.N. and K. Klinka. 1994. A field guide to site identification and interpretation for the Vancouver Forest Region. B.C. Min. For., Victoria, B.C. Land Manage. Handb. No. 28.

Pojar, J., C. Rowan, A. MacKinnon, D. Coates, and P. LePage. 1999. Silvicultural options in the Central Coast. Land Use Coordination Office, Victoria, B.C. Unpubl. report.

Spies, T.A. 1998. Forest structure: a key to the ecosystem. Northwest Sci. 72:34–39.

Western Redcedar–Douglas-fir/Vine Maple

Thuja plicata–Pseudotsuga menziesii/Acer circinatum

Original prepared by J. Pojar

Plant Community Information

Description

This forest community has a canopy of western redcedar (*Thuja plicata*) and Douglas-fir (*Pseudotsuga menziesii*). Western hemlock (*Tsuga heterophylla*) is usually present, but with low cover and as a subcanopy or suppressed tree, and Pacific yew (*Taxus brevifolia*) can be present, also with low cover. Black cottonwood (*Populus balsamifera* ssp. *trichocarpa*), red alder (*Alnus rubra*), and, in the south, bigleaf maple (*Acer macrophyllum*) can persist in mature seral stands. The shrub layer is usually sparse except for regeneration of redcedar and western hemlock, but vine maple (*Acer circinatum*) is locally frequent and often abundant in the south. The herb layer is diverse and characterized by false Solomon's-seal (*Maianthemum racemosum*), clasping twistedstalk (*Streptopus amplexifolius*), queen's cup (*Clintonia uniflora*), wild ginger (*Asarum caudatum*), and one-leaved foamflower (*Tiarella trifoliata* var. *unifoliata*); rattlesnake-plantain (*Goodyera oblongifolia*) and broadleaved starflower (*Trientalis borealis* ssp. *latifolia*) are common. Sword fern (*Polystichum munitum*) and spiny wood fern (*Dryopteris expansa*) are often abundant. The moss layer is dominated by step moss (*Hylocomium splendens*), coastal leafy moss (*Plagiomnium insigne*), Oregon beaked moss (*Kindbergia oregana*), and electrified cat's-tail moss (*Rhytidiadelphus triquetrus*), frequently also with pipecleaner moss (*Rhytidiopsis robusta*). See Green and Klinka (1994).

These forests occur at low elevations, on lower or level slope positions, on colluvial fans and aprons, on fluvial/colluvial fans and upper fluvial terraces, and sometimes on morainal deposits. Soils are moderately well drained but sometimes exhibit seepage or fluctuating water tables, and are sandy or loamy, frequently with lots of coarse fragments. Sites are slightly dry to fresh (relative within subzone), and nutrient conditions are rich to very rich.

Distribution

Global

Unknown.

British Columbia

Western redcedar–Douglas-fir/vine maple occurs in the drainages of the lower Fraser River east and north of Chilliwack, and in the eastern portion of the Coast/Cascade Mountains from upper Harrison Lake to the Homathko River.

Forest regions and districts

Coast: Chilliwack, North Island, Squamish, Sunshine Coast

Southern Interior: Cascades, Chilcotin

Ecoprovinces and ecosections

CEI: CCR, WCR

COM: EPR, KIM, NPR, SPR

SOI: LPR

Biogeoclimatic units

CWH: ds1/05

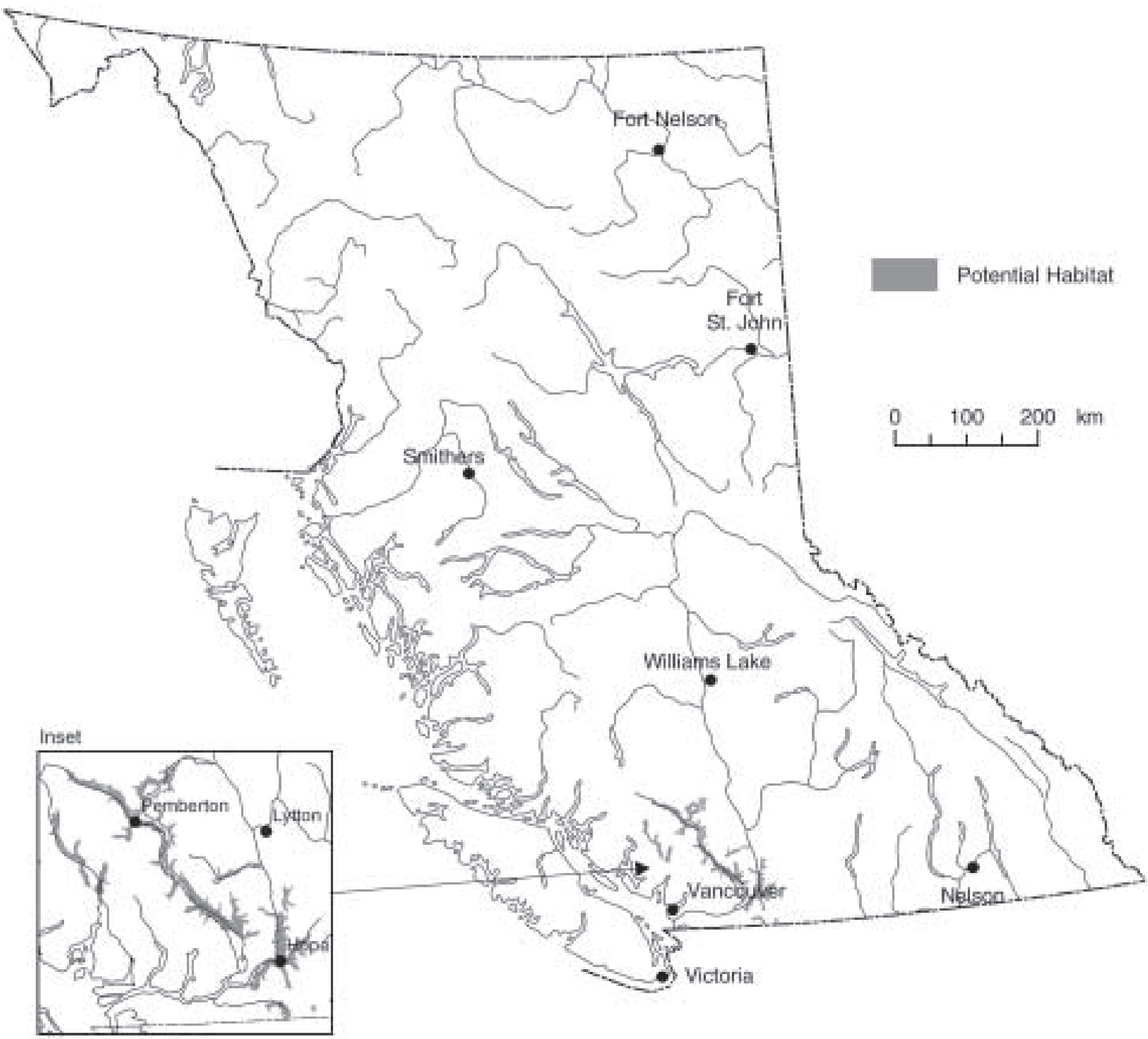
Broad ecosystem unit

CW

Elevation

Near sea level to 650 m

Western Redcedar - Douglas-fir / Vine Maple
(Thuja plicata - Pseudotsuga menziesii / Acer circinatum)



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
7: old forest

Natural disturbance regime

Infrequent stand-initiating events (NDT2) (MOF and MELP 1995), primarily wildfire (perhaps every 200–300 years, on average) and windthrow, sometimes snow avalanches and landslides. Occasional direct mortality of individual or small groups of trees due to defoliating insects and root rots, or indirect mortality via predisposition of attacked trees to blowdown (see Pojar et al. 1999). Gap dynamics prevail in old forests.

Fragility

Relatively robust. Soils typically are deep, somewhat coarse-textured, and nutrient-rich. Hence these sites are less susceptible to degradation due to soil compaction, erosion, and nutrient losses. They do sometimes occur on unstable landforms, however, and could be susceptible to mass movements, especially those triggered by forestry activity such as road building. They should also recover relatively quickly after stand-destroying disturbances, provided biological legacies such as snags and large downed logs persist on site. However, the transitional (i.e., between coast and interior) nature of the climate is reflected in periodic climatic extremes (summer drought, cold air ponding, outflow winter winds, heavy snows). The climatic factors can delay forest regeneration and could slow recovery after disturbance.

Conservation and Management

Status

The western redcedar–Douglas-fir/vine maple plant community is on the provincial *Red List* in British Columbia. It is ranked S1S2 in British Columbia. Its global rank is unknown.

Trends

The CWHds is a moderately sized subzone with a long history (by B.C. standards) of disturbance by humans. Many forest sites are productive with much old-growth Douglas-fir; thus, timber harvesting has been extensive. This plant community was rather widely distributed as small to moderately large patches over a localized area, but has been heavily logged over much of its range, and continues to be logged. It has also been reduced by urban and agricultural developments. Timber harvesting of remaining patches of old growth on these productive sites will continue, as will localized urbanization.

Threats

This plant community is primarily threatened by forest harvesting and consequent rarity of sizeable, old, high quality occurrences. Such high quality occurrences are rare both because they are naturally small, patchy, and heterogeneous, and because of the history of disturbance of these forests and the areas surrounding them. This community is also threatened from agricultural, rural, urban development (Fraser, Pemberton, and Bella Coola valleys) and probably climate change.

The greatly diminished connectivity of old forest in the CWHds is a serious issue, especially at the lower elevations typically occupied by this subzone. Most of the remaining patches of old growth outside of parks are fragments in a matrix of second growth.

Legal Protection and Habitat Conservation

There is no legal protection for plant communities except for those occurring within protected areas and parks.

Several occurrences potentially occur within parks and protected areas including Tweedsmuir (especially along middle Dean River and on the east side of Talchako River), Homathko, Mehatl, Chilliwack Lake, Skagit Valley, Garibaldi, and Birkenhead Lake parks.

The *Forest and Range Practices Act* guidelines for riparian management may not apply to some occurrences of this plant community. Old growth management areas (OGMAs) could address, at least in part, some occurrences provided old forest retention objectives cannot be met in the non-contributing land base. At this time it is not known to what extent OGMAs can address the occurrences of this plant community.

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

Western redcedar–Douglas-fir/vine maple historically was widely distributed across the lower slopes of both large and small valleys within its range. It occurs as small to large patches, occasionally as linear systems along small creeks and streams. It is recommended to:

- ❖ 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;
- ❖ maximize connectivity of old forest within both the CWHds1 and the CWHds2; and
- ❖ wherever possible, protect remaining occurrences through the placement of old growth management areas.

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 >10 ha and mature (structural stage 6) occurrences >50 ha and in a relatively natural state. Old patches should be buffered by younger stands in as natural a condition as possible. As a lower priority, establish WHAs within regenerating younger forests containing the same plant community, to recover community to climax condition. Select areas that are (in order of priority):

- the oldest, most structurally complex secondary forests available, ideally stands containing some old residual conifers;
- relatively lightly damaged and can be expected to recover to a more natural state;
- part of a network of reserve areas;
- in areas where the forest community has been severely depleted; 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 30 and 200 ha.

Design

The WHA should include the entire occurrence of the community and ~100 m (approximately two tree heights) surrounding the perimeter of the 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 and ecological processes as natural examples of the plant community; see Green and Klinka 1994).
2. Maintain or enhance old forest structure (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 interior forest-interior conditions.
4. Prevent physical disturbance, especially of the soil.

5. 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 boundary.

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 a WHA, particularly during road development and maintenance.

Consider using prescribed fire in larger occurrences that are part of a very large protected area (e.g., Tweedsmuir) to promote natural characteristics.

Consider restoration techniques such as accelerating development of old forest structure or to replace (recruit) shade-intolerant species (e.g., when large veteran Douglas-fir or cottonwood die and are not naturally replaced). Consider fill-planting in a natural gap sufficiently large that full light conditions would occur in part of the opening, or create suitable openings through small-group selection logging.

Information Needs

1. Further inventory and confirmation of classification to clarify the extent of this community.
2. Mapping of present-day occurrences and assessment of structural stages and successional dynamics of the occurrences.
3. Identification of the most optimal networks to connect this and other listed communities in the CWHds.

Cross References

Grizzly Bear, Spotted Owl, western hemlock–Douglas-fir/electrified cat's-tail moss, western redcedar–Douglas-fir/devil's-club

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.

Green, R.N. and K. Klinka. 1994. A field guide to site identification and interpretation for the Vancouver Forest Region. B.C. Min. For., Victoria, B.C. Land Manage. Handb. No. 28.

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Spies, T.A. 1998. Forest structure: a key to the ecosystem. Northwest Sci. 72:34–39.

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

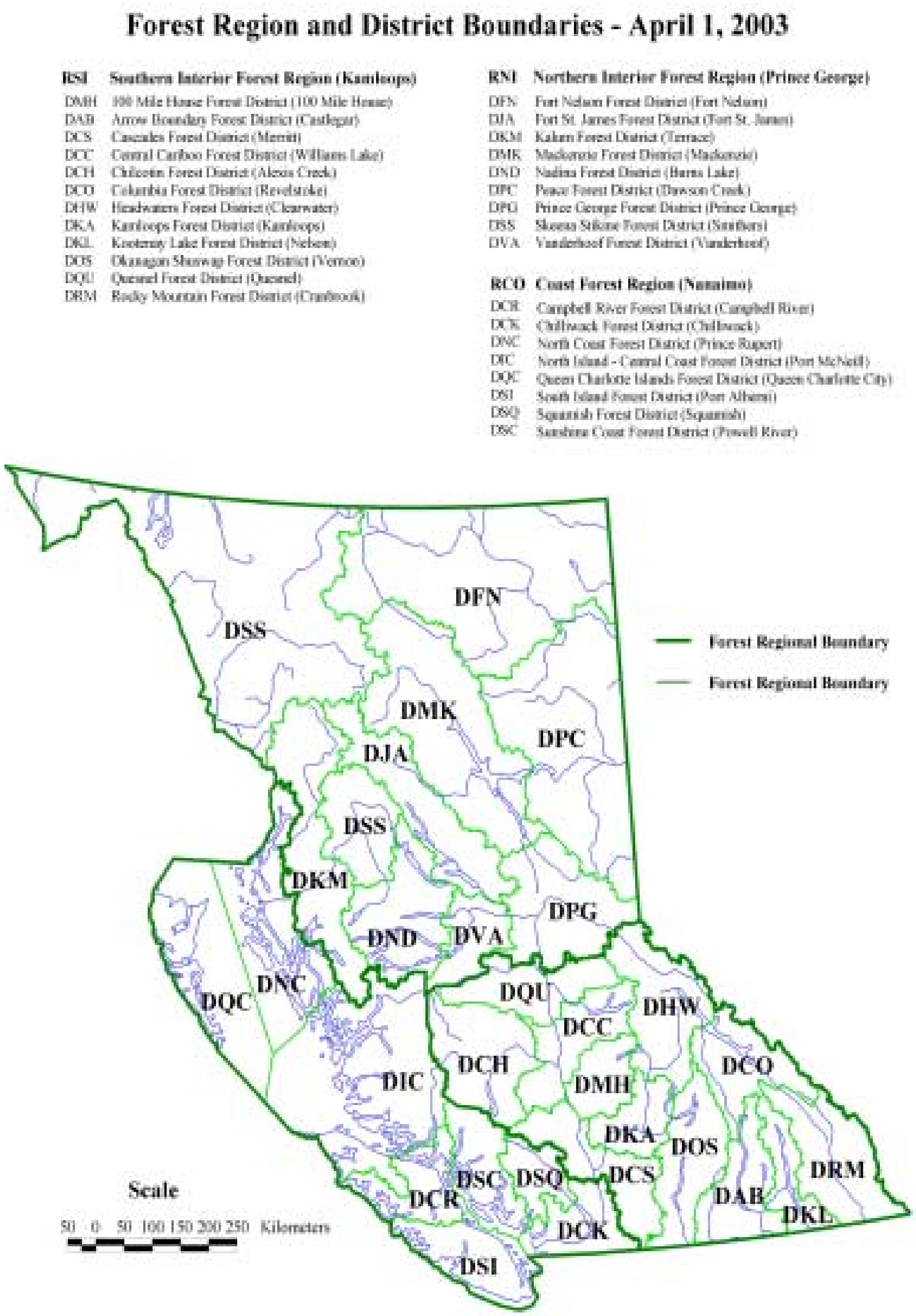
Ministry of Fisheries, Research
Gordon Haas (09/99 – 09/00)

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	Code	Ecoprovince/Ecosections
COM	**Coast and Mountains Ecoprovince**	**SIM**	**Southern Interior Mountains Ecoprovince**
CBR	Central Boundary Ranges	BBT	Big Bend Trench
CPR	Central Pacific Ranges	BOV	Bowron Valley
CRU	Cranberry Upland	CAM	Cariboo Mountains
DIE	Dixon Entrance	CCM	Central Columbia Mountains
EPR	Eastern Pacific Ranges	COC	Crown of the Continent
HEL	Hecate Lowland	CPK	Central Park Ranges
HES	Hecate Strait	EKT	East Kootenay Trench
KIM	Kimsquit Mountains	ELV	Elk Valley
KIR	Kitimat Ranges	EPM	Eastern Purcell Mountains
MEM	Meziadin Mountains	FLV	Flathead Valley
NAB	Nass Basin	FRR	Front Ranges
NAM	Nass Mountains	MCR	McGillivray Ranges
NBR	Northern Boundary Ranges	NKM	Northern Kootenay Mountains
NIM	Northern Island Mountains	NPK	Northern Park Ranges
NPR	Northern Pacific Ranges	QUH	Quesnel Highland
NWC	Northwestern Cascade Ranges	SCM	Southern Columbia Mountains
NWL	Nahwiti Lowland	SFH	Selkirk Foothills
OUF	Outer Fiordland	SHH	Shuswap Highland
QCL	Queen Charlotte Lowland	SPK	Southern Park Ranges
QCS	Queen Charlotte Sound	SPM	Southern Purcell Mountains
QCT	Queen Charlotte Strait	UCV	Upper Columbia Valley
SBR	Southern Boundary Ranges	UFT	Upper Fraser Trench
SKP	Skidegate Plateau	**SOI**	**Southern Interior Ecoprovince**
SPR	Southern Pacific Ranges	GUU	Guichon Upland
VIS	Vancouver Island Shelf	HOR	Hozameen Range
WIM	Windward Island Mountains	LPR	Leeward Pacific Ranges
WQC	Windward Queen Charlotte Mountains	NIB	Nicola Basin
GED	**Georgia Depression Ecoprovince**	NOB	Northern Okanagan Basin
FRL	Fraser Lowland	NOH	Northern Okanagan Highland
GEL	Georgia Lowland	NTU	Northern Thompson Upland
JDF	Juan de Fuca Strait	OKR	Okanagan Range
LIM	Leeward Island Mountains	PAR	Pavilion Ranges
NAL	Nanaimo Lowland	SCR	Southern Chilcotin Ranges
SGI	Southern Gulf Islands	SHB	Shuswap Basin
SOG	Strait of Georgia	SOB	Southern Okanagan Basin
SAL	**Southern Alaska Mountains Ecoprovince**	SOH	Southern Okanagan Highland
ALR	Alsek Ranges	STU	Southern Thompson Upland
ICR	Icefield Ranges	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 ridgecrests 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).

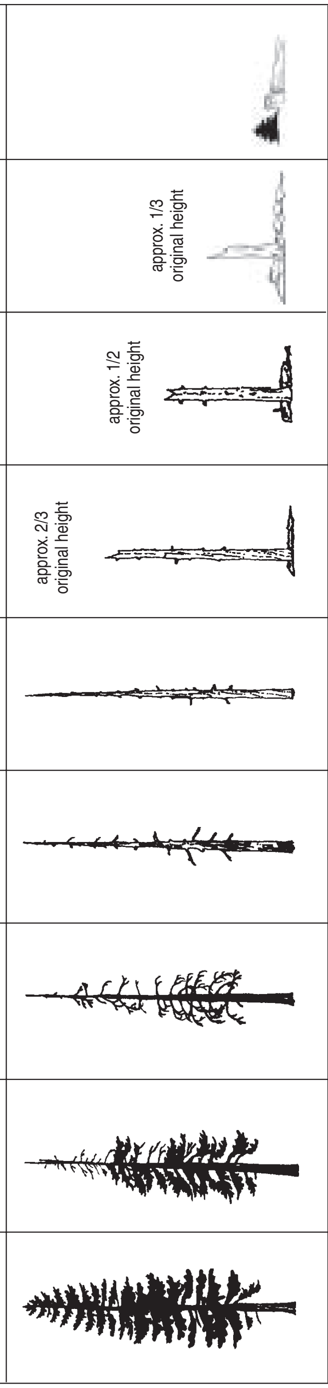
c Structural stages 4–7 will typically be estimated from a combination of attributes based on forest inventory maps and aerial photography. In addition to structural stage designation, actual age for forested units can be estimated and included as an attribute in the database, if required.

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
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

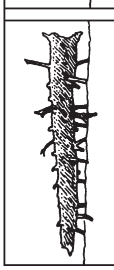
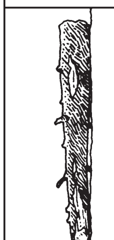
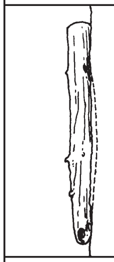
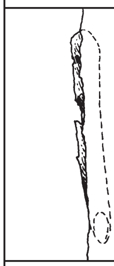
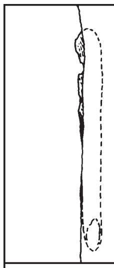
3 SCU = secondary cavity user

* 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 * $\sqrt{n}$ (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. Coast region Identified Wildlife forest district tables

Campbell River Forest District

Common Name	CPR	JOS	LIM	NAL	NIM	NWL	OUF	SOG	WIM
Invertebrates									
Quatsino Cave Amphipod			X	X	X			P	X
Amphibians									
Coastal Tailed Frog	X						X		
Red-legged Frog			X	X	X	X	P		X
Birds									
Cassin's Auklet		X				X		X	X
Great Blue Heron	X		X	X	X	X	X	X	X
Long-billed Curlew			I	I					I
Marbled Murrelet	X	X	X	X	X	X	X	X	X
Queen Charlotte Goshawk			X	X	X	X	P	X	X
Sandhill Crane	X		X	X	X	X	X		X
Short-eared Owl			X	X	X				X
Vancouver Island Northern Pygmy-Owl			X	X	X	X	X		X
Vancouver Island White-tailed Ptarmigan			X		X				X
Mammals									
Keen's Long-eared Myotis	X		X	X	X	X	X		X
Fisher	X								
Grizzly Bear	X						X		
Vancouver Island Common Water Shrew			X	X	X	X			X
Vancouver Island Marmot			X						
Wolverine	P		P	P	P	P			P
Plant communities									
Douglas-fir/Dull Oregon-grape				X				X	

X = Present; T = Introduced; I = Irregular/incidental; P = Possible; H = Historic; * = Extirpated in parts

Chilliwack Forest District

Common Name	EPR	FRL	GEL	HOR	LPR	NWC	SOG	SPR
Invertebrates								
Johnson's Hairstreak		X	H					
Sonora Skipper	X							
Fish								
Bull Trout	X	X		X	X	X		X
Amphibians								
Coastal Giant Salamander		X	X			X		X
Coastal Tailed Frog	X	X	X	X	X	X		X
Red-legged Frog	P	X	X			X		X
Birds								
American White Pelican		X	X			X	X	
Burrowing Owl		H						
Great Blue Heron	X	X	X		X	X	X	X
Lewis's Woodpecker		H						
Long-billed Curlew		I	I					
Marbled Murrelet	X	X	X			X	X	X
Sandhill Crane		X						
Short-eared Owl		X	X					
Spotted Owl	X	X		X	X	X		X
Yellow-breasted Chat		X						
Mammals								
Badger				X				
Grizzly Bear	*	H	H	X	X	H		*
Keen's Long-eared Myotis		X						X
Pacific Water Shrew	X	X						X
Wolverine	X			X	X	X		X
Plants								
Tall Bugbane	X					X		
Plant communities								
Douglas-fir/Dull Oregon-grape		X	X				X	
Western Hemlock – Douglas-fir/ Electrified Cat's-tail Moss	X				X			X
Western Redcedar – Douglas-fir/ Devil's-club	X							X
Western Redcedar – Douglas-fir/ Vine Maple	X				X	X		X

X = Present; T = Introduced; I = Irregular/incidental; P = Possible; H = Historic; * = Extirpated in parts

North Coast Forest District

Common Name	HEL	KIR	MEM	NAM	SBR
Amphibians					
Coastal Tailed Frog	X	X		X	X
Birds					
Cassin's Auklet	X				
Great Blue Heron	X	X	X	X	X
Marbled Murrelet	X	X	X	X	X
Queen Charlotte Goshawk	P				P
Sandhill Crane	X	X		X	
Mammals					
Fisher			X	X	
Grizzly Bear	X	X	X	X	X
Keen's Long-eared Myotis		X			X
Wolverine	X	X	X	X	X

X = Present; T = Introduced; I = Irregular/incidental; P = Possible; H = Historic; * = Extirpated in parts

North Island–Central Coast Forest District

Common Name	CCR	CPR	HEL	KIM	KIR	NAU	NEU	NIM	NPR	NWL	OUF	WCR	WIM
Invertebrates													
Quatsino Cave Amphipod								X					X
Fish													
Bull Trout	X	X		X		X	X					X	
Amphibians													
Coastal Tailed Frog		X	X	X	X				X		X		
Red-legged Frog			P					X		X	P		X
Birds													
Cassin's Auklet			X							X			X
Great Blue Heron		X	X	X	X	X	X	X	X	X	X		X
Marbled Murrelet		X	X	X	X			X	X	X	X		X
Queen Charlotte Goshawk			P					X		X	P		X
Sandhill Crane		X	X	X	X	X	X	X	X	X	X	X	X
Short-eared Owl	X							X					X
Vancouver Island Northern Pygmy-Owl								X		X	X		X
Vancouver Island White-tailed Ptarmigan								X					X
Mammals													
Fisher	X	X		X		X	X					X	
Grizzly Bear	X	X	X	X	X	*	X		X		X	X	
Keen's Long-eared Myotis		X		X	X			X	X	X	X		X
Northern Caribou					X	X	X					X	
Vancouver Island Common Water Shrew								X		X			X
Wolverine	P	P		P	P	P	P	P	P	P		P	P
Plant communities													
Western Redcedar – Douglas-fir/Devil's-club		X							X			X	
Western Redcedar – Douglas-fir/Electrified Cat's-tail Moss		X							X				
Western Redcedar – Douglas-fir/Vine Maple	X	X		X					X			X	

X = Present; T = Introduced; I = Irregular/incidental; P = Possible; H = Historic; * = Extirpated in parts

Queen Charlotte Islands Forest District

Common Name	QCL	SKP	WQC
Birds			
Ancient Murrelet		X	X
Cassin's Auklet		X	X
Great Blue Heron	X	X	X
Marbled Murrelet	X	X	X
Queen Charlotte Hairy Woodpecker	X	X	X
Queen Charlotte Goshawk	X	X	X
Queen Charlotte Northern Saw-whet Owl	X	X	X
Sandhill Crane	X	X	X
Mammals			
Keen's Long-eared Myotis	X	X	X

X = Present; T = Introduced; I = Irregular/incidental; P = Possible; H = Historic; * = Extirpated in parts

South Island Forest District

Common Name	LIM	NAL	SGI	SOG	WIM
Invertebrates					
Johnson's Hairstreak		H			
Quatsino Cave Amphipod	X	X		P	X
Amphibians					
Northern Leopard Frog		T			
Red-legged Frog	X	X	X		X
Birds					
American White Pelican		X	X	X	
Cassin's Auklet				X	X
Great Blue Heron	X	X	X	X	X
Lewis's Woodpecker	H	H			
Long-billed Curlew	I	I			I
Queen Charlotte Goshawk	X	X	X	X	X
Marbled Murrelet	X	X	X	X	X
Sandhill Crane	X	X			X
Short-eared Owl	X	X			X
Vancouver Island Northern Pygmy-Owl	X	X	X		X
Vancouver Island White-tailed Ptarmigan	X				X
Mammals					
Keen's Long-eared Myotis	X	X			X
Vancouver Island Common Water Shrew	X	X	X		X
Vancouver Island Marmot	X				
Plants					
Scouler's Corydalis	X				X
Plant communities					
Douglas-fir/Alaska Oniongrass		X	X	X	
Douglas-fir/Dull Oregon-grape		X	X	X	

X = Present; T = Introduced; I = Irregular/incidental; P = Possible; H = Historic; * = Extirpated in parts

Squamish Forest District

Common Name	CPR	EPR	LPR	SCR	SOG	SPR
Fish						
Bull Trout	X	X	X	X		X
Amphibians						
Coastal Tailed Frog	X	X	X	X		X
Red-legged Frog		P				X
Reptiles						
Racer			X	X		
Birds						
Great Blue Heron	X	X	X	X	X	X
Marbled Murrelet	X	X			X	X
Sandhill Crane	X					
Spotted Owl		X	X			X
Mammals						
Fisher	X		X	X		
Grizzly Bear	X	*	X	X		*
Pacific Water Shrew		X				X
Keen's Long-eared Myotis	X					X
Wolverine	X	X	X	X		X
Plant communities						
Western Hemlock – Douglas-fir/ Electrified Cat's-tail Moss	X	X	X			X
Western Hemlock – Douglas-fir/ Devil's-club	X	X	X			X
Western Redcedar – Douglas-fir/ Vine Maple		X	X			X

X = Present; T = Introduced; I = Irregular/incidental; P = Possible; H = Historic; * = Extirpated in parts

Sunshine Coast Forest District

Common Name	CCR	CPR	EPR	GEL	OUF	SCR	SOG	SPR
Fish								
Vananda Creek Sticklebacks							X	
Amphibians								
Coastal Tailed Frog		X	X	X	X	X		X
Red-legged Frog			P	X	P			X
Birds								
American White Pelican				X			X	
Great Blue Heron		X	X	X	X	X	X	X
Marbled Murrelet		X	X	X	X		X	X
Queen Charlotte Goshawk				P	P		X	
Mammals								
Fisher	X	X				X		
Grizzly Bear	X	X	*	H	X	X		*
Keen's Long-eared Myotis		X			X			X
Wolverine	X	X	X		X	X		X
Plant communities								
Douglas-fir/Alaska Oniongrass							X	
Douglas-fir/Dull Oregon-grape				X			X	
Western Hemlock – Douglas-fir/ Electrified Cat's-tail Moss		X	X					X
Western Redcedar – Douglas-fir/ Devil's-club		X	X					X
Western Redcedar – Douglas-fir/ Vine Maple	X		X					X

X = Present; T = Introduced; I = Irregular/incidental; P = Possible; H = Historic; * = Extirpated in parts