Preliminary Assessment of the Effectiveness of Wildlife Tree Retention on Cutblocks Harvested Between 1999 and 2001 under the Forest Practices Code

FREP Report #2

February 2005

British Columbia
Ministry of Forests
Ministry of Sustainable Resource Management
Ministry of Water, Land and Air Protection

Library and Archives Canada Cataloguing in Publication Data

Machmer, Marlene M.

Preliminary assessment of the effectiveness of wildlife tree retention on cutblocks harvested between 1999 and 2001 under the Forest Practices Code

(FREP report ; #2)

"Prepared by Marlene Machmer and Christoph Steeger."--P.
At head of title: FRPA Resource Evaluation Program.
Co-published by Ministry of Sustainable Resource Management and Ministry of Water, Land and Air Protection.
Issued by Pandion Ecological Research Ltd.
Includes bibliographical references: p.
ISBN 0-7726-5281-3

1. Wildlife habitat improvement – British Columbia. 2. Habitat conservation – British Columbia. 3. Forest management – Environmental aspects – British Columbia. I. Steeger, Christoph, 1958– . II. British Columbia. Forest Practices Branch. III. British Columbia. Ministry of Sustainable Resource Management. IV. British Columbia. Ministry of Water, Land and Air Protection. V. Pandion Ecological Research Ltd. VI. British Columbia. FRPA Resource Evaluation Program. VII. Title. VIII. Series.

QL84.26.B7M32 2005   639.9'2'09711   C2005-960026-8

Citation:
British Columbia Ministry of Forests. 2005. Preliminary assessment of the effectiveness of wildlife tree retention on cutblocks harvested between 1999 and 2001 under the Forest Practices Code. B.C. Min. For., For. Prac. Br., Victoria, B.C. FREP Ser. 002.
<http://www.for.gov.bc.ca/hfp/frep/6_evaluation_reports.html>

Prepared by
Marlene Machmer and Christoph Steeger
Pandion Ecological Research Ltd.
Nelson, British Columbia

Copies of this report may be obtained, depending on supply, from:
Government Publications
PO Box 9452, Stn Prov Govt
Victoria BC V8W 9V7

In Victoria (250) 387-6409
Outside Victoria 1-800-663-6105

http://www.publications.gov.bc.ca

For more information on Forest Practices Branch publications, visit our web site at:
http://www.for.gov.bc.ca/hfp/pubs.htm

Preface

This is a revised version of the March 31, 2004 report. It results from a technical editorial review by Steven J. Smith and associated clarifications. This process was facilitated by Paul Nystedt. This version also enters the report into the FRPA Resource Evaluation Program (FREP) series.

The Wildlife Tree Adequacy project was initiated in 2001 to assess the Wildlife Tree Policy as a "coarse-filter" mechanism for protecting wildlife habitat. The adequacy project started with a special focus on the question of whether the habitat needs of relevant species at risk might be met by this coarse filter applied across forest landscapes. This project assesses whether the biological needs of wildlife tree-dependent species are being met in relation to habitat features recorded during a survey of wildlife tree retention in 12 forest districts. This survey was conducted as part of the main Wildlife Tree Policy Evaluation project (Bradford et al. 2003).

Marlene Machmer and Christoph Steeger prepared this report on behalf of Pandion Ecological Research Ltd. Jakob Dulisse assisted with the preparation of draft data tables. Their project team made use of published and unpublished data gathered by Pandion Ltd. on wildlife and wildlife trees, other relevant literature, and the Columbia River Database for Wildlife-Habitat Relationships in British Columbia (http://habitat.cbt.org) that they compiled for this office.

The study presents survey results and interpretations we consider important. This report has undergone a process of review and revision, but the ecological interpretations presented are those of the authors. Their recommendations are being considered for incorporation into the wildlife tree policy and other relevant documents. Particular contention remains on the comparison of wildlife tree attribute levels in retention areas and in unmanaged stands, the relative function of wildlife tree retention areas in meeting landscape-scale habitat needs, and the interpretation of risk to wildlife tree-dependent species in the context of this study. These issues can be resolved only with time and further studies. Information on the main Wildlife Tree Policy Evaluation project is available at the website: http://www.for.gov.bc.ca/hfp/wlt/links.htm.

A number of people are acknowledged for their contributions to the project. Stewart Guy of the Ministry of Water, Land and Air Protection, and researchers from Ministry of Forests and academic institutions contributed to the project concept. All of the data presented in this report were gathered during the main Wildlife Tree Policy Evaluation project (in which the authors took part) chaired by Peter Bradford. Amanda Nemec later summarized the data in a form suitable for subsequent analyses. The following people provided helpful feedback and review comments: Evelyn Hamilton, Nancy Densmore, Richard Thompson, John Deal (Canfor), and Dave Huggard.

Wayne Erickson and Brian Nyberg administered the project, and Ministry of Forests is acknowledged for funding and other support.

Range and Integrated Resources Section
Forest Practices Branch
BC Ministry of Forests

Executive Summary

In January of 2002, the Forest Practices Branch of the BC Ministry of Forests initiated this preliminary assessment of the adequacy of the provincial *Wildlife Tree Policy* as a coarse filter mechanism for conserving habitat for wildlife tree-dependent species. This project addresses the biological effectiveness of policy and resulting stand management practices and builds directly on the Phase 1 project "Evaluation of wildlife tree retention for cutblocks harvested between 1996–2001 under the Forest Practices Code." Explicit policy and management guidelines regarding wildlife tree retention were released initially in the Forest Practices Code of British Columbia (1995 Biodiversity Guidebook and 1999 Landscape Unit Planning Guide), followed by the provincial *Wildlife Tree Policy and Management Recommendations* in 2000.

Our assessment had four broad objectives:

1. Determine the extent to which levels and patterns of wildlife tree retention being achieved under the Forest Practices Code serve to provide habitat for the full range of vertebrates that use wildlife trees, including species listed under the provincial *Identified Wildlife Management Strategy* (IWMS).
2. Describe the wildlife tree requirements of species whose needs are not being met by existing policies.
3. Identify options for modification of the policy that would expand the number of species they provide habitat for.
4. Recommend further evaluation work that should be pursued in future years to determine the effectiveness across the province of the policy or any alternative approach developed under the Results-based Code initiative.

Our review identified 70 vertebrate species in British Columbia with a relatively high dependence on wildlife tree habitat. We summarized the habitat use and requirements of these species in terms of dependence on several wildlife tree "habitat elements" identified in the Columbia Basin Database for Wildlife-Habitat Relationships. The habitat elements are: snags, hard snags, moderate snags, soft snags, large snags, mistletoe brooms, dead parts of live trees, hollow living trees, tree cavities, loose bark, live remnant legacy trees, and large live tree branches). Through a literature review, we also summarized the characteristics of trees (i.e., tree species, diameter, height, decay class ranges) that wildlife tree-dependent species use for breeding, foraging, and other life requisites. Nesting densities, and home range and territory sizes are provided for those species, for which information is available in the Columbia Basin Database.

We summarized levels of wildlife tree retention, using data from the Phase 1 of the wildlife tree evaluation project conducted by the province of British Columbia (2003). That latter project assessed wildlife tree retention on 128 cutblocks in representative biogeoclimatic ecological clalssification (BEC) zones across British Columbia. We evaluated the density and characteristics of retained trees and specific wildlife tree habitat elements, as well as reserve characteristics (by cutblock, BEC zone, and all zones combined). We then compared the level of wildlife tree retention with species' habitat requirements, to

address the intended biological effectiveness (i.e., conservation of the habitat of willife tree-dependent vertebrate species) of provincial policy (Province of British Columbia 1995, 1999b, 2000).

Our comparisons of the observed levels of wildlife tree retention relative to (1) habitat requirements and use patterns of dependent species and (2) reported densities of these elements in unmanaged stands suggest that the life requisites of wildlife tree-dependent species will not likely be met in managed forests under current practices. This is suggested by the absence of any *functional* (i.e., ≥20 m dbh and ≥10 m height) snag retention on 46% of all cutblocks sampled, and the low levels of snag retention on the remaining blocks. Although some species can use live trees as well as snags to satisfy some of their wildlife tree requirements, only negligible densities of larger live trees with evidence of decay, insects, diseases, or cavities were retained. While retention of smaller, live trees may provide recruitment wildllife tree habitat, no trees with current evidence of cavities, hollow boles, nests, dens, roosts, or other *uncommon habitat features* were found in reserves on the 128 cutblocks sampled. This suggests that criteria other than habitat value and current wildlife use were used during the reserve selection process.

Approximately half of all individual patch reserves (n = 173) measured less than 1.0 ha, with a quarter being less than 0.5 ha. The habitat value of very small patches may be low, given that they are comprised entirely of edge habitat, they are not large enough to buffer danger trees of valuable size, and most wildlife tree users require breeding territories of several hectares in size. Small patches could function as connectivity habitat; however, the extent to which individual species will use patches (within the context of surrounding fragmentation levels and seral stage distributions) is not well known.

We developed preliminary risk ratings for guilds of wildlife tree users based on the median retention densities (very high risk = 0 sph; high = 0.1–2.5 sph; moderate = 2.6–5 sph; low = 5–10 sph; very low = >10 sph) of habitat elements reported by the Phase 1 project for sampled blocks. These stems per hectare values are in part based on wildlife tree retention targets commonly used in the Pacific Northwest. All focal species of this study fell into the "high" or "very high" risk categories for one or more habitat elements present at levels of ≤2.5 sph under the monitored wildlife tree retention practices. Relative to other guild members, species that are (1) listed by the Provincial Conservation Data Centre and IWMS and/or (2) dependent on wildlife trees for all their life requisites may be at particularly high risk. Our ratings should be considered as a preliminary indication of potential risks to populations due to estimated wildlife tree deficiencies, relative to the retention results on the 128 cutblocks sampled.

The *Identified Wildlife Management Strategy* is a fine-filter mechanism designed to conserve habitat for species that are sensitive to forest and range practices, but whose needs are not adequately addressed through coarse-filter management. Our findings regarding the low level of biological effectiveness of observed wildlife tree retention practices suggest the need for (1) review and possible modification of the wildlife tree policy, to achieve more effective implementation, (2) a greater emphasis on the IWMS to protect habitat for sensitive wildlife tree users, (3) consideration of IWMS designation for a greater number of wildlife tree-dependent species, and (4) assessment of the implementation and biological effectiveness of the IWMS (to ensure that its intended objectives are being met).

Our conclusions are based on a dataset that suggests that wildlife tree retention practices do not meet the intentions of several ecological guiding principles included in the current policy. If, generally, the principles and guidelines of wildlife tree policy are followed closely during implementation, the risk to dependent species may be less. Whether or not thorough implementation of the current policy would suffice to ensure self-sustaining wildlife tree user populations over time cannot quantitatively be addressed here. However, the following recommendations for modifying the wildlife tree policy may help improve its biological effectiveness:

1. Focus retention on *functional* wildlife trees (particularly snags) using a *density-based* approach. Required densities should reflect the natural range of variability of wildlife trees by BEC subzone and stand type and targets for both live and dead tree components should be specified to ensure that retained trees provide present as well as future habitat.
2. Reconsider the BC Workers' Compensation Board (WCB) hazard tree regulations, the timber supply impact assumptions of the wildlife tree policy, and the synergistic effects of both on tree retention, to better facilitate conservation of wildlife tree habitat. The main three factors affecting wildlife tree habitat (worker safety, timber production, and habitat retention) cannot all be maximized simultaneously in any given area.
3. Modify the policy to increase retention of larger patches with dimensions that are biologically effective for wildlife tree users (e.g., > 2 ha).
4. Develop temporal and spatial distribution requirements for wildlife tree retention that ensure minimum habitat fragmentation and creation of population sink habitats.
5. Emphasize that small-scale salvage of retained wildlife trees is undesirable and should generally be avoided.
6. Consider policy direction regarding large-scale salvage, because forests affected by natural disturbances provide population source habitats for many wildlife tree users.

In addition to its scope and allocated resources, this assessment was limited by available information pertaining to wildlife requirements and habitat supply. Empirical information on species' habitat requirements and population densities relative to habitat quality is either lacking or scarce. For these reasons, our assessment can provide only preliminary answers to questions regarding the biological effectiveness of wildlife tree retention practices. We identify information gaps and provide recommendations for further evaluation of the effectiveness of wildlife tree retention in British Columbia.

Acknowledgements

We appreciate the contributions of all collaborators and reviewers of previous drafts. Jakob Dulisse assisted with the compilation of information in the tables. Amanda Linnell summarized the raw data from the Phase 1 project and provided analyses and much help in clarifying assumptions regarding the dataset. Wendy Bergerud, Nancy Densmore, and Peter Bradford provided technical advice. Jakob Dulisse, Doug Ellis, Bill Golding, Dean McGeough, Bruce Morrow, and Eliot Terry helped clarify sampling methods and results. Robert Barclay, Mark Brigham, Erica McClaren, Todd Manning, Kathy Paige, and Rich Weir contributed technical information through personal communication and copies of reports. Nancy Densmore, Richard Thompson, Evelyn Hamilton, John Deal, and Dave Huggard reviewed earlier drafts of this document. Finally, we thank Wayne Erickson and Brian Nyberg for administering this contract and for their patience throughout.

Table of Contents

List of Tables

List of Figures

List of Appendices

1.0 Background and Introduction

Following the initial introduction of province-wide retention requirements for wildlife trees under the Forest Practices Code (Province of British Columbia 1995), the *British Columbia Wildlife Tree Policy and Management Recommendations* were released in February 2000, to set wildlife tree retention targets and objectives at the landscape level and to provide guidance for wildlife tree retention at the stand level. The wildlife tree policy provides a coarse-filter mechanism intended to conserve habitat for dependent species in managed landscapes, while keeping timber supply impacts at levels not exceeding the Chief Forester's estimate of 1.8% (Province of BC 2000). The *Identified Wildlife Management Strategy* (IWMS) provides a fine-filter mechanism designed to conserve habitat for species that are not adequately addressed through coarse-filter management and are considered sensitive to forest and range practices (Province of British Columbia 1999a).

While the policy provides *ecological guiding principles* for wildlife tree retention, no biological risk assessment or effectiveness evaluation has been conducted to date. Work is currently underway to refine the policy and evaluate its level of implementation. As part of this process, the Phase 1 Wildlife Tree Evaluation Project (hereafter called Phase 1 project) (Province of British Columbia 2003) was conducted, involving field assessment of 128 cutblocks for various aspects of wildlife tree retention. The cutblock sample represented two forest districts from each of the province's six forest regions, with cutblocks being logged during the period 1996–2001. The Phase 1 project was designed to evaluate (1) how effective current wildlife tree retention practices are with respect to the ecological and administrative guiding principles of the policy, (2) the timber supply impacts of current practices, (3) the structural and compositional changes in wildlife tree retention areas associated with current practices and how these influence their ecological value, and (4) whether current practices are achieving intended biological objectives while minimizing costs.

In January of 2002, Pandion Ecological Research Ltd. was contracted to conduct a preliminary assessment of the adequacy of the wildlife tree policy as a coarse-filter mechanism for conserving wildlife tree habitat. Our assessment focuses on the intended biological effectiveness (i.e., conservation of the habitat of wildlife tree-dependent vertebrate species) of the policy, its implementation, and previous process under the Forest Practices Code. We also attempt to evaluate the degree to which the wildlife tree policy complements the IWMS with respect to conservation of the habitat of listed species.

In addition to its preliminary scope and allocated resources, this assessment was limited by available information pertaining to wildlife requirements and habitat supply. Empirical information on species' habitat requirements and population densities relative to habitat quality is either lacking or scarce. For these reasons, our assessment can provide only preliminary answers to questions regarding the biological effectiveness of wildlife tree retention practices. It also identifies information gaps and provides direction and recommendations for further evaluation of the effectiveness of wildlife tree retention in British Columbia.

1.1 Objectives

We assessed the adequacy of the policy as a coarse-filter mechanism for protecting wildlife habitat by addressing the following four broad objectives:

1. Determine the extent to which levels and patterns of wildlife tree retention being achieved under the Forest Practices Code serve to provide habitat for the full range of vertebrates that use wildlife trees, including IWMS species.
2. Describe the wildlife tree requirements of species whose needs are not being met by existing policies (e.g., certain species at risk).
3. Identify options for modification of the wildlife tree policy that would expand the number of species it provides habitat for.
4. Recommend further evaluation work, including field data collection, that should be pursued in future years to determine the effectiveness across the province of the policy or any alternative approach developed under the Results-based Code initiative.

2.0 Methods

We used the following approach and methods to address each of the project objectives:

Objective 1: *Determine the extent to which levels and patterns of wildlife tree retention being achieved under the Forest Practices Code serve to provide habitat for the full range of vertebrates that use wildlife trees, including IWMS species.*

We developed a short list of candidate vertebrate wildlife tree users in British Columbia to be considered for more detailed analysis. The following information sources were used: Backhouse and Lousier 1991; Johnson and O'Neil 2001; Steeger et al. 2001; and Paige 2002. For each candidate species, we determined its status based on updated lists supplied by the Conservation Data Centre (CDC), the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), and the IWMS. We also evaluated the nature of wildlife tree use and assigned wildlife tree dependency rankings (1, 2, 3, and 0 for "high," "moderate," "low," and "no dependency" on wildlife trees, respectively) by species for reproduction, foraging, and other life requisites (shelter, communication, etc.). Rankings were based on Backhouse and Lousier 1991 for the most part, with some modifications to reflect updated information sources.

We then filtered the list of candidate wildlife tree users (118 species total; Appendix 1) for species that were: (1) listed by the CDC and ranked high [1] or moderate [2] in dependency on at least one life requisite category; (2) ranked high [1] or moderate [2] in dependency for reproduction; or (3) ranked high [1] in dependency for at least one life requisite category. Filtering resulted in a list of 70 species that fit these criteria. For this shorter list, we determined species occurrence by ecoprovince, and by biogeoclimatic (BEC) zones and forest districts sampled for the wildlife tree Evaluation Project. Species occurrence was determined using a variety of sources, including: Cowan and Guiget 1978; Gregory and Campbell 1984; Campbell et al. 1990a, b, 1997, 2001; Nagorsen and Brigham 1993; Stevens 1995; Corkran and Thomas 1996; Cannings et al. 1999; Paige 2002.

We also determined the association of the 70 focal species with various wildlife tree "habitat elements" (Table 1) to provide a qualitative summary of species-specific wildlife tree habitat requirements. We obtained this information from the *Columbia Basin Database for Wildlife-Habitat Relationships* (WHR); (Johnson and O'Neil 2001, Steeger et al. 2001; http://habitat.cbt.org). The latter is a peer-reviewed, state-of-knowledge database that features detailed descriptions of the associations of terrestrial vertebrates with habitat attributes at various scales. The British Columbia database (447 species) is an extension of the US project on wildlife-habitat relationships in Washington and Oregon (743 species; Johnson and O'Neil 2001), which covers marine and coastal species as well. The British Columbia Columbia Basin WHR Database covers the habitat associations of 93% of the 70 focal species in this project. For the remaining five species, which use coastal habitats, we used the US database, which provides a good approximation of baseline information. Note that the definition of "habitat element," which was used for describing wildlife-habitat associations in Oregon and Washington (Johnson and O'Neil 2001) and incorporated into this analysis, implies a relatively high degree of dependency by a species for a habitat element. Johnson and O'Neil (2001) define habitat elements as "… those components of the environment believed to most influence wildlife species' distribution, abundance, fitness, and viability."

Based on a review of pertinent British Columbia literature, we identified the wildlife tree requirements of the focal species (by BEC zone where possible). Researchers were contacted where information was lacking and a subset of these responded. Emphasis was placed on field studies providing empirical data on species-specific wildlife tree use. Where information from British Columbia was not available, we considered data from other areas with comparable forest types to those in British Columbia. We summarized the data in tabular format by species, differentiating between wildlife tree use for reproduction (i.e., nesting/denning/maternity roosting) and foraging. Data summarized include wildlife tree use by tree species, size (diameter at breast height and height), and decay class, as well as comments on use of specific habitat elements (mistletoe brooms, old woodpecker cavities, etc.).

To address the adequacy of wildlife tree retention from a spatial perspective, we summarized empirical data on nesting densities and home range and territory sizes for selected species. Due to project constraints, a search of the primary literature was not possible, so values from the Columbia Basin WHR Database were used. These values were compared with patch reserve sizes to evaluate how patch reserves relate to the spatial requirements of wildlife tree users.

***Table 1.* Wildlife tree habitat elements (definitions) identified in the US Wildlife-Habitat Relationship Database (Johnson and O'Neil 2001) and closest surrogate parameters from the Phase 1 Wildlife Tree Evaluation Project (Province of British Columbia 2003).**

Habitat Element[a]	Definition[a]	Surrogate Parameter
Snags	standing dead trees	Decay class 3–8 wildlife trees
Hard	little wood decay evident; bark, branches, top present; recently dead	Decay class 3–4 wildlife trees
Moderate	moderately decayed wood; some branches or bark missing and/or loose; top broken	Decay class 5 wildlife trees
Soft	well-decayed wood; bark and branches generally absent; top broken	Decay class 6–8 wildlife trees
Large	snags 50–70 cm diameter at breast height (dbh)	Decay class 3–8 wildlife trees measuring ≥50 cm dbh
Mistletoe/witches brooms	dense masses of deformed branches caused by any type of broom-forming parasite (fungal or plant)	Parameter N – Mistletoe (on field card)
Dead parts of live trees	portions of live trees with rot; can include broken tops; branches with decay; tree base with rot	no variables on the field card correspond closely with this habitat element (the "suspect" tree category is too broad)
Hollow living trees	"chimney trees;" tree bole with large hollow chambers	Parameter S – Visible Internal Decay (on field card)[b]
Tree cavities	smaller chamber in a tree; can be in bole, limbs, or forks of live and dead trees; may be excavated or result from decay or damage	Parameter S – Visible Internal Decay (on field card)[b] and Parameter U – Uncommon Habitat Feature (on field card)[c]
Loose bark	includes crevices, fissures, and loose or exfoliating bark	Parameter U – Uncommon Habitat Feature (on field card)[c]
Live remnant/legacy trees	a live mature or old-growth tree remaining from the previous stand; context is remnant trees in recently harvested or burnt stands up through young forested stands	Parameter H – Tree Class; category 5 – Veteran (defined as mature living tree on field card)
Large live tree branches	large branches often growing horizontally out from the tree bole	no variables on the field card correspond closely with this habitat element

a Habitat elements and definitions are based on Johnson and O'Neil (2001).

b Note that parameter S (visible internal decay) is a much broader term than either hollow living trees or tree cavities, but would certainly include all trees with these features.

c Note that parameter U (uncommon habitat feature) is much broader and includes trees with cavities, dens, roosts, hollow trees, open nests, mark and perch trees, as well as other evidence of wildlife use.

Table 2. Number of cutblocks sampled (total cutblocks from which each sample was chosen) by forest region, forest district, and BEC zone for the Phase 1 Wildlife Tree Evaluation Project.

Forest Region	Forest District	BWBS	CWH	ESSF	ICH	IDF	SBPS	SBS	Total
Cariboo (RCA)	Chilcotin (DCH)					6 (144)	5 (1411)		11 (1555)
	Quesnel (DQU)						1 (492)	4 (887)	5 (1379)
Kamloops (RKA)	Clearwater (DCL)			2 (276)	7 (413)				14 (689)
	Kamloops (DKA)					7 (187)	8 (516)		5 (703)
Nelson (RNE)	Arrow (DAR)				5 (250)	5 (650)			10 (900)
	Kootenay Lake (DKL)				9 (185)	3 (387)			12 (572)
Prince George (RPG)	Fort St. John (DFO)	8 (406)		2 (27)					10 (433)
	Prince George (DPG)			4 (115)				5 (1698)	9 (1813)
Prince Rupert (RPR)	Kispiox (DKI)		6 (40)		8 (258)				14 (298)
	North Coast (DNC)		10 (182)						10 (182)
Vancouver (RVA)	Chilliwack (DCH)		8 (423)	3 (42)					11 (465)
	South Island (DSI)		7 (699)						7 (699)
Total Sample		8 (406)	31 (1344)	30 (895)	30 (1895)	14 (660)	6 (1903)	9 (2585)	128 (9688)

We identified retention levels of wildlife tree habitat elements by first defining parameters from the Phase 1 Project field card that were analogous to the wildlife tree habitat elements in Table 1. Parameters for that project were developed to assess timber supply impacts and, in a few cases, none of the variables corresponded to the wildlife tree habitat elements in Table 1. Based on our specific data requests, Amanda Linnell (data analyst for the Phase 1 Project) generated descriptive statistics by cutblock, all cutblocks sampled within a particular BEC zone/forest district, or all blocks pooled. We summarized the analytical results provided in tabular or graphical format, to provide a general overview of trends for that habitat element or feature.

Amanda Linnell made the following assumptions during her analyses (pers. comm.):

1. Any part of a cutblock not included in a reserve (patch or dispersed) was assumed to be a clearcut with no retention (this included 12 of the 128 cutblocks sampled that had no reserves at all).
2. Individual reserves and clearcut areas within blocks were weighted by their area; cutblocks, forest districts, and BEC zones were weighted by the TAUP (total area under prescription).
3. Stems/ha counts were rounded to the nearest 0.1 stems/ha.
4. Where information was not recorded for all trees (e.g., wildlife tree class, occurrence of mistletoe, insects and disease), density estimates for full-count reserves were based on sub-sample estimates (i.e., sph = sub-sample % × total sph).

The Phase 1 project collected data on all live and dead trees ≥12.5 cm in diameter at breast height (dbh). Many of the smaller trees assessed provide negligible (current) wildlife tree habitat value and therefore only trees of *functional* size were considered for most of our analyses. Functional trees were defined as trees measuring ≥20 cm in diameter at breast height (dbh) and ≥10 m in height. These minimum size thresholds were developed based on a review of empirical studies of wildlife tree use for reproduction and foraging by dependent species (see Appendices 2 and 3, respectively). Implicit in the emphasis on larger trees, aside from their value in accommodating larger species, is the probability of such trees to experience greater longevity and potentially more wildlife use. Data collection methods for coarse woody debris did not follow standard protocols, hence only the wildlife tree decay classes 1–8 (Province of British Columbia 2002) were considered in all analyses.

On the basis of the previous steps, we compared the wildlife tree retention levels documented by the Phase 1 project with the habitat use patterns and requirements of wildlife tree-dependent species. Note that retention levels (i.e., stems/ha) refer to the total area under prescription (TAUP) and all retention within TAUP (even retention with unspecified objectives and longevity based on information taken from Silviculture Prescriptions) was included in the wildlife tree retention analyses.

Objective 2: *Describe the wildlife tree requirements of species whose needs are not being met by existing policies, (e.g., certain species at risk)*.

For the 70 focal wildlife tree users, we developed risk ratings based on the median density (very high = 0 sph; high = 0.1–2.5 sph; moderate = 2.6–5 sph; low = 5–10 sph; very low = >10 sph) of habitat elements retained on sampled cutblocks. Stems-per-hectare values for habitat elements pertain to the TAUP of the cutblocks. The risk ratings were considered in combination with other species-specific factors (e.g., CDC and IWMS listing, geographic/ecosystem occurrence, and degree of habitat specialization or dependency), to provide an overview of guilds and species whose needs may not be met by the current wildlife tree retention practices. Our ratings should be considered as a hypothesis regarding risks to populations due to estimated deficiencies in supply of wildlife tree habitat elements, relative to the retention results on the 128 sampled cutblocks. The ratings were calculated on a species-specific basis; that is, the values used in comparison with the risk categories were computed only for the BEC zones in which they occur.

For the BEC units sampled in the Phase 1 project, we compiled mean snag densities in unmanaged stands for comparative purposes, using data form the Provincial Ecology Program (PEP) (Province of British Columbia 2001). These means were computed by averaging the reported mean snag (>20 cm dbh/ha) values for all mature and old stands (>100 years) from all subzones, variants, and site series in a given BEC zone. Overall, the PEP data are considered useful for broad comparative purposes of habitat supply.

Objective 3: *Identify options for modifications of the wildlife tree policy that would expand the number of species it provides provide habitat for.*

Objective 4: *Recommend further evaluation work, including field data collection, that should be pursued in future years to determine the effectiveness across the province of the policy or any alternative approach developed under the Results-based Code initiative.*

We formulated recommendations for modifications of the policy that address both the ecological and administrative guiding principles. We considered operational opportunities and constraints as well as requirements for information extension, and implementation and effectiveness monitoring. We also provide recommendations for further evaluation work on the effectiveness of the policy.

3.0 Results and Discussion

3.1 Dependency of Wildlife Tree Users on Specific Habitat Elements

Appendix 1 provides a complete list of candidate wildlife tree-using species (118 species total). Also provided for each species are their conservation status, wildlife tree dependency ratings (for reproduction, foraging, and other life requisites), and occurrence by ecoprovince (short-listed species only). Based on the filtering criteria described in section 2.0, 70 of the 118 species in Appendix 1 were determined to be dependent on wildlife trees. These are listed in Table 3 with a summary of their conservation status, dependency ratings, general comments on wildlife tree use, and specific use of wildlife tree habitat elements.

Table 3 indicates that of 70 wildlife tree-dependent species, 20 species are listed by the CDC (12 taxa are red-listed and 10 blue-listed), 11 are listed by COSEWIC (four are threatened, four are of special concern, two are endangered, and one is being reviewed but available data is deficient), and 15 are included in the 2003 version of the IWMS. Note that the above totals of listed species are not additive, as these lists are not independent of each other.

Of the species listed in Table 3, 37 (52.8%) and 32 (45.7%) species are considered highly and moderately dependent on wildlife trees for reproduction, respectively. Forty-six species (65.7%) use wildlife trees for foraging and 13 (18.6%) are considered highly dependent. At least 32 species (45.7%) in Table 3 are known to use wildlife trees for other life requisites; 17 (24.3%) are considered highly dependent and another 20 (28.6%) are moderately dependent. Thirteen species in Table 3 are classified as strong primary cavity excavators and another five are weak excavators. Secondary cavity users comprise 43 of 70 (61.4%) species, and an additional seven are open nesters. The Clouded Salamander uses loose bark for reproduction, foraging, and shelter and caribou are highly dependent on lichens growing on remnant/legacy trees, large live tree branches, and snags (Paige 2002).

Based on the Columbia Basin WHR Database, the number of species dependent on specific wildlife tree habitat elements is as follows (Table 3): snags (66 of 70 species); hard snags (15 species); moderate snags (17 species); soft snags (8 species); large snags (48 species); mistletoe/witches broom (12 species); dead parts of live trees (28 species); hollow living trees (20 species); tree cavities (57 species); bark (23 species); live remnant legacy trees (29 species); and large live tree branches (9 species).

3.2 Summary of Species-Specific Empirical Data on Wildlife Tree Habitat Use

Appendix 2 summarizes studies with empirical information on the characteristics of trees used for reproduction (i.e., nesting, denning, and maternity roosting) by wildlife tree-dependent vertebrates. The data are presented by BEC zone (or study area if BEC zone was not indicated) and emphasis is placed on studies conducted in British Columbia. Data from other jurisdictions (Washington, Montana, Idaho, Oregon, and Alberta) are included if such data are absent or lacking for British Columbia.

Wildlife tree use varies tremendously by BEC zone and wildlife species (Appendix 2) and few generalizations can be made with respect to selection of particular tree species. In the BWBS zone, black cottonwood, trembling aspen, and white spruce appear to be highly used species. Douglas-fir, red alder, black cottonwood, western hemlock, western red cedar and yellow-cedar, grand and amabilis fir, and trembling aspen are all used by a wide range of species in the CWH zone. Douglas-fir, western larch, ponderosa pine, western white pine, grand fir, black cottonwood, trembling aspen, and paper birch show highest use levels in ICH subzones where they occur. In addition to the latter species, lodgepole pine and spruce species are important trees for bark foragers in this zone (Appendix 3). Similarly, western larch, Douglas-fir, ponderosa pine, black cottonwood, and trembling aspen are well-used wildlife tree species in the IDF. Few data on species-specific wildlife tree use and selection are available for the ESSF, SBPS, and SBS zones (Appendices 2 and 3).

Pooling all empirical studies in Appendix 2, mean diameters of trees used for reproduction measure 18.2–136.6 cm (actual values range from 14.0 to 418.9 cm dbh). Average tree heights in these studies measure 4.3–48.0 m (actual values range from 0.6 to 112 m height). At least 95% of all studies listed in Appendix 2 report average diameters and heights of used trees measuring ≥20 cm dbh and ≥10 m, respectively. Median decay classes of trees used for reproduction are classified from 1 to 6 (individual values range from 1 to 8); however, with the exception of open-nesting Great Blue Herons and Northern Goshawks, all studies reported trees of decay classes ≥2 (Appendix 2). For the purpose of our analyses, "functional" wildlife trees for reproduction are therefore defined as trees measuring ≥20 cm dbh and ≥10 m height, in decay classes 1–8.

Table 3. Wildlife tree-dependent vertebrates of British Columbia their conservation status (based on listings from the British Columbia Conservation Data Centre [CDC], the Committee on the Status of Endangered Wildlife in Canada [COSEWIC], and the Identified Wildlife Management Strategy [IWMS]), their level of dependency on wildlife trees for reproduction (R), foraging (F), and other (O) life requisites, comments on wildlife tree use, and dependency on wildlife tree habitat elements (Johnson and O'Neil 2001; Steeger et al. 2001).

	Conservation Status			Level of Dependency[a]				Dependency on Wildlife Tree Habitat Elements											
Vertebrate Species	CDC[b]	COSEWIC[c]	IWMS	R	F	O	Comments on Wildlife Tree Use	Snags	Hard Snags	Moderate Snags	Soft Snags	Large Snags	Mistletoe/Witches Broom	Dead Parts of Live Trees	Hollow Living Trees	Tree Cavities	Loose Bark	Live Remnant/Legacy Trees	Large Live Branches
Clouded Salamander				2	2	2	most arboreal of BC salamanders; found under loose bark of logs, trees, or stumps	X									X		X
Great Blue Heron	B	SC (*fannini*)	x	2	0	0	Open Nester (ON); nests in large live and recently dead trees near water	X	X	X		X							
Wood Duck				1	0	0	Secondary cavity user (SCU); uses natural or excavated cavities usually in mature deciduous trees near water	X	X			X				X			
Bufflehead				1	0	0	SCU; uses excavated or natural cavities usually in live or dead deciduous or coniferous trees near water	X				X				X			
Common Goldeneye				1	0	0	SCU; nests mainly in natural cavities of dead deciduous and coniferous trees near water	X				X				X			
Barrow's Goldeneye				1	0	0	SCU; nests mainly in natural cavities of dead deciduous and coniferous trees near water; may use excavated PIWO and NOFL cavities	X				X				X			
Hooded Merganser				1	0	0	SCU; nests mainly in natural cavities of live and dead deciduous and coniferous trees near water	X	X			X				X			
Common Merganser				2	0	0	SCU; nests mainly in natural cavities of large live and dead deciduous and coniferous trees near water	X				X			X	X			

a Level of dependency for R (reproduction), F (foraging) and O (other): 1= highly dependant on wildlife trees; 2 = commonly uses wildlife trees; 3 = occasionally uses wildlife trees; 0 = not known to use wildlife trees.

b CDC listing: B = blue-listed; R = red-listed; parentheses indicate the listing of only one population or subspecies.

c COSEWIC ranking: DD = taxa reviewed for listing but data deficient; SC = special concern; T = threatened; E = endangered; parentheses indicate the listing of only one population or subspecies.

Vertebrate Species	Conservation Status			Level of Dependency[a]			Comments on Wildlife Tree Use	Dependency on Wildlife Tree Habitat Elements											
	CDC[b]	COSEWIC[c]	IWMS	R	F	O		Snags	Hard Snags	Moderate Snags	Soft Snags	Large Snags	Mistletoe/Witches Broom	Dead Parts of Live Trees	Hollow Living Trees	Tree Cavities	Loose Bark	Live Remnant/Legacy Trees	Large Live Branches
Osprey				2	2	2	ON; uses snags, dead parts of live trees, and live remnant legacy trees for nest placement, hunting perches, and roosts	X				X		X				X	
Bald Eagle				2	2	2	ON; uses snags, dead parts of live trees, and live remnant legacy trees for hunting perches, roosts, and nest placement	X				X		X				X	
Northern Goshawk	R (*laingi*)	T (*laingi*)	x (*laingi*)	2	2	0	ON; uses mistletoe brooms for nesting platforms and snags for plucking posts	X					X					X	
American Kestrel				2	2	0	SCU; uses abandoned woodpecker cavities and natural cavities for nesting; snags and dead parts of live trees for hunting perches	X	X	X		X		X		X			
Marbled Murrelet	R	T	x	2	0	0	ON; nests on large live tree branches; will use mistletoe						X						X
Flammulated Owl	B	SC	x	1	0	0	SCU; nests in abandoned woodpecker (e.g., NOFL) cavites in large Douglas-fir and ponderosa pine snags; snags used as hunting perches	X				X				X			
Western Screech-owl	B (*saturatus*); R (*macfarlanei*)	DD	x (*macfarlanei*)	1	0	2	SCU; nests in abandoned woodpecker (especially NOFL and PIWO) cavities in coniferous and deciduous trees	X				X				X			
Great Horned Owl				2	2	0	ON; nests in large coniferous and deciduous trees; used old open nests and also snags with broken tops or natural cavities; will nest on large Douglas-fir brooms	X				X	X		X	X		X	
Northern Hawk Owl				2	2	0	SCU; nests in natural cavities and woodpecker (e.g., PIWO, NOFL) holes; dead parts of live trees and live remnant/legacy trees used for hunting perches	X		X	X	X		X		X		X	

Vertebrate Species	Conservation Status			Level of Dependency[a]			Comments on Wildlife Tree Use	Dependency on Wildlife Tree Habitat Elements											
	CDC[b]	COSEWIC[c]	IWMS	R	F	O		Snags	Hard Snags	Moderate Snags	Soft Snags	Large Snags	Mistletoe/Witches Broom	Dead Parts of Live Trees	Hollow Living Trees	Tree Cavities	Loose Bark	Live Remnant/Legacy Trees	Large Live Branches
Red-naped Sapsucker				1	1	1	PCE; uses live trees and snags for nesting/roosting; bark forager and sapsucker	X	X	X		X		X		X		X	
Red-breasted Sapsucker				1	1	1	PCE; uses live trees and snags for nesting/roosting; bark forager and sapsucker	X	X	X		X		X		X			
Downy Woodpecker				1	1	1	PCE; uses snags for nesting and roost-ing, and will nest secondarily; bark forager; uses live remnant/legacy trees for nesting, roosting, feeding	X		X	X	X		X		X	X	X	
Hairy Woodpecker	B (*picoides*)		x (*picoides*)	1	1	1	PCE; will nest secondarily; bark forager	X	X	X		X		X		X	X	X	
White-headed Woodpecker	R	E	x	1	1	1	PCE; will nest secondarily; seed and bark forager; uses pines for foraging and nesting	X		X		X				X	X	X	
Three-toed Woodpecker				1	1	1	PCE; will nest secondarily; bark forager; live remnant/legacy trees for nesting, roosting, and feeding	X	X	X				X		X	X	X	
Black-backed Woodpecker				1	1	1	PCE; will nest secondarily; bark forager; live remnant/legacy trees for nesting, roosting, feeding	X	X	X				X		X	X	X	
Northern Flicker				1	1	1	PCE; live remnant/legacy trees for nesting, roosting, feeding	X		X	X	X		X	X	X		X	
Pileated Woodpecker				1	1	1	PCE; uses large, hard snags for nesting and roosting and softer snags for feeding; hollow living trees for winter roosting only; bark forager	X	X			X		X	X	X	X	X	
Purple Martin	R			2	0	0	SCU; usually uses nest boxes in BC	X								X			
Tree Swallow				2	0	0	SCU; nests in abandoned woodpecker holes and roost in woodpecker and natural cavities	X								X			
Violet-green Swallow				2	0	0	SCU; nests in abandoned woodpecker holes and roost in woodpecker and natural cavities	X								X			

Vertebrate Species	Conservation Status			Level of Dependency[a]			Comments on Wildlife Tree Use	Dependency on Wildlife Tree Habitat Elements											
	CDC[b]	COSEWIC[c]	IWMS	R	F	O		Snags	Hard Snags	Moderate Snags	Soft Snags	Large Snags	Mistletoe/Witches Broom	Dead Parts of Live Trees	Hollow Living Trees	Tree Cavities	Loose Bark	Live Remnant/Legacy Trees	Large Live Branches
Northern Pygmy-owl	B (*swarthi*)		x (*swarthi*)	1	0	0	SCU; nests in abandoned woodpecker holes in coniferous trees; roosts in woodpecker or natural cavities	X	X	X		X				X			
Spotted Owl	R	E	x	1	0	0	SCU; nests in natural cavities or old open nests	X					X		X	X			X
Barred Owl				2	0	0	SCU; nests in natural cavities or old open nests in large coniferous or deciduous trees	X				X	X		X	X		X	
Great Gray Owl				2	0	0	ON; nests in abandoned raptor nests (e.g., NOGO, RTHA), on broken-top snags, or on mistletoe brooms	X				X	X		X			X	
Boreal Owl				1	0	0	SCU; nests in natural and abandoned woodpecker (e.g., NOFL and PIWO) cavities	X				X				X			
Northern Saw-whet Owl	B (*brooksi*)		x (*brooksi*)	1	2	0	SCU; nests in abandoned woodpecker (e.g., NOFL and PIWO) cavities; roosts in natural and woodpecker cavities and mistletoe brooms	X				X	X			X			
Vaux's Swift				1	0	0	SCU; uses hollow trees for nesting and roosting and old cavities excavated by PIWO	X							X	X			
Lewis' Woodpecker	R (GD pop); B (other pops)	SC	x	1	1	1	Primary cavity excavator (PCE)/SCU; often uses cavities excavated by other woodpeckers or natural cavities; snags used for roosting and hawking perches; aerial insectivore	X				X		X		X		X	
Williamson's Sapsucker	R (*nataliae*); B (*thyroideus*)		x	1	1	1	PCE; uses live trees or snags for nesting/roosting; uses live remnant/ legacy trees; bark forager and sap-sucker	X	X	X		X		X		X	X	X	
Yellow-bellied Sapsucker				1	1	1	PCE; uses live trees or snags for nesting/roosting; uses live remnant/ legacy trees; bark forager and sap-sucker	X	X	X				X		X	X		

Vertebrate Species	Conservation Status			Level of Dependency[a]			Comments on Wildlife Tree Use	Dependency on Wildlife Tree Habitat Elements											
	CDC[b]	COSEWIC[c]	IWMS	R	F	O		Snags	Hard Snags	Moderate Snags	Soft Snags	Large Snags	Mistletoe/Witches Broom	Dead Parts of Live Trees	Hollow Living Trees	Tree Cavities	Loose Bark	Live Remnant/Legacy Trees	Large Live Branches
Black-capped Chickadee				1	0	1	weak PCE; needs softer, more decayed wood, but will use existing cavities in any decay class	X			X	X		X		X			
Mountain Chickadee				1	0	1	weak PCE; needs softer, more decayed wood, but will use existing cavities in any decay class, especially sapsucker cavities (although BNA account says that cavity excavation remains unsubstantiated)	X			X	X		X		X			
Chestnut-backed Chickadee				1	0	0	weak PCE; needs softer, more decayed wood, but will use existing cavities in any decay class	X			X	X		X		X			
Boreal Chickadee				1	0	1	weak PCE; needs softer, more decayed wood, but will use existing cavities in any decay class	X			X			X		X			
Red-breasted Nuthatch				1	0	0	weak PCE; prefers larger snags, but uses a wide range of sizes; dead parts of live trees for bark foraging	X				X		X		X	X		
White-breasted Nuthatch				1	0	0	SCU/weak PCE; uses dead parts of live trees for bark foraging	X						X		X	X		
Pygmy Nuthatch				1	0	1	PCE/SCU; excavates in decayed conifers or nests in abandoned holes; uses dead parts of live trees for foraging	X	X			X		X	X	X			
Brown Creeper				1	0	0	SCU; places nests behind loose bark; forages in deep, fissured bark	X	X	X		X		X			X	X	
Bewick's Wren				1	0	0	SCU; nests in natural or woodpecker cavities	X								X			
House Wren				2	0	0	SCU; nests in woodpecker (e.g., Red-naped Sapsucker) cavities; sometimes nests behind loose bark	X								X	X		
Western Bluebird	R (GD pop)			1	0	0	SCU; nests and roosts in abandoned woodpecker holes (e.g., NOFL, HAWO) or natural cavities; hollow living trees for winter roosting	X					X		X	X			

Vertebrate Species	Conservation Status			Level of Dependency[a]			Comments on Wildlife Tree Use	Dependency on Wildlife Tree Habitat Elements											
	CDC[b]	COSEWIC[c]	IWMS	R	F	O		Snags	Hard Snags	Moderate Snags	Soft Snags	Large Snags	Mistletoe/Witches Broom	Dead Parts of Live Trees	Hollow Living Trees	Tree Cavities	Loose Bark	Live Remnant/Legacy Trees	Large Live Branches
Mountain Bluebird				1	0	0	SCU;; nests and roosts in abandoned woodpecker holes (e.g., NOFL, HAWO) or natural cavities	X				X				X			
California Myotis				2	0	2	SCU; breeds and roosts in tree cavities and under loose bark	X				X		X	X	X	X	X	
Yuma Myotis				2	0	2	SCU; breeds and roosts in tree cavities	X				X		X	X	X	X	X	
Little Brown Myotis				2	0	2	SCU; breeds and roosts in tree cavities and under loose bark	X				X		X	X	X	X	X	
Long-legged Myotis				2	0	2	SCU; breeds and roosts in tree cavities and under loose bark; live remnant/ legacy trees that project above the canopy are particularly important	X				X		X	X	X	X	X	
Keen's Long-eared Myotis	R	SC	x	2	0	2	SCU; breeds and roosts in tree cavities and under loose bark												
Western Long-eared Myotis				2	0	2	SCU; breeds and roosts in tree cavities and under loose bark	X				X					X	X	
Northern Long-eared Myotis	B			2	0	2	SCU; breeds and roosts in tree cavities and under loose bark	X		X	X				X	X	X		
Silver-haired Bat				1	0	1	SCU; breeds and roosts in tree hollows and spaces underneath bark; snag height is the key within or around surrounding canopy	X				X			X	X	X	X	
Big Brown Bat				2	0	2	SCU; breeds and roosts in tree hollows and spaces underneath loose bark	X				X		X	X	X	X	X	
Pallid Bat	R	T		2	0	3	SCU; may breed or roost in tree cavities	X				X			X	X	X	X	
Yellow-pine Chipmunk				2	0	2	SCU; nests may occur in tree cavities	X								X			
Red Squirrel				2	3	2	SCU; nests may occur in tree cavities or on brooms; may nest secondarily in abandoned woodpecker holes						X		X	X			X
Douglas' Squirrel				2	3	2	SCU; nests may occur in tree cavities or on brooms; may nest secondarily in abandoned woodpecker holes											X	X

Vertebrate Species	Conservation Status			Level of Dependency[a]			Comments on Wildlife Tree Use	Dependency on Wildlife Tree Habitat Elements											
	CDC[b]	COSEWIC[c]	IWMS	R	F	O		Snags	Hard Snags	Moderate Snags	Soft Snags	Large Snags	Mistletoe/Witches Broom	Dead Parts of Live Trees	Hollow Living Trees	Tree Cavities	Loose Bark	Live Remnant/Legacy Trees	Large Live Branches
Northern Flying Squirrel				2	3	2	SCU; nests in abandoned woodpecker holes (e.g., TTWO, BBWO) and on mistletoe or rust brooms	X		X		X	X		X	X			X
Black Bear	B (*emmonsii*)			2	0	2	SCU; uses hollow trees for denning	X				X			X		X		
Raccoon				2	0	2	SCU; uses cavities or hollow trees for denning	X							X	X			
American Marten				2	0	2	SCU; may use cavities for denning if large enough; also checks cavities for prey	X				X	X			X		X	X
Fisher	B		x	1	0	2	SCU; uses cavities or hollow trees for denning	X				X	X	X		X		X	X
Caribou	R (southern pop)	T (southern mountain pop)	x (caribou subspecies)	0	1	0	forages on lichen growing on remnant/ legacy trees, large live tree branches, and snags	X				X							X
Total = 70	Listed = 20	Listed = 11	Listed = 15	1 = 37 2 = 32 3 = 0	1 = 13 2 = 6 3 = 3	1 = 17 2 = 20 3 = 1	13 strong PCEs; 5 weak PCEs; 43 SCUs; 7 ONs; 1 lichen forager; 1 bark user for reproduction, foraging and other	66	15	17	8	48	12	28	22	57	23	29	9

Table 4. Occurrence of wildlife tree-dependent vertebrates in British Columbia by forest district and BEC zone sampled for the Wildlife Tree Evaluation Project.

Species/Taxa	CDC[a]	IWMS [b]	Occurrence by Sampled Forest District[c]														Occurrence by BEC[d] (sampled zones are shaded)											
Clouded Salamander			DSI	DCK																MH						CDF		CWH
Great Blue Heron	B	x	DSI	DCK	DAR	DKL	DKA	DCL	DCH	DQU	DPG	DJO	DKI	DNC			BWBS	SBPS	SBS	MH		MS	BG	PP	IDF	CDF	ICH	CWH
Wood Duck			DSI	DCK	DAR	DKL	DKA	DCL	DCH	DQU		DJO					BWBS						BG	PP	IDF	CDF	ICH	CWH
Bufflehead			DSI	DCK	DAR	DKL	DKA	DCL	DCH	DQU	DPG	DJO	DKI	DNC				SBPS	SBS	MH	ESSF	MS	BG	PP	IDF	CDF	ICH	CWH
Common Goldeneye			DSI	DCK	DAR	DKL	DKA	DCL	DCH	DQU	DPG	DJO	DKI	DNC	AT	SWB	BWBS	SBPS	SBS	MH	ESSF	MS	BG	PP	IDF	CDF	ICH	CWH
Barrow's Goldeneye			DSI	DCK	DAR	DKL	DKA	DCL	DCH	DQU	DPG	DJO	DKI	DNC	AT	SWB	BWBS	SBPS	SBS	MH	ESSF	MS	BG	PP	IDF	CDF	ICH	CWH
Hooded Merganser			DSI	DCK	DAR	DKL	DKA	DCL	DCH	DQU	DPG	DJO	DKI	DNC				SBPS	SBS		ESSF	MS	BG	PP	IDF	CDF	ICH	CWH
Common Merganser			DSI	DCK	DAR	DKL	DKA	DCL	DCH	DQU	DPG	DJO	DKI	DNC				SBPS	SBS	MH	ESSF	MS	BG	PP	IDF	CDF	ICH	CWH
Osprey			DSI	DCK	DAR	DKL	DKA	DCL	DCH	DQU	DPG	DJO	DKI	DNC		SWB	BWBS	SBPS	SBS			MS	BG	PP	IDF	CDF	ICH	CWH
Bald Eagle			DSI	DCK	DAR	DKL	DKA	DCL	DCH	DQU	DPG	DJO	DKI	DNC	AT	SWB	BWBS	SBPS	SBS	MH	ESSF	MS	BG	PP	IDF	CDF	ICH	CWH
Northern Goshawk			DSI	DCK	DAR	DKL	DKA	DCL	DCH	DQU	DPG	DJO	DKI	DNC	AT	SWB	BWBS	SBPS	SBS	MH	ESSF	MS	BG	PP	IDF	CDF	ICH	CWH
Laingi subsp. (Queen Charlotte Islands)	R	x	DSI																	MH								CWH
American Kestrel			DSI	DCK	DAR	DKL	DKA	DCL	DCH	DQU	DPG	DJO	DKI	DNC	AT	SWB	BWBS	SBPS	SBS	MH	ESSF	MS	BG	PP	IDF	CDF	ICH	CWH
Marbled Murrelet	R	x	DSI											DNC												CDF		CWH
Flammulated Owl	B	x					DKA															MS	BG	PP	IDF			
Western Screech-owl			DSI	DCK	DAR	DKL	DKA						DKI	DNC									BG	PP	IDF	CDF	ICH	CWH
Saturatus subsp. (SE Van. Island and Gulf Islands)	B		DSI																							CDF		CWH
Macfarlanei subsp. (BC interior)	R	x			DAR	DKL	DKA																BG	PP	IDF			
Great Horned Owl			DSI	DCK	DAR	DKL	DKA	DCL	DCH	DQU	DPG	DJO	DKI	DNC		SWB	BWBS	SBPS	SBS	MH	ESSF	MS	BG	PP	IDF	CDF	ICH	CWH
Northern Hawk Owl			DSI	DCK	DAR	DKL	DKA	DCL	DCH	DQU	DPG	DJO		DNC		SWB	BWBS	SBPS	SBS	MH		MS	BG	PP	IDF	CDF	ICH	CWH
Northern Pygmy-owl			DSI	DCK	DAR	DKL	DKA	DCL	DCH	DQU	DPG	DJO		DNC			BWBS	SBPS	SBS	MH	ESSF		BG	PP	IDF	CDF	ICH	CWH
Swarthi subsp. (Van. Island & adjacent Islands)	B	x	DSI																	MH						CDF		CWH

a CDC listing: B = blue-listed; R = red-listed.

b IWMS ranking: 1 = high priority for inclusion in Volume II; 2 = intermediate priority for inclusion in Volume II.

c Occurrence by sampled Forest Districts: DSI = South Island; DCK = Chilliwack; DAR = Arrow; DKL = Kootenay Lake; DKA = Kamloops; DCL = Clearwater; DCH = Chilcotin; DQU = Quesnel; DPG = Prince George; DJO = Fort St. John; DKI = Kispiox; DNC = North Coast (note that six species occur in forest districts that were not sampled as part of the WT Evaluation project).

d Occurrence by sampled BEC zones: AT = Alpine Tundra; SWB = Spruce-Willow-Birch; BWBS = Boreal White and Black Spruce; SBPS = Sub-Boreal Pine-Spruce; SBS = Sub-Boreal Spruce; MH = Mountain Hemlock; ESSF = Engelmann Spruce-Subalpine Fir; MS = Montane Spruce; BG = Bunchgrass; PP = Ponderosa Pine; IDF = Interior Douglas-fir; CDF = Coastal Douglas-fir; ICH = Interior Cedar-Hemlock; CWH = Coastal Western Hemlock.

Species/Taxa	CDC[a]	IWMS[b]	Occurrence by Sampled Forest District[c]														Occurrence by BEC[d] (sampled zones are shaded)											
Spotted Owl	R	x		DCK															MH								CWH
Barred Owl			DSI	DCK	DAR	DKL	DKA	DCL		DQU	DPG	DJO	DKI	DNC			BWBS	SBPS	SBS	MH		MS	BG	PP	IDF	CDF	ICH	CWH
Great Gray Owl			DSI	DCK	DAR	DKL	DKA	DCL	DCH	DQU	DPG	DJO	DKI				BWBS	SBPS	SBS			MS	BG	PP	IDF	CDF	ICH	CWH
Boreal Owl				DCK	DAR	DKL	DKA	DCL	DCH	DQU		DJO	DKI			SWB	BWBS	SBPS	SBS	MH	ESSF	MS	BG	PP	IDF		ICH	CWH
Northern Saw-whet Owl			DSI	DCK	DAR	DKL	DKA	DCL	DCH	DQU	DPG	DJO	DKI	DNC	AT		BWBS	SBPS	SBS	MH			BG	PP	IDF	CDF	ICH	CWH
Brooksi subsp. (Queen Charlotte Islands)	B	x																										CWH
Vaux's Swift			DSI	DCK	DAR	DKL	DKA	DCL	DCH	DQU	DPG	DJO	DKI	DNC		SWB	BWBS	SBPS	SBS	MH	ESSF	MS	BG	PP	IDF	CDF	ICH	CWH
Lewis' Woodpecker			DSI	DCK	DAR	DKL	DKA	DCL										SBPS	SBS				BG	PP	IDF	CDF	ICH	CWH
Georgia Depression population	R	x	DSI	DCK																								CWH
Interior population	B	x			DAR	DKL	DKA	DCL										SBPS	SBS				BG	PP	IDF	CDF	ICH	
Williamson's Sapsucker																						MS			IDF		ICH	
Nataliae subsp. (southeastern BC)	R	x																				MS			IDF		ICH	
Thyroideus subsp. (south-central BC)	B	x			DAR		DKA															MS			IDF		ICH	
Yellow-bellied Sapsucker											DPG	DJO					BWBS		SBS									
Red-naped Sapsucker				DCK	DAR	DKL	DKA	DCL	DCH	DQU								SBPS	SBS			MS	BG	PP	IDF	CDF	ICH	CWH
Red-breasted Sapsucker			DSI	DCK				DCL	DCH	DQU	DPG		DKI	DNC									BG	PP	IDF	CDF	ICH	CWH
Downy Woodpecker			DSI	DCK	DAR	DKL	DKA	DCL	DCH	DQU	DPG	DJO	DKI	DNC		SWB	BWBS	SBPS	SBS		ESSF	MS	BG	PP	IDF	CDF	ICH	CWH
Hairy Woodpecker			DSI	DCK	DAR	DKL	DKA	DCL	DCH	DQU	DPG	DJO	DKI	DNC		SWB	BWBS	SBPS	SBS	MH	ESSF	MS	BG	PP	IDF	CDF	ICH	CWH
Picoides subsp. (Queen Charlotte Islands)	B	x																		MH								CWH
White-headed Woodpecker	R	x																			ESSF	MS	BG	PP	IDF		ICH	
Three-toed Woodpecker				DCK	DAR	DKL	DKA	DCL	DCH	DQU	DPG	DJO	DKI			SWB	BWBS	SBPS	SBS	MH	ESSF	MS		PP	IDF	CDF	ICH	CWH
Black-backed Woodpecker				DCK	DAR	DKL	DKA	DCL	DCH	DQU	DPG	DJO	DKI			SWB	BWBS	SBPS	SBS		ESSF	MS	BG	PP	IDF		ICH	CWH
Northern Flicker			DSI	DCK	DAR	DKL	DKA	DCL	DCH	DQU	DPG	DJO	DKI	DNC		SWB	BWBS	SBPS	SBS	MH			BG	PP	IDF	CDF	ICH	CWH
Pileated Woodpecker			DSI	DCK	DAR	DKL	DKA	DCL	DCH	DQU	DPG	DJO	DKI				BWBS	SBPS	SBS	MH	ESSF	MS	BG	PP	IDF	CDF	ICH	CWH
Purple Martin	R		DSI	DCK													BWBS									CDF		CWH
Tree Swallow			DSI	DCK	DAR	DKL	DKA	DCL	DCH	DQU	DPG	DJO	DKI	DNC		SWB	BWBS	SBPS	SBS	MH	ESSF	MS	BG	PP	IDF	CDF	ICH	CWH
Violet-green Swallow			DSI	DCK	DAR	DKL	DKA	DCL	DCH	DQU	DPG	DJO	DKI	DNC	AT	SWB	BWBS	SBPS	SBS			MS	BG	PP	IDF	CDF	ICH	CWH
Black-capped Chickadee				DCK	DAR	DKL	DKA	DCL	DCH	DQU	DPG	DJO	DKI				BWBS	SBPS	SBS				BG	PP	IDF		ICH	CWH
Mountain Chickadee				DCK	DAR	DKL	DKA	DCL	DCH	DQU	DPG		DKI			SWB	BWBS	SBPS	SBS		ESSF	MS	BG	PP	IDF		ICH	CWH
Chestnut-backed Chickadee			DSI	DCK	DAR	DKL		DCL	DCH		DPG		DKI	DNC					SBS	MH		MS			IDF	CDF	ICH	CWH
Boreal Chickadee				DCK	DAR	DKL	DKA	DCL	DCH	DQU	DPG	DJO	DKI			SWB	BWBS	SBPS	SBS		ESSF	MS			IDF		ICH	

Species/Taxa	CDC[a]	IWMS [b]	Occurrence by Sampled Forest District[c]														Occurrence by BEC[d] (sampled zones are shaded)											
Red-breasted Nuthatch			DSI	DCK	DAR	DKL	DKA	DCL	DCH	DQU	DPG	DJO	DKI	DNC		SWB	BWBS	SBPS	SBS	MH	ESSF	MS		PP	IDF	CDF	ICH	CWH
White-breasted Nuthatch				DCK	DAR		DKA		DCH	DQU	DPG	DJO										MS	BG	PP	IDF		ICH	
Pygmy Nuthatch							DKA																BG	PP	IDF			
Brown Creeper			DSI	DCK	DAR	DKL	DKA	DCL	DCH	DQU	DPG	DJO	DKI	DNC			BWBS	SBPS	SBS	MH	ESSF	MS		PP	IDF	CDF	ICH	CWH
Bewick's Wren			DSI	DCK																						CDF		CWH
House Wren			DSI	DCK	DAR	DKL	DKA			DQU	DPG	DJO					BWBS	SBPS	SBS			MS	BG	PP	IDF	CDF	ICH	CWH
Western Bluebird			DSI	DCK	DAR	DKL	DKA	DCL	DCH	DQU												MS	BG	PP	IDF	CDF	ICH	CWH
Georgia Depression population	R		DSI	DCK																						CDF		CWH
Mountain Bluebird			DSI	DCK	DAR	DKL	DKA	DCL	DCH	DQU	DPG	DJO	DKI		AT	SWB	BWBS	SBPS	SBS	MH	ESSF	MS	BG	PP	IDF	CDF	ICH	CWH
California Myotis			DSI	DCK	DAR	DKL	DKA	DCL														MS	BG	PP	IDF	CDF	ICH	CWH
Yuma Myotis			DSI	DCK	DAR	DKL	DKA	DCL	DCH					DNC									BG	PP	IDF	CDF	ICH	CWH
Little Brown Myotis			DSI	DCK	DAR	DKL	DKA	DCL	DCH	DQU	DPG	DJO		DNC	AT	SWB	BWBS	SBPS	SBS		ESSF	MS	BG	PP	IDF	CDF	ICH	CWH
Long-legged Myotis			DSI	DCK		DKL	DKA						DKI					SBPS	SBS		ESSF	MS	BG	PP	IDF	CDF	ICH	CWH
Keen's Long-eared Myotis	R	x	DSI																									CWH
Western Long-eared Myotis			DSI	DCK		DKL	DKA		DCH		DPG					SWB	BWBS	SBPS	SBS		ESSF	MS	BG	PP	IDF	CDF	ICH	CWH
Northern Long-eared Myotis	B																BWBS										ICH	
Silver-haired Bat			DSI	DCK	DAR	DKL	DKA			DQU	DPG	DJO		DNC		SWB	BWBS	SBPS	SBS	MH	ESSF	MS	BG	PP	IDF	CDF	ICH	CWH
Big Brown Bat			DSI	DCK			DKA				DPG	DJO					BWBS	SBPS	SBS			MS	BG	PP	IDF	CDF	ICH	CWH
Pallid Bat	R																						BG	PP				
Yellow-pine Chipmunk				DCK	DAR	DKL	DKA	DCL	DCH	DQU	DPG		DKI					SBPS	SBS	MH		MS	BG	PP	IDF		ICH	CWH
Red Squirrel			DSI		DAR	DKL	DKA	DCL	DCH	DQU	DPG	DJO	DKI	DNC		SWB	BWBS	SBPS	SBS	MH	ESSF	MS	BG	PP	IDF	CDF	ICH	CWH
Douglas' Squirrel				DCK																MH						CDF		CWH
Northern Flying Squirrel				DCK	DAR	DKL	DKA	DCL	DCH	DQU	DPG	DJO	DKI	DNC		SWB	BWBS	SBPS	SBS	MH	ESSF	MS		PP	IDF		ICH	CWH
Black Bear			DSI	DCK	DAR	DKL	DKA	DCL	DCH	DQU	DPG	DJO	DKI	DNC	AT	SWB	BWBS	SBPS	SBS	MH	ESSF	MS	BG	PP	IDF	CDF	ICH	CWH
Emmonsii subsp. (Alsek/Tatshenshini)	B														AT					MH								CWH
Raccoon			DSI	DCK	DAR	DKL																MS	BG	PP	IDF	CDF	ICH	CWH
American Marten			DSI	DCK	DAR	DKL	DKA	DCL	DCH	DQU	DPG	DJO	DKI	DNC		SWB	BWBS	SBPS	SBS	MH	ESSF	MS		PP	IDF	CDF	ICH	CWH
Fisher	B	x			DAR		DKA	DCL	DCH	DQU	DPG	DJO	DKI	DNC		SWB	BWBS	SBPS	SBS	MH	ESSF	MS		PP	IDF		ICH	CWH
Caribou					DAR	DKL		DCL	DCH	DQU	DPG	DJO	DKI		AT	SWB	BWBS	SBPS	SBS		ESSF	MS					ICH	
Southern population	R	x			DAR	DKL		DCL		DQU	DPG				AT				SBS		ESSF						ICH	

Available empirical data on wildlife trees used for foraging are summarized in Appendix 3 for the bark-foraging, foliage-gleaning, and sapsucking wildlife guilds of the southern interior. Mean diameters and heights of trees used for foraging average 20–42.3 cm dbh and 10–22.5 m height, respectively. Median decay classes range from 1 to 5 (with actual decay class values ranging from 1 to 9). For the purpose of our analyses, *functional* wildlife trees for foraging are therefore defined as trees measuring ≥20 cm dbh and ≥10 m height in decay classes 1 to 8.

Available empirical data on home range sizes, territory sizes, and breeding densities of wildlilfe tree-dependent species are summarized in Appendix 4. Home range size data were available for 52 of the 70 species. The percentage of species using particular home range size classes was: <1 ha = 7.7%; 1–10 ha = 34.6%; 1–50 ha = 11.5%; 1–100 ha = 2%; 10–500 ha = 3.6%; 100–500 ha = 9.6%; 50–1000 ha = 2%; 100–1000 = 5.8%; 500–10000 ha = 5.8%; 1000–10000 ha = 15.4%; >10000 = 2%.

Information on territory sizes and breeding densities was available for eight and 16 of the 70 species, respectively. Estimated sizes of breeding territories for eight species (two cavity-nesting ducks; five nuthatch, chickadee, and bluebird species; and the Downy Woodpecker) ranged from 0.52 to 8.8 ha. Sizes were <1 ha for two of the eight species, and the larger species (for which sizes are more difficult to estimate) were not included in the sample. Estimated breeding densities ranged from 0.001 to 1.4 pairs/ha for 16 species (most woodpeckers and selected cavity-nesting ducks, nuthatches, chickadees, and Brown Creeper). Breeding territory size and density values in Appendix 4 must be interpreted with caution because they were generated throughout North America in ecosystems that are not necessarily comparable to those found in British Columbia. Some of the studies that determined breeding territory and home range sizes were conducted in unmanaged stands. Clearly, territory and home range sizes are related to habitat quality, and in managed forests where only a portion of wildlife tree habitat elements have been retained, a concomitant increase in size is expected. We can conclude from the information and data gaps in Appendix 4 that the vast majority of wildlife tree-dependent species occupy home ranges and breeding territories much larger than 1 ha in area.

3.3 Geographic and Ecosystem Coverage of the Phase 1 Evaluation Project

Six forest regions, 12 forest districts (those in place before March 31, 2002), seven BEC zones, and 128 cutblocks were sampled as part of the Phase 1 project (Table 2). The occurrence of wildlife tree-dependent vertebrates in sampled forest districts and BEC zones is shown in Table 4. Seven CDC-listed taxa (i.e., Northern Saw-whet Owl *brooksi* subsp., Williamson's Sapsucker *nataliae* subsp., Hairy Woodpecker *picoides* subsp., White-headed Woodpecker, Northern Long-eared Myotis, Pallid Bat, and Black Bear *emmonsii* subsp.) do not occur in any of the forest districts sampled. Another seven species occur in only one of the 12 forest districts sampled (Flammulated Owl, Western Screech Owl *saturatus* subsp., Northern Pygmy Owl *swarthi* subsp., Spotted Owl, Pygmy Nuthatch, Keen's Long-eared Myotis, Douglas Squirrel). Similarly, 17 species are known to occur in only one of the BEC units sampled (Table 4). This lacking or low representation (in terms of habitat sampling) limits our evaluation of the adequacy of wildlife tree retention for the above species, many of which are listed by the provincial Conservation Data Centre.

3.4 Retention Levels of Habitat Elements in Relation to Wildlife Requirements

This section summarizes levels of retention of wildlife tree habitat elements, based on data from the Phase 1 project. Average densities of selected wildlife tree habitat elements in unmanaged stands are provided for comparison, when available from the same BEC zone, based on mensuration data gathered from the Provincial Ecology Program (Province of British Columbia 2001). These data were gathered through extensive sampling of unmanaged stands throughout British Columbia. They reflect stand structure densities in both mature and older stands to which endemic wildlife tree users would presumably be adapted.

Snags

Table 5 summarizes average densities of live and dead trees of functional size retained by forest districts and BEC zones. The data are broken down by tree decay and diameter classes and pooled. Also shown are the percentages of sampled cutblocks in each forest district and BEC zone for which the retention of functional snags did not exceed certain thresholds (i.e., 0 sph, ≤2.5 sph, and ≤5 sph). Mean densities ranged from 0 to 29.6 sph and from 0.2 to 31.8 sph in the forest districts and BEC zones sampled, respectively. These values are averages for all cutblocks sampled and it is important to note that there was tremendous variation in retention levels among cutblocks. Pooling all 128 blocks, almost half (46%) had no functional snag retention, and 79% of all cutblocks sampled had ≤2.5 sph of functional snags (Figure 1). The percentage of cutblocks with no functional snag retention was 83.3% in the SBPS, 50% in the ESSF, 42.9% in the IDF, 33.3% in the SBS, 32.2% in the CWH, 20% in the ICH, and 12.5% in the BWBS (Table 5). The percentage of blocks with no snag retention ranged from 13.3 to 81.8% among forest districts (81.8% in the Chilcotin, 50% in Kootenay Lake, 42.9% in Clearwater, 40% in the North Coast and Arrow, 36.2% in Chilliwack, 33.3% in Prince George, 28.6% in South Island, 21.4% in Kispiox, 20% in Quesnel and Fort St. John, and 13.3% in Kamloops; Table 5). Levels of functional snag retention exceeded 10 sph on 19 of 128 (14.8%) cutblocks sampled.

Comparing snag densities from the Phase 1 project with those observed in the same BEC units in samples from the Provincial Ecology Program (PEP) demonstrates the magnitude of dead wood reduction associated with the current practices. Average functional snag densities in the 128 cutblocks are 5% (ESSF), 7.4% (SBS), 12.5% (ICH), 12.8% (CWH), and 15% (IDF) of PEP levels (Table 5). No sampling data were available for comparison from the BWBS or SBPS zones. Pooling the five zones for which data were available, *average* snag densities were 10.5% of those reported for unmanaged stands (i.e., approximately one order of magnitude less). This corresponds to the average area retention value of 9.3% (for wildlife tree retention + Riparian Reserves) observed for all sampled cutblocks (Province of British Columbia 2003, Table 21a). While overall snag levels in reserves appear to reflect levels observed in natural stands, the actual magnitude of decline is 90% over the sampled total area under prescription (TAUP). Further analysis is required to determine the implications of this trend for sensitive wildlife tree users over time, especially if the operable land base (i.e., TAUP) increases in British Columbia.

An estimated 66 species are directly dependent on snags for reproduction, foraging, or other life requisites (Table 3). Each individual of most of the species of interest likely requires several suitable snags per hectare to meet its overall requirements for nesting, denning, roosting, foraging, and other life requisites. Furthermore, multiple species with overlapping requirements would be expected to co-occur in the same stand. The absence of snags on close to half the blocks sampled, coupled with the low levels of snag retention on the remaining blocks, is a conservation concern for all dependent species. We consider most at risk the listed species, those with a limited occurrence by ecosystem, those with high dependency scores for all life requisites, and those with very specialized snag requirements (e.g., secondary cavity users requiring large trees with cavities of appropriate size). Snag users in the SBPS and IDF zones, where average snag densities were only 0.2 and 4.2 sph, respectively, may also be at higher risk.

Hard Snags

Densities of residual hard, moderate and soft snags in reserves are provided in Table 5. Hard snags (decay classes 3–4) averaged 0.1–13.8 sph and 0–12.8 sph by BEC zone and forest district, respectively, but again, almost half (46%) of the blocks had no functional snags. Average densities in the SBPS (0.1 sph) were lowest, but with the exception of the BWBS (13.8 sph), densities in all BEC zones were <5 sph. At least 15 species (and two subspecies) are dependent on hard snags; 12 of these species are also dependent on large snags (Table 3), so only a subset of the stems ≥20 cm dbh would be suitable for them. Species likely most at risk are the five listed species/subspecies requiring hard snags, species in the SBPS, the five secondary cavity-using species/subspecies (they require hard snags with abandoned cavities for breeding), and the Pygmy Nuthatch, which is confined only to the IDF zone.

Table 5. ***Mean density of functional size (≥20 cm dbh and ≥10 m height) trees retained by forest region/district and BEC zone. Values are sph within tree decay and diameter classes. Also shown for comparison are the percentages of sampled cutblocks by district/BEC zone with snag retention densities of 0 sph, ≤2.5 sph, and ≤5 sph, and snag retention densities reported by the Provincial Ecology Program.***

Sampling Units		No. of Blocks	Class 1 (live healthy) dbh Classes					Class 2 (live defective) dbh Classes					Class 3–4 (hard snags) dbh Classes					Class 5 (moderate snags) dbh Classes					Class 6–8 (soft snags) dbh Classes					All Snags (sph)	Percent of Blocks with Snag Retention of:			PEP Snag Density (sph)[a]
			20–30	30–40	40–50	≥50	Total ≥20	20–30	30–40	40–50	≥50	Total ≥20	20–30	30–40	40–50	≥50	Total ≥20	20-30	30–40	40–50	≥50	Total ≥20	20–30	30–40	40–50	≥50	Total ≥20		0 sph	≤2.5 sph	≤5 sph	
Region/District:																																
RCA	DCH	11	0.2	0.1	0	0.1	0.4	0.8	0.2	0.1	0	1.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	81.8	100.0	100.0	–
RCA	DQU	5	18.5	2.5	0.4	0.5	21.9	17	5.3	0.2	0.2	22.7	1.2	0.2	0	0.2	1.6	0	0	0	0	0	0.3	0	0	0	0.3	3.5	20.0	60.0	100.0	–
RKA	DCL	14	21.8	3.6	1.3	0.8	27.5	7.2	2.2	1.2	0.9	11.5	1.3	0.8	0	0	2.1	0	0.2	0.2	0.1	0.5	0.6	0.3	0	0.1	1	6.2	42.9	57.1	64.3	–
RKA	DKA	15	16.9	6.4	4	4.7	32	14.6	2.3	2	4.5	23.4	2	0.6	0.2	0.6	3.4	0.3	0	0	0	0.3	0.2	0	0	0.4	0.6	8	13.3	46.7	53.3	–
RNE	DAR	10	6.6	4.2	3.4	2.5	16.7	7	4.3	2.2	3.4	16.9	1.3	0.3	0.2	0.2	2	0.6	0	0.3	0	0.9	0	0	0	0	0	5.8	40.0	60.0	70.0	–
RNE	DKL	12	12.2	7.2	1.7	3.1	24.2	14.6	6.5	4.7	4.3	30.1	3.1	1	0.1	0.1	4.3	0	0	0.1	0	0.1	0	0	0	0	0	8.8	50.0	58.3	58.3	–
RPG	DJO	10	42	18.1	4.4	1.7	66.2	14.8	7.6	1.5	0.9	24.8	9.9	1.2	1.6	0.1	12.8	1.5	0.2	0.3	0	2	0	0	0	0	0	29.6	20.0	40.0	40.0	–
RPG	DPG	9	10.3	7.5	4.3	0.7	22.8	7.7	0.4	1.6	0.4	10.1	1.5	1.7	0.2	0	3.4	0	0	0	0	0	0	0	0	0	0	6.8	33.3	66.7	77.8	–
RPR	DKI	14	8.9	7.1	2.8	4.6	23.4	2.9	2.1	2	4.1	11.1	2.3	0.7	0.2	0.2	3.4	0.2	0.4	0.1	0.4	1.1	1.4	1	0	0.5	2.9	11.9	21.4	57.1	57.1	–
RPR	DNC	10	5.6	8.1	5.9	9.9	29.5	0	3.6	4	4.8	12.4	1.5	0.7	0	0.3	2.5	0	0	0.4	0.2	0.6	1.4	0	0	0.8	2.2	8.4	40.0	80.0	90.0	–
RVA	DCK	11	4.5	6	14.4	5.5	30.4	7.4	3.3	4.7	7.9	23.3	0.7	0.7	0.3	0.2	1.9	0.6	0	0	0	0.6	0	0	0	0.1	0.1	5.1	36.2	72.7	72.7	–
RVA	DSI	7	12.6	13.1	8.2	4.5	38.4	9.7	9.5	4.7	4.3	28.2	5.3	0.4	0	0.1	5.8	0	0.1	0	0	0.1	0	0	0	0.5	0.5	12.3	28.6	57.1	57.1	–
BEC Zone:																																
BWBS		8	35.1	18.7	4.8	1.8	60.4	15.6	8.2	1.6	0.9	26.3	10.7	1.3	1.7	0.1	13.8	1.6	0.2	0.3	0	2.1	0	0	0	0	0	31.8	12.5	25.0	25.0	–
CWH		31	10	10.8	10.1	5.6	36.5	8.2	7.1	4.6	6	25.9	3.2	0.4	0.1	0.2	3.9	0.1	0.1	0.1	0.1	0.4	0.2	0	0	0.5	0.7	9.3	32.2	71.0	74.2	72.4
ESSF		30	17.4	2.6	0.4	0.4	20.8	3.9	2.6	0.8	0.3	7.6	1.8	1	0.1	0.1	3	0.2	0.2	0	0	0.4	0	0.2	0	0.1	0.3	7.1	50.0	70.0	70.0	143.2
ICH		30	14.3	6.9	3.8	4.4	29.4	9.9	3.2	2.9	4.3	20.3	1.6	0.5	0.2	0.3	2.6	0.4	0.1	0.3	0.1	0.9	0.6	0.2	0	0.3	1.1	8.1	20.0	46.7	53.3	65.0
IDF		14	10.6	2.4	1.7	1	15.7	9.5	1.8	1.2	1.9	14.4	1.5	0.4	0.1	0	2	0	0	0	0	0	0.2	0	0	0	0.2	4.2	42.9	71.4	78.6	27.9
SBPS		6	5.8	0.6	0	0	6.4	7.4	1.7	0	0	9.1	0	0	0	0.1	0.1	0	0	0	0	0	0	0	0	0	0	0.2	83.3	100.0	100.0	–
SBS		9	11.8	6.5	3.5	0.8	22.6	9.1	1.7	1.3	0.4	12.5	1.5	1.4	0.2	0	3.1	0	0	0	0	0	0.1	0	0	0	0.1	6.3	33.3	55.6	88.9	85.1

a Densities are mean snags/ha (≥20 cm dbh) in mature and old (>100 years) stands with all subzones, variants and site series in a given BEC zone averaged.

Moderate Snags

Average densities of moderate snags (decay class 5) of functional size ranged from 0 to 2.1 sph by BEC zone and from 0 to 1.1 sph by forest district. Blocks in the IDF, SBPS, and SBS zones (and in 46% of blocks sampled) had no retention of moderately decayed snags in sample plots. At least 17 species (and two subspecies) are dependent on moderately decayed snags, and 80% of these species also require large snags (Table 3). At highest risk may be the seven listed species/subspecies requiring moderate snags and the 7 secondary cavity users requiring snags with abandoned woodpecker holes of appropriate size (Table 3).

Soft Snags

Average densities of soft snags (decay classes 6–8) ranged from 0 to 1.1 sph by BEC zone and from 0 to 2.9 by forest district. There was no soft snag retention in the IDF, SBPS, or SBS zones (or in 46% of cutblocks sampled). The absence and/or very low densities of soft snags retained in cutblocks may pose a conservation concern for a minimum of eight species dependent on this habitat element (Table 3). Likely at highest risk are the listed Northern Long-eared Myotis and the Northern Hawk Owl, both of which are secondary cavity users.

Large Live Trees and Large Snags

Densities of large (≥50 cm dbh) live trees and snags are shown in Table 6. Stem densities of large live trees ranged from 0 sph in the SBPS to 11.6 sph in the CWH. Based on the data from the Provincial Ecology Program, densities of large live trees in mature and old stands range from 31.0 sph in the ESSF to 115.0 sph in the CWH (i.e., approximately one order of magnitude greater than those found during the Phase 1 project).

An analysis of the pre- versus post-harvest diameters and heights of trees sampled for the Phase 1 project indicated that there was a shift to smaller diameters and heights in reserve trees (Province of British Columbia 2003). Of the 51 BEC zone/tree species combinations analyzed, 48 (94%) showed reductions in average height, 18 (35.3%) of which was statistically significant. Three BEC zone/tree species combinations (6%) showed increases in average height, none of which were statistically significant. Thirty of the 51 BEC zone/tree species combinations (59%) showed decreases in average diameter, four of which were statistically significant. Twenty of the BEC zone/tree species combinations (39%) showed increases in average diameter, two of which were statistically significant. Decreases in average tree diameter and height of reserve trees may have been due to (1) selection of reserve locations with low site quality, (2) selection of marginally merchantable trees, understorey trees, and large advanced regeneration for retention, and (3) selection of trees with lower height/diameter ratio, to reduce windthrow risk.

Pooling all decay classes, average densities of large snags (≥50 cm dbh) ranged from 0.1 to 1.5 sph in the sampled cutblocks (46% had no snag retention). The Provincial Ecology Program reported average densities of large snags of 2.6–14.7 sph (Table 6), which is approximately one order of magnitude larger than those found on cutblocks sampled for the Phase 1 project.

Table 6. Mean density (sph) of large (≥50 cm dbh and ≥10 m height) live trees and snags retained by BEC zone. Also shown for comparison are large live tree and snag densities reported by the Provincial Ecology Program.

BEC Zone	No. Blocks	PEP Live Tree Density	Class 1–2 (live trees)	Class 3–4 (hard snags)	Class 5 (mod. snags)	Class 6–8 (soft snags)	All Snags	PEP Snag Density[a]
BWBS	8	–	2.7	0.1	0	0	0.1	–
CWH	31	115.0	11.6	0.2	0.1	0.7	1.0	14.7
ESSF	30	31.0	0.7	0.1	0	0.3	0.4	6.4
ICH	30	101.4	8.7	0.3	0.1	1.1	1.5	6.1
IDF	14	63.2	2.9	0	0	0.2	0.2	2.6
SBPS	6	–	0	0.1	0	0	0.1	–
SBS	9	34.3	1.2	0	0	0.1	0.1	3.2

a Densities are mean snags/ha (≥50 cm dbh) in mature and old (>100 years) stands, with all subzones, variants, and site series in a given BEC zone averaged.

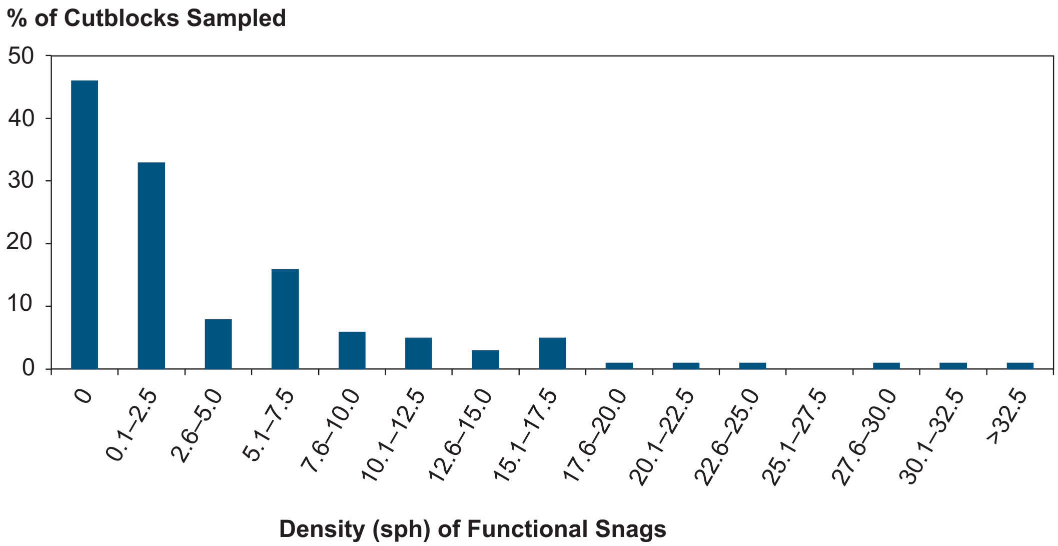

Figure 1. Frequency distribution showing percent retention (sph) of functional size (≥20 cm dbh and ≥10 m height) snags in 128 cutblocks sampled for the Phase 1 Wildlife Tree Evaluation Project.

The requirement for large trees and snags has been well documented in the literature (review in Bull et al. 1997; Johnson and O'Neil 2001; Laudenslayer et al. 2002). Large size is associated with lower rates of nest predation and detection (Li and Martin 1991), greater thermoregulatory capacity, and appropriate decay conditions at preferred heights (Bull et al. 1997). Large-diameter trees with deeply furrowed bark also provide optimal temperature and moisture conditions for insect larvae and pupae to overwinter. They harbour a greater density of insects within a given search area, and thereby reduce the energetic costs of foraging (Jackson 1979; Bull 1987; Mariani and Manuwal 1990). At least 48 species (and seven subspecies) are dependent on large snags (Table 3). The low densities of large trees and snags coupled with the decreasing trend in the size of post-harvest reserve trees may pose a conservation concern for all dependent species. At highest risk are the 15 listed species/subspecies dependent on large snags, the Pygmy Nuthatch (which is confined to the IDF zone), and to some extent the 32 secondary cavity users in this guild (Table 3).

Trees with Mistletoe/Witches Brooms

Table 7 summarizes average densities of retained trees with mistletoe brooms by BEC zone. A frequency distribution showing the density of trees with mistletoe brooms in all cutblocks sampled is shown in Figure 2. Means ranged from 0 to 2.5 functional sph by BEC however, the vast majority (87.5%) of cutblocks had no trees with mistletoe brooms retained. There was also no retention of this habitat element in the IDF, where species such as Northern Goshawk show strong selection (>80%) for trees with mistletoe broom for nesting (Machmer 2002). At least 12 species (and three subspecies) rely heavily on mistletoe brooms as nest/den platforms and/or as a food source (Table 3). While it is unclear how many trees had mistletoe brooms prior to harvesting, low supply of broomed trees may put dependent species at increased risk. Risk may be greatest for the six listed species/subspecies in this group and for species occurring in the IDF, ICH, ESSF, and SBPS where levels of trees with mistletoe brooms were lowest.

Table 7. Mean densities (± SE) of functional trees with mistletoe retained by BEC zone.

BEC Zone	No. Blocks	Mean	SE
BWBS	8	0.9	0.58
CWH	31	2.5	1.5
ESSF	30	0.1	0.01
ICH	30	0.2	0.07
IDF	14	0	0.07
SBPS	6	0.1	0.07
SBS	9	0.8	0.42

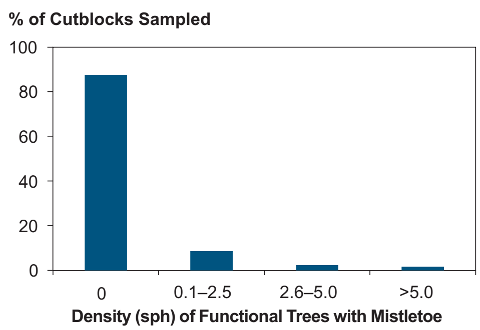

Figure 2. Frequency distribution of the density of trees with mistletoe retained in 128 cutblocks.

Dead Parts of Live Trees

None of the variables assessed for the Phase 1 project is a good surrogate for this habitat element (decay class 2 trees include a broader category of live trees with a wide variety of structural defects, presence of insects or diseases, etc.). Although at least 28 species are dependent on live trees with dead parts, the adequacy of wildlife tree retention that addresses their habitat requirements cannot be evaluated at this time.

Hollow Trees and Trees with Cavities

The only parameter from the Phase 1 project that approximates hollow trees is "trees with visible internal decay" (parameter S on field card), although the latter descriptor is much broader. Assessors noted any trees with cavities and/or dens they encountered and these were scored as "uncommon habitat features" (parameter U on the field card). Average stem densities of functional trees (live and dead) with visible internal decay ranged from 0.2 to 4.5 sph in the BEC zones sampled (Table 8). Over half (52%) of the cutblocks sampled had no trees with decay and 80.9% of cutblocks sampled had ≤2.5 sph of functional size trees with decay (Figure 3). The five cutblocks (3.9%) with stem densities of trees with internal decay exceeding 10 sph were all located in the CWH zone. No trees with cavities (i.e., cavity, hollow, or potential nest den or roost cavity) or other uncommon habitat features were found on the 128 sampled cutblocks.

Table 8. Mean densities (± SE) of functional trees with internal decay retained by BEC zone.

BEC Zone	No. Blocks	Mean	SE
BWBS	8	1.2	0.85
CWH	31	4.5	2.57
ESSF	30	0.5	0.16
ICH	30	2.8	0.98
IDF	14	0.7	0.24
SBPS	6	0.3	0.18
SBS	9	0.2	0.08

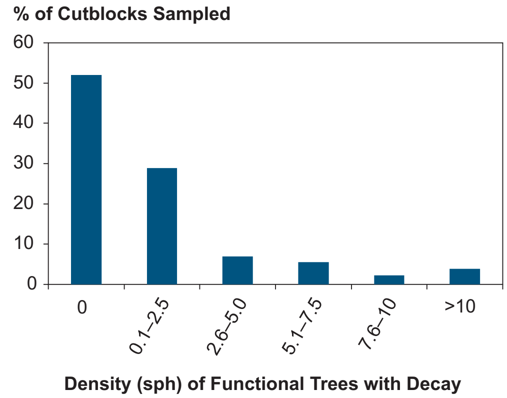

Figure 3. Frequency distribution of the density of trees with internal decay retained in 128 cutblocks.

At least 28 species are dependent on hollow trees or trees with large hollow chambers, and 57 species require tree cavities for nesting, denning, roosting, and shelter (Table 3). The negligible densities of trees with decay/cavities on sampled plots may pose a conservation concern for all dependent species. Risks are likely greatest for listed species and secondary cavity users that are not capable of excavating their own cavities. This risk may be lower in the CWH, where more trees with internal decay were retained.

Loose Bark

At least 23 species are dependent on loose bark for nesting, roosting, and feeding. Variables from the Phase 1 project do not address the "loose bark" habitat element *per se*; however, this feature was to be noted under the parameter "uncommon habitat features" (parameter U on the field card), which might not have been collected consistently. The result of this assessment of no reported cases of retention of trees with loose bark must be interpreted against this potential sampling problem.

Large Live Remnant Legacy Trees

An estimated 29 species are dependent on large remnant legacy trees. This habitat element is most closely approximated by the parameter "veteran trees" (parameter H – category 5 "veteran" on the field card). Densities of veteran trees retained in cutblocks ranged from 0 to 2.8 sph in the BEC zones sampled (Table 9). The vast majority (81.3%) of blocks sampled had no veteran tree retention and 92.2% had ≤2.5 sph (Figure 4). Although veteran trees are relatively rare features in natural stands, their low densities observed on sampled cutblocks also contribute to the overall shortage of large tree structure. As discussed under Large Live Trees and Large Snags (see page 23), a shortage of large trees might have negative implications for nest/roost/den detection and predation, thermoregulation, and foraging efficiency.

Table 9. Mean densities (± SE) of veteran trees retained by BEC zone.

BEC Zone	No. Blocks	Mean	SE
BWBS	8	0.0	0
CWH	31	0.5	0.31
ESSF	30	0.0	0.02
ICH	30	0.5	0.17
IDF	14	2.8	1
SBPS	6	0.3	0.6
SBS	9	1.4	4.38

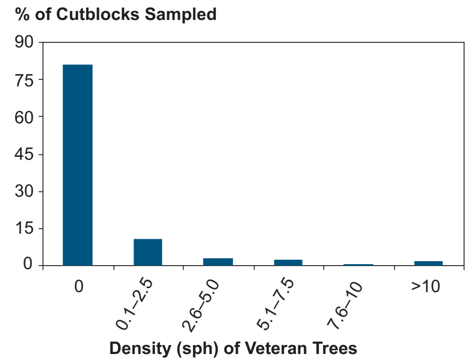

Figure 4. Frequency distribution of the density of veteran trees retained in 128 cutblocks.

Large Live Tree Branches

Large live tree branches were not sampled as part of the Phase 1 project and the adequacy of current wildlife tree retention practices with respect to this habitat element cannot be addressed at the present time.

Trees with Insects

Although trees with insects are not explicitly identified as a wildlife tree habitat element in the Columbia River Database, the latter trees represent critical foraging substrates for insectivorous wildlife tree users (Machmer and Steeger 1995; Miller 1998; Steeger et al. 1998). Based on a review of the diets of wildlife tree users, a minimum of 40 species, including bark foragers, foliage gleaners, and sapsuckers, are highly dependent on tree-dwelling insects (Machmer and Steeger 1995; see Table 3). Note that the insects of importance to many wildlife tree users are wood-boring beetles, which received emphasis during sampling. Evidence of beetle attack is typically determined by wildlife tree assessors on the basis of pitch tubes, exit holes, and evidence of woodpecker foraging.

Trees with current evidence of insects or diseases were identified during field surveys (parameter V on the field card). Since insects and diseases werecombined, reported densities will overestimate numbers of trees with insects, but still provide some indication of maximum density thresholds. Mean densities of functional trees retained with evidence of insects/diseases ranged from 0 to 2.1 sph in the BEC zones sampled (Table 10). Almost 77% of the 128 cutblocks sampled had no trees with any evidence of insects/diseases and close to 90% of blocks sampled had ≤2.5 sph of trees with insects/diseases (Figure 5).

***Table 10.* Mean densities (± SE) of trees with evidence of insects/disease retained by BEC zone.**

BEC Zone	No. Blocks	Mean	SE
BWBS	8	2.1	1.14
CWH	31	1.3	0.8
ESSF	30	1.4	1.09
ICH	30	0.4	0.2
IDF	14	0.5	0.27
SBPS	6	0.0	0
SBS	9	0.7	0.39

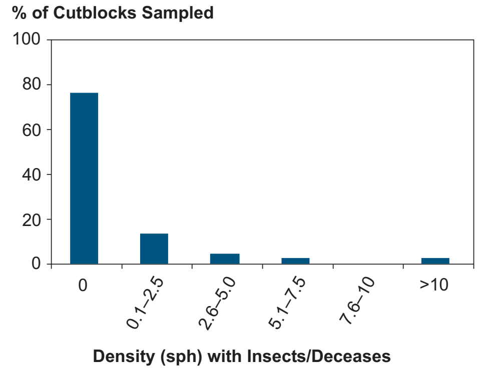

***Figure 5.* Frequency distribution of the density of trees with insects/ diseases in 128 cutblocks.**

Rare or Valuable Tree Species

Average densities of functional trees retained by tree species and decay class are shown in Table 11. As previously stated, the vast majority of trees retained were live trees (average densities of live trees ranged from 15.9 to 81.1 sph) and only a small proportion were snags (0.1–14.1 sph). Note that rare species are not present in all variants within a zone, and the Phase 1 assessments sampled only a subset of variants. Also, by virtue of being rare, some tree species were likely not present within the TAUP of the sampled cutblocks, and thus cannot be represented among retained trees. Therefore, only general trends in rare species retention are presented here. A breakdown by BEC zone is as follows:

BWBS: Half the snag retention in the BWBS consisted of trembling aspen, with the remainder as white spruce (35%) and lodgepole pine (15%). Overall species composition by volume shifted toward trembling aspen (10–36%) and away from lodgepole pine (55–16%); (Province of British Columbia 2003). This large increase in aspen was due to the high level of dispersed aspen retained on most cutblocks in this zone.

CWH: In the CWH, snag retention was comprised mainly of Douglas-fir (36.2%), red alder (25.5%), western hemlock (12.8%), amabilis fir (8.5%), and western redcedar (8.4%); some rarer and/or intensively used wildlife tree species (e.g., western white pine, Sitka spruce, black cottonwood, and bigleaf maple; see Appendix 2) were not represented in reserves. In terms of tree species composition by volume in the CWH, there was a decrease in fir (31–16%) and an increase in spruce (5–28%); (Province of British Columbia 2003).

ESSF: Tree retention in the ESSF was comprised mainly of subalpine fir (55.6%), with lesser amounts of lodgepole pine (19.4%), Engelmann spruce, and hybrid white spruce (11.1% each). Overall tree species composition by volume shifted towards lodgepole pine (19–29%) and away from hybrid white spruce (30–44%). Again, some of the rare but valuable wildlife tree species found in this zone (e.g., western redcedar, Douglas-fir) were not represented in reserves.

Table 11. Mean densities (sph) of functional size (≥20 cm dbh and ≥10 m height) trees retained by tree species and BEC zone in 128 cutblocks sampled for the Phase 1 Evaluation Project. The percentage of total snags retained by tree species is shown in parentheses.

BEC Zone	No. Blocks	Decay Class	All Species	Ac[a]	At	B	Ba	Bg	Bl	C	Cw	Cy	D	Dr	Ep	F	Fd	H	Hm	Hw	Lw	Mb	Pl	Pw	Py	Sb	Se	Ss	Sw	Sx	Y	Yc
BWBS	8	1	55.4	0.2	16.0	–[b]	–	–	0.0[c]	–	–	–	–	–	–	–	–	–	–	–	–	–	11.2	–	–	4.5	–	–	23.5	–	–	–
		2	25.7	0.5	20.1	–	–	–	0.0	–	–	–	–	–	–	–	–	–	–	–	–	–	2.9	–	–	0.0	–	–	2.2	–	–	–
		3–4	12.7	0.0	5.7	–	–	–	0.0	–	–	–	–	–	–	–	–	–	–	–	–	–	2.1	–	–	0.0	–	–	4.9	–	–	–
		5	1.3	0.0	1.3	–	–	–	0.0	–	–	–	–	–	–	–	–	–	–	–	–	–	0.0	–	–	0.0	–	–	0.0	–	–	–
		6–8	0.0	0.0	0.0	–	–	–	0.0	–	–	–	–	–	–	–	–	–	–	–	–	–	0.0	–	–	0.0	–	–	0.0	–	–	–
		all snags	14.0	0.0	7.0 (50)	–	–	–	0.0	–	–	–	–	–	–	–	–	–	–	–	–	–	2.1 (15)	–	–	0.0	–	–	4.9 (35)	–	–	–
CWH	31	1	36.4	0.0	0.0	0.1	0.9	–	2.0	1.7	2.5	0.1	2.3	0.0	–	12.5	1.4	3.4	0.2	3.8	–	0.8	0.0	–	–	–	4.3	0.1	–	–	0.2	0.1
		2	25.8	0.0	0.0	0.8	1.0	–	0.1	0.6	0.9	0.0	5.1	0.4	–	1.9	1.0	5.8	0.5	5.7	–	0.5	0.0	–	–	–	1.2	0.0	–	–	0.0	0.3
		3–4	3.9	0.0	0.0	0.1	0.2	–	0.1	0.0	0.0	0.0	1.2	0.0	–	1.7	0.0	0.1	0.0	0.5	–	0.0	0.0	–	–	–	0.0	0.0	–	–	0.0	0.0
		5	0.1	0.0	0.0	0.0	0.0	–	0.0	0.1	0.0	0.0	0.0	0.0	–	0.0	0.0	0.0	0.0	0.0	–	0.0	0.0	–	–	–	0.0	0	–	–	0.0	0.0
		6–8	0.7	0.0	0.0	0.0	0.2	–	0.0	0.2	0.1	0.0	0.0	0.1	–	0.0	0.0	0.0	0.0	0.1	–	0.0	0.0	–	–	–	0.0	0.0	–	–	0.0	0.0
		all snags	4.7	0.0	0.0	0.1 (2)	0.4 (8.5)	–	0.1 (2)	0.3 (6.4)	0.1 (2)	0.0	1.2 (25.5)	0.1 (2)	–	1.7 (36.2)	0.0	0.1 (2)	0.0	0.6 (12.8)	–	0.0	0.0	–	–	–	0.0	0.0	–	–	0.0	0.0
ESSF	30	1	18.5	0.0	0.0	1.9	0.0	–	6.3	0.0	0.1	–	–	–	0.0	0.0	0.3	0.0	0.0	0.4	0.1	–	3.6	0.0	–	–	0.0	–	2.2	3.6	–	–
		2	7.5	0.0	0.0	0.0	0.0	–	2.9	0.0	0.4	–	–	–	0.0	0.0	0.0	0.0	0.0	0.2	0.1	–	2.8	0.0	–	–	0.2	–	0.0	0.9	–	–
		3–4	2.9	0.0	0.0	0.0	0.0	–	1.5	0.0	0.0	–	–	–	0.0	0.0	0.0	0.0	0.0	0.0	0.0	–	0.7	0.1	–	–	0.2	–	0.0	0.4	–	–
		5	0.4	0.0	0.0	0.0	0.0	–	0.2	0.0	0.0	–	–	–	0.0	0.0	0.0	0.0	0.0	0.0	0.0	–	0.0	0.0	–	–	0.2	–	0.0	0.0	–	–
		6–8	0.3	0.0	0.0	0.0	0.0	–	0.3	0.0	0.0	–	–	–	0.0	0.0	0.0	0.0	0.0	0.0	0.0	–	0.0	0.0	–	–	0.0	–	0.0	0.0	–	–
		all snags	3.6	0.0	0.0	0.0	0.0	–	2.0 (55.6)	0.0	0.0	–	–	–	0.0	0.0	0.0	0.0	0.0	0.0	0.0	–	0.7 (19.4)	0.1 (2.8)	–	–	0.4 (11.1)	–	0.0	0.4 (11.1)	–	–
ICH	30	1	29.0	0.3	0.0	0.0	0.0	0.0	2.8	0.0	8.5	–	0.0	0.0	0.5	0.0	5.9	0.0	–	3.5	1.0	0.0	3.5	0.0	0.5	–	0.0	–	–	2.5	0.0	0.0
		2	20.6	0.2	0.6	0.0	0.1	0.0	0.9	0.0	6.2	–	0.0	0.0	0.5	0.0	5.4	0.0	–	2.7	1.6	0.0	1.5	0.2	0.2	–	0.0	–	–	0.5	0.0	0.0
		3–4	2.5	0.0	0.0	0.0	0.0	0.0	1.1	0.0	0.7	–	0.0	0.0	0.0	0.0	0.5	0.0	–	0.0	0.0	0.0	0.0	0.0	0.0	–	0.0	–	–	0.2	0.0	0.0
		5	1.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	–	0.0	0.0	0.4	0.0	0.0	0.0	–	0.0	0.0	0.0	0.0	0.3	0.0	–	0.0	–	–	0.2	0.0	0.0
		6–8	1.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	–	0.0	0.0	0.0	0.0	0.1	0.0	–	0.0	0.0	0.0	0.4	0.0	0.0	–	0.0	–	–	0.1	0.0	0.0
		all snags	4.5	0.0	0.0	0.0	0.0	0.0	1.6 (35.6)	0.0	0.7 (15.6)	–	0.0	0.0	0.4 (8.9)	0.0	0.6 (13.3)	0.0	–	0.0	0.0	0.0	0.4 (8.9)	0.3 (6.7)	0.0	–	0.0	–	–	0.5 (11.1)	0.0	0.0

a Tree species: Act = black cottonwood; At = trembling aspen; B = balsam fir; Ba = amabilis fir; Bg = grand fir; Bl = subalpine fir; C = cedar; Cw = western redcedar; Cy = yellow cedar; D = alder; Dr = red alder; Ep = paper birch; F = Douglas-fir; Fd = Douglas-fir; H = hemlock; Hm = mountain hemlock; Hw = western hemlock; Lw = western larch; Mb = bigleaf maple; Pl = lodgepole pine; Pw = western white pine; Py = ponderosa pine; Sb = black spruce; Se = Engelmann spruce; Ss = Sitka spruce; Sw = white spruce; Sx = hybrid white spruce; Y = yew; Yc = yellow cedar

b trees do not occur in the ecosystem

c trees were present but not of functional size (i.e., ≥20 cm dbh and ≥10 m height) or were not present at all.

BEC Zone	No. Blocks	Decay Class	All Species	Ac[a]	At	B	Ba	Bg	Bl	C	Cw	Cy	D	Dr	Ep	F	Fd	H	Hm	Hw	Lw	Mb	Pl	Pw	Py	Sb	Se	Ss	Sw	Sx	Y	Yc
IDF	14	1	15.5	0.0	0.3	0.0	–	0.0	0.2	0.0	0.7	–	0.0	0.0	0.0	0.0	12.7	0.0	–	0.0	0.0	0.0	0.3	0.0	0.1	–	–	–	–	1.2	0.0	0.0
		2	14.7	0.5	1.6	0.0	–	0.0	0.0	0.0	0.7	–	0.0	0.0	1.2	0.0	8.2	0.0	–	0.0	0.0	0.0	1.2	0.0	0.7	–	–	–	–	0.6	0.0	0.0
		3–4	2.2	0.0	0.2	0.0	–	0.0	0.0	0.0	0.0	–	0.0	0.0	0.0	0.0	1.0	0.0	–	0.0	0.0	0.0	0.8	0.0	0.0	–	–	–	–	0.2	0.0	0.0
		5	0.0	0.0	0.0	0.0	–	0.0	0.0	0.0	0.0	–	0.0	0.0	0.0	0.0	0.0	0.0	–	0.0	0.0	0.0	0.0	0.0	0.0	–	–	–	–	0.0	0.0	0.0
		6–8	0.2	0.0	0.0	0.0	–	0.0	0.0	0.0	0.0	–	0.0	0.0	0.2	0.0	0.0	0.0	–	0.0	0.0	0.0	0.0	0.0	0.0	–	–	–	–	0.0	0.0	0.0
		all snags	2.4	0.0	0.2 (8.3)	0.0	–	0.0	0.0	0.0	0.0	–	0.0	0.0	0.2 (8.3)	0.0	1.0 (41.7)	0.0	–	0.0	0.0	0.0	0.8 (33.3)	0.0	0.0	–	–	–	–	0.2 (8.3)	0.0	0.0
SBPS	6	1	6.7	0.0	0.0	0.0	–	–	–	–	–	–	0.0	0.0	0.0	0.0	0.0	–	–	–	–	0.0	4.8	0.0	–	–	–	–	–	1.9	0.0	0.0
		2	9.2	0.0	7.2	0.0	–	–	–	–	–	–	0.0	0.0	0.0	0.0	0.0	–	–	–	–	0.0	2.0	0.0	–	–	–	–	–	0.0	0.0	0.0
		3–4	0.1	0.0	0.0	0.0	–	–	–	–	–	–	0.0	0.0	0.0	0.0	0.0	–	–	–	–	0.0	0.0	0.0	–	–	–	–	–	0.1	0.0	0.0
		5	0.0	0.0	0.0	0.0	–	–	–	–	–	–	0.0	0.0	0.0	0.0	0.0	–	–	–	–	0.0	0.0	0.0	–	–	–	–	–	0.0	0.0	0.0
		6–8	0.0	0.0	0.0	0.0	–	–	–	–	–	–	0.0	0.0	0.0	0.0	0.0	–	–	–	–	0.0	0.0	0.0	–	–	–	–	–	0.0	0.0	0.0
		all snags	0.1	0.0	0.0	0.0	–	–	–	–	–	–	0.0	0.0	0.0	0.0	0.0	–	–	–	–	0.0	0.0	0.0	–	–	–	–	–	0.1 (100)	0.0	0.0
SBS	9	1	22.7	0.0	0.6	0.0	0.0	–	2.7	–	–	–	0.0	0.0	0.3	0.0	1.2	0.0	0.0	2.9	–	0.0	7.8	–	–	0.0	0.0	0.0	0.0	7.2	0.0	0.0
		2	11.8	0.4	1.2	0.0	0.0	–	0.0	–	–	–	0.0	0.0	0.1	0.0	0.2	0.0	0.0	3.9	–	0.0	5.5	–	–	0.0	0.0	0.0	0.0	0.5	0.0	0.0
		3–4	3.2	0.0	0.0	0.0	0.0	–	0.1	–	–	–	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	–	0.0	2.1	–	–	0.0	0.0	0.0	0.0	0.4	0.0	0.0
		5	0.0	0.0	0.0	0.0	0.0	–	0.0	–	–	–	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	–	0.0	0.0	–	–	0.0	0.0	0	0.0	0.0	0.0	0.0
		6–8	0.1	0.0	0.0	0.0	0.1	–	0.0	–	–	–	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	–	0.0	0.0	–	–	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		all snags	3.3	0.0	0.0	0.0	0.1 (3.0)	–	0.1 (3.0)	–	–	–	0.0	0.0	0.0	0.0	0.6 (18.2)	0.0	0.0	0.0	–	0.0	2.1 (63.6)	–	–	0.0	0.0	0.0	0.0	0.4 (12.1)	0.0	0.0

ICH: In the ICH, balsam fir comprised 36.5% of the average 4.5 sph of functional snags, with the remainder as western redcedar (15.6%), Douglas-fir (13.3%), and white spruce (11.1%). From a wildlife habitat perspective, a few of the most intensively used tree species in this zone (e.g., black cottonwood, western larch, grand fir; pers. obs.) were not represented in reserves.

IDF: Douglas-fir (41.7%) and lodgepole pine (33.3%) made up most of the average 2.4 sph of snags retained in the IDF, with trembling aspen, paper birch, and hybrid spruce forming only a minor component (8.3% each). There was no observed retention of three of the most valuable and highly used species in this zone (western larch, ponderosa pine, and black cottonwood).

SBPS/SBS: The average retention of 0.1 functional snags/ha in the SBPS was comprised entirely of hybrid white spruce. In the SBS, 63.6% of all snags were lodgepole pine; Douglas-fir (18.2%), hybrid spruce (12.1%) amabilis fir, and subalpine fir (3% each) comprised the remainder.

Based on data of wildlife tree use from the CWH, ICH, and IDF zones (see Appendix 2), there is no evidence to suggest that trees retained tended to be species of higher than average wildlife tree value. In fact, tree species (e.g., western larch, ponderosa pine, black cottonwood, Douglas maple, yellow-cedar, grand fir) of high value to species of conservation concern show little or no representation in reserves. Examples include ponderosa pine snags for White-headed Woodpecker and Flammulated Owl in the IDF, hard western larch snags for Williamson's Sapsucker in the IDF and ICH, and black cottonwood snags for Western Screech Owl in the IDF and CWH (compare Appendix 2 with Table 12 for more examples).

Table 12. Number and percentage of sampled cutblocks that contain patch reserves, dispersed reserves, both patch and dispersed reserves or no retention (from Province of British Columbia 2003, Table 8).

BEC Zone	No. Blocks	Patches		Dispersed		Patch & Dispersed		No Retention	
		No.	%	No.	%	No.	%	No.	%
BWBS	8	2	25	3	38	3	38	0	0
CWH	31	20	65	2	6	7	23	2	6
ESSF	30	7	23	8	27	10	33	5	17
ICH	30	10	33	12	40	7	23	1	3
IDF	14	4	29	6	43	3	21	1	7
SBPS	6	0	0	3	50	1	17	2	33
SBS	9	2	22	3	33	3	33	1	11
Total	128	45	–	37	–	34	–	12	–
Average		–	35	–	30	–	27	–	9

Reserve Sizes

Cutblocks surveyed for the Phase 1 project either had patch reserves (35.1% of 128 cutblocks), dispersed reserves (28.9%), both patch and dispersed reserves (26.6%), or no retention (9.4%) (Table 12). The percentage of cutblocks with no retention ranged from 0% in the BWBS to 33% in the SBPS. The cutblocks with patch reserves (i.e., 61.7% of those surveyed) are emphasized in this section because the vast majority of trees retained in dispersed retention areas were live trees ≤20 cm dbh (Province of British Columbia 2003) and currently of low value to wildlife tree-dependent species.

Evaluating the wildlife habitat value of reserves in a spatial context is problematic because levels of functional wildlife tree retention were low (Tables 5–11; Figures 1–5), yet relatively large areas were delineated for patch or dispersed retention on a per-hectare basis (Table 13). The average number of patches in cutblocks with patch reserves ranged from 1.6 in the ICH to as high as 5 in the SBS and SBPS (Table 13). Average patch reserve area per cutblock ranged from 1.1 to 4.2 ha by BEC (Table 13); however, the latter figure represents the *summed area of all individual patches* within a block. Sizes of individual patches were much smaller (median patch size was 1.0 ha; Figure 6). Approximately 28% of all patches (n = 173) were ≤0.5 ha in area and more than half (52%) measured ≤1.0 ha in area. Very small patches of 0.1 ha (6% of the total 172), 0.2 ha (4%), and 0.3 ha (10%) were not uncommon. The habitat value of these smaller patches is questionable, given that they are comprised entirely of edge habitat (i.e., few thermoregulatory benefits), they are not large enough to buffer danger trees of valuable size, and they are smaller than the smallest territories of wildlife tree users in Appendix 4.

Gyug and Bennett (1995) evaluated the use of wildlife tree patches by birds in the southern interior. They found that small patches received little or no use and therefore recommended a minimum wildlife tree patch size of 3 ha. Above this “functional size threshold,” some of the smaller and more sedentary wildlife tree users in Appendix 4 could potentially use patches as “territories,” assuming they contain suitable and sufficient nesting, feeding, and roosting trees, and other life requisites. Of the 173 patches sampled in the Phase 1 project, only 16.3% exceeded 3 ha (note that patches were present on only 61.7% of blocks).

Table 13. Number of cutblocks with patch and dispersed reserves and minimum, mean, and maximum area (ha) occupied by patch and dispersed reserves per cutblock (values are means for all cutblocks within a given BEC zone).

BEC Zone	No. Blocks with Patch Reserves	Mean No. Patches per Block	Mean Area of Cut-blocks	Area of Patch Reserves			No. Blocks with Dispersed Reserves	Area of Dispersed Reserves		
				Min.	Mean	Max.		Min.	Mean	Max.
BWBS	5	2.6	23.1	3.6	3.9	4.3	6	11.5	14.1	17.0
CWH	27	2.8	28.9	1.6	2.4	3.3	9	29.6	29.6	29.6
ESSF	17	1.9	27.7	1.6	2.0	2.5	18	14.1	15.7	18.0
ICH	17	1.6	23.9	3.7	3.9	4.2	19	13.2	14.5	15.9
IDF	7	2	3301	1.4	1.7	2.0	9	21.5	24.6	25.4
SBPS	1	5	3702	0.4	1.1	1.8	4	43.0	43.0	43.0
SBS	5	5	3906	4.2	4.2	4.3	6	5.7	12.2	24.2

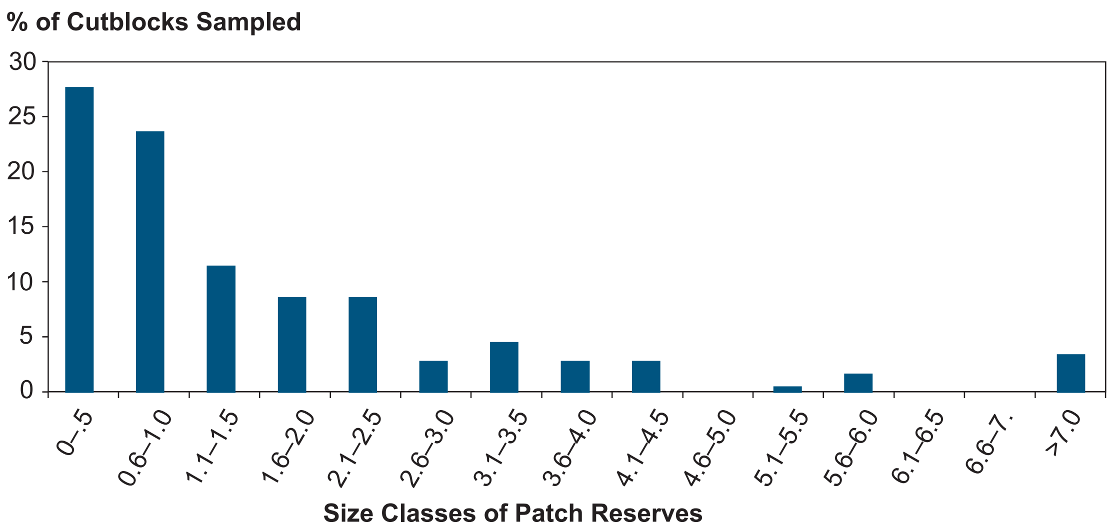

Figure 6. Frequency distribution of the sizes of 173 patches in 79 cutblocks with patch reserves.

Table 14. Risk ratings[a] for wildlife tree user guilds based on the median density

Common Name	CDC and IWMS Listing	Sampled BECs	Dependency R	Dependency F	Dependency O	General Comments on Wildlife	Snags	Hard Snags	Moderate Snags	Soft Snags	Large Snags	Mistletoe/ Witches Broom	Hollow Living Trees	Tree Cavities	Loose Bark	Live Remnant/ Legacy	Trees with Insects
American Kestrel		all zones	2	2	0	SCU	L	M	H		H			VH			
American Marten		all zones	2	0	2	SCU	L				H	H		VH		H	
Bald Eagle		all zones	2	2	2	ON	L				H					H	
Barred Owl		BWBS, SBPS, SBS, IDF, ICH, CWH	2	0	0	SCU	L				H	H	H	VH		H	
Barrow's Goldeneye		all zones	1	0	0	SCU	L				H			VH			
Bewick's Wren		CWH	1	0	0	SCU	L							VH			H
Big Brown Bat		BWBS, SBPS, SBS, IDF, ICH, CWH	2	0	2	SCU	L				H		H	VH	VH	H	H
Black Bear	B (*emmonsii*)	CWH	2	0	2	SCU	L				H		H		VH		
Black Bear		all zones	2	0	2	SCU	L				H		H		VH		
Black-backed Woodpecker		all zones	1	1	1	PCE	L	M	H					VH	VH	H	H
Black-capped Chickadee		BWBS, SBPS, SBS, IDF, ICH, CWH	1	0	1	weak PCE	L			H	H			VH			H
Boreal Chickadee		BWBS, SBPS, SBS, ESSF, IDF, ICH	1	0	1	weak PCE	L			H				VH			H
Boreal Owl		all zones	1	0	0	SCU	L				H			VH			
Brown Creeper		all zones	1	0	0	SCU	L	M	H		H				VH	H	H
Bufflehead		SBPS, SBS, ESSF, IDF, ICH, CWH	1	0	0	SCU	L				H			VH			
California Myotis		IDF, ICH, CWH	2	0	2	SCU	L				H		H	VH	VH	H	H
Caribou	R (southern pop.), IWMS	SBS, ESSF, ICH	0	1	0	lichen forager	L				H						
Caribou		BWBS, SBPS, SBS, ESSF, ICH	0	1	0	lichen forager	L				H						
Chestnut-backed Chickadee		all zones	1	0	0	weak PCE	L			H	H			VH			H
Clouded Salamander		CWH	2	2	2	bark user	L								VH		

a (very high = 0 sph; high = 0.1–2.5 sph; moderate = 2.6–5 sph; low = 5–10 sph; very low = >10 sph) of each habitat element on sampled blocks (all BEC zones pooled). Shaded species are (1) listed by the CDC, (2) occur only in one sampled BEC zone, and/or (3) are highly dependent on wildlife trees for all life requisites (i.e., all dependency scores are "1"). The latter are considered being at a higher overall level of risk relative to other guild members.

Common Name	CDC and IWMS Listing	Sampled BECs	Dependency R	F	O	General Comments on Wildlife	Snags	Hard Snags	Moderate Snags	Soft Snags	Large Snags	Mistletoe/ Witches Broom	Hollow Living Trees	Tree Cavities	Loose Bark	Live Remnant/ Legacy	Trees with Insects
Common Goldeneye		all zones	1	0	0	SCU	L				H			VH			
Common Merganser		SBPS, SBS, ESSF, IDF, ICH, CWH	2	0	0	SCU	L				H		H	VH			
Douglas' Squirrel		CWH	2	3	2	SCU										H	
Downy Woodpecker		all zones	1	1	1	PCE	L		H	H	H			VH	VH	H	H
Fisher	B, IWMS	all zones	1	0	2	SCU	L				H	H		VH		H	
Flammulated Owl	B, IWMS	IDF	1	0	0	SCU	M				VH			VH			H
Great Blue Heron	B, IWMS	BWBS, SBPS, SBS, IDF, ICH, CWH	2	0	0	ON	L	M	H		H						
Great Gray Owl		BWBS, SBPS, SBS, IDF, ICH, CWH	2	0	0	ON	L				H	H	H			H	
Great Horned Owl		all zones	2	2	0	ON	L				H	H	H	VH		H	
Hairy Woodpecker	B (*picoides*), IWMS	CWH	1	1	1	PCE	L	M	H		H			VH	VH	H	H
Hairy Woodpecker		all zones	1	1	1	PCE	L	M	H		H			VH	VH	H	H
Hooded Merganser		SBPS, SBS, ESSF, IDF, ICH, CWH	1	0	0	SCU	L	H			H			VH			
House Wren		BWBS, SBPS, SBS, IDF, ICH, CWH	2	0	0	SCU	L							VH	VH		H
Keen's Long-eared Myotis	R, IWMS	CWH	2	0	2	SCU											H
Lewis' Woodpecker	B (rest of BC), IWMS	SBPS, SBS, IDF, ICH	1	1	1	PCE/SCU	L				H			VH		H	H
Lewis' Woodpecker	R (Georgia Depr.), IWMS	CWH	1	1	1	PCE/SCU	L				H			VH		H	H
Little Brown Myotis		all zones	2	0	2	SCU	L				H		H	VH	VH	H	H
Long-legged Myotis		SBPS, SBS, ESSF, IDF, ICH, CWH	2	0	2	SCU	L				H		H	VH	VH	H	H
Marbled Murrelet	R, IWMS	CWH	2	0	0	ON						H					
Mountain Bluebird		all zones	1	0	0	SCU	L				H			VH			H
Mountain Chickadee		all zones	1	0	1	weak PCE	L			H	H			VH			H
Northern Flicker		BWBS, SBPS, SBS, IDF, ICH, CWH	1	1	1	PCE	L		H	H	H		H	VH		H	H
Northern Flying Squirrel		all zones	2	3	2	SCU	L		H		H	H	H	VH			
Northern Goshawk	R (*laingi*), IWMS	CWH	2	2	0	ON	L					H				H	

Common Name	CDC and IWMS Listing	Sampled BECs	Dependency R	Dependency F	Dependency O	General Comments on Wildlife	Snags	Hard Snags	Moderate Snags	Soft Snags	Large Snags	Mistletoe/ Witches Broom	Hollow Living Trees	Tree Cavities	Loose Bark	Live Remnant/ Legacy	Trees with Insects
Northern Goshawk		all zones	2	2	0	ON	L					H				H	
Northern Hawk Owl		BWBS, SBPS, SBS, IDF, ICH, CWH	2	2	0	SCU	L		H	H	H			VH		H	
Northern Long-eared Myotis	B	BWBS, ICH	2	0	2	SCU	L		H	H			H	VH	VH		H
Northern Pygmy-owl	B (*swarthi*), IWMS	CWH	1	0	0	SCU	L	M	H		H			VH			
Northern Pygmy-owl		all zones	1	0	0	SCU	L	M	H		H			CH			
Northern Saw-whet Owl	B (*brooksi*), IWMS	CWH	1	2	0	SCU	L				H	H		VH			
Northern Saw-whet Owl		BWBS, SBPS, SBS, IDF, ICH, CWH	1	2	0	SCU	L				H	H		VH			
Osprey		all zones	2	2	2	ON	L				H					H	
Pallid Bat	R	no sampled zones	2	0	3	SCU	-				-		-	-	-	-	-
Pileated Woodpecker		all zones	1	1	1	PCE	L	M			H		H	VH	VH	H	H
Purple Martin	R	BWBS, CWH	2	0	0	SCU	L							VH			H
Pygmy Nuthatch		IDF	1	0	1	PCE/SCU	M	H			VH		H	VH			H
Raccoon		IDF, ICH, CWH	2	0	2	SCU	L						H	VH			
Red Squirrel		all zones	2	3	2	SCU						H	H	VH			
Red-breasted Nuthatch		all zones	1	0	0	weak PCE	L				H			VH	VH		H
Red-breasted Sapsucker		IDF, ICH, CWH	1	1	1	PCE	L	M	H		H			VH			H
Red-naped Sapsucker		SBPS, SBS, IDF, ICH, CWH	1	1	1	PCE	L	H	H		H			VH		H	H
Silver-haired Bat		all zones	1	0	1	SCU	L				H		H	VH	VH	H	H
Spotted Owl	R, IWMS	CWH	1	0	0	SCU	L					H	H	VH			
Three-toed Woodpecker		all zones	1	1	1	PCE	L	M	H					VH	VH	H	H
Tree Swallow		all zones	2	0	0	SCU	L							VH			H
Vaux's Swift		all zones	1	0	0	SCU	L						H	VH			H
Violet-green Swallow		BWBS, SBPS, SBS, IDF, ICH, CWH	2	0	0	SCU	L							VH			H
Western Bluebird	R (Georgia Depression)	CWH	1	0	0	SCU	L					H	H	VH			

Common Name	CDC and IWMS Listing	Sampled BECs	Dependency R	Dependency F	Dependency O	General Comments on Wildlife	Snags	Hard Snags	Moderate Snags	Soft Snags	Large Snags	Mistletoe/ Witches Broom	Hollow Living Trees	Tree Cavities	Loose Bark	Live Remnant/ Legacy	Trees with Insects
Western Bluebird		IDF, ICH, CWH	1	0	0	SCU	L					H	H	VH			H
Western Long-eared Myotis		all zones	2	0	2	SCU	L				H				VH	H	H
Western Screech-owl	B (*saturatus*)	CWH	1	0	2	SCU	L				H			VH			
Western Screech-owl	R (*macfarlanei*) IWMS	IDF	1	0	2	SCU	M				VH			VH			
White-breasted Nuthatch		IDF, ICH	1	0	0	SCU/weak PCE	L							VH	VH		H
White-headed Woodpecker	R, IWMS	ESSF, IDF, ICH	1	1	1	PCE	L		H		H			VH	VH	H	H
Williamson's Sapsucker	R (*nat.*); B (*thy.*), IWMS	IDF, ICH	1	1	1	PCE	L	H	H		H			VH	VH	H	H
Wood Duck		BWBS, IDF, ICH, CWH	1	0	0	SCU	L	L			H			VH			
Yellow-bellied Sapsucker		BWBS, SBS	1	1	1	PCE	L	L	H					VH	VH		H
Yellow-pine Chipmunk		SBPS, SBS, IDF, ICH, CWH	2	0	2	SCU	L							VH			
Yuma Myotis		IDF, ICH, CWH	2	0	2	SCU	L				H		H	VH	VH	H	

In addition to patch size, patch suitability will depend on the density of functional wildlife trees in patches and the forest mosaic surrounding a patch (i.e., patch distribution, degree of forest fragmentation, seral stage distribution, etc.). The latter was not explicitly considered as part of the Phase 1 project. Many wildlife tree users defend mutually exclusive breeding territories (see Appendix 4) and conspecific pairs would not be expected to co-occupy the same patches.

3.5 Summary of the Adequacy of Retention Levels for Wildlife Tree Users

Based on findings from the Phase 1 project summarized in section 3.4, we consider the observed levels of wildlife tree habitat element retention inadequate relative to (1) the known use and requirements of wildlife tree habitat by dependent species (Table 3, and Appendices 2 & 3), and (2) the reported densities of these elements in unmanaged stands from the Provincial Ecology Program. In particular, the needs of species dependent on moderate to soft snags, large snags, mistletoe broom, internal decay, hollow trees, tree cavities, loose bark, live remnant legacy trees, or trees with insects may be compromised under the current wildlife tree retention practices. Most apparent from our analysis is the absence of any functional snag retention on 46% of all cutblocks sampled and the low level of snag retention on the remaining blocks. Although some species in Table 14 can use live trees as well as snags to satisfy their requirements, only negligible densities of functional-size live trees with evidence of decay, insects, and/or diseases (i.e., the characteristics that would make these trees *currently* suitable for wildlife) were retained. These mostly smaller, live trees may provide some recruitment wildlife tree habitat in the future, if they are managed as wildlife trees beyond the end of the harvest rotation. No trees with uncommon habitat features (cavities, hollow trees, nests, dens, roosts, etc.) were found in any of the reserves sampled on 128 cutblocks, suggesting that criteria other than habitat value and current wildlife use were used during the reserve selection process.

Table 14 provides general risk ratings for each wildlife tree user guild based on the median density (very high risk = 0 sph; high = 0.1–2.5 sph; moderate = 2.6–5 sph; low = 5–10 sph; very low = >10 sph) of each wildlife tree habitat element on sampled blocks. All BEC zones were pooled because densities of habitat elements were similar among zones (zones in which retention densities of elements differed substantially were identified in section 3.4). Note that our approach is conservative in that it considers only residual densities of each wildlife tree habitat element, rather than the residual densities of trees that satisfy the combined element requirements of particular species. For example, Table 14 indicates that (with the exception of the Douglas Squirrel, Keen's Long-eared Myotis, and Marbled Murrelet), all species are dependent on multiple wildlife tree habitat elements to satisfy their requirements (e.g., many require snags of large size with abandoned cavities in addition to snags in particular decay classes). Furthermore, all species in Table 14 fall into the "high" or "very high" risk categories, based on their requirement for one or more habitat elements that averaged ≤2.5 sph under the current policy. Table 14 also shows species in each habitat element group that are (1) listed by the CDC and IWMS, (2) occur only in one sampled BEC zone, and (3) are very dependent on wildlife trees for all life requisites (i.e., all dependency scores are "1"). The latter species are considered to be more at risk under current wildlife tree retention practices, relative to other guild members. Conversely, species with lower dependency on wildlife trees and currently not of conservation concern (e.g., raccoon, red squirrel, yellow-pine chipmunk) are at lower risk, relative to other guild members

With respect to the wildlife tree habitat needs of IWMS species, the values in Table 14 suggest that four woodpecker species (Lewis's Woodpecker, "Queen Charlotte" Hairy Woodpecker, White-headed Woodpecker, and Williamson's Sapsucker) might experience potentially critical deficits in habitat supply, if wildlife tree retention practices in their territories and ranges mirror the results of the 128 sampled cutblocks. Another group of IWMS species potentially put at increased risk by current practices is comprised of five listed owl species (Flammulated Owl, "Interior" Western Screech Owl, "Vancouver Island" Northern Pygmy-owl, Spotted Owl, and "Queen Charlotte" Northern Saw-whet Owl). All are highly dependent on cavities in large trees (especially snags) and are, to some extent, dependent on woodpeckers for cavity creation. Three open-nesting IWMS species (Great Blue Heron, Marbled Murrelet, and Queen Charlotte Goshawk) may experience habitat decline, due to reductions in essential wildlife tree habitat elements. In addition, the IWMS-listed mammals fisher and mountain caribou have specific wildlife tree requirements (cavities in large snags and lichen-bearing trees, respectively) that may put them at increased risk if loss of wildlife trees spreads across the landscape. This preliminary risk assessment for IWMS species is not spatially explicit. Most of the focal IWMS species are locally restricted in distribution. It is therefore unlikely that the number and distribution of sampled cutblocks (Province of British Columbia 2003) captured wildlife tree retention practices in the areas occupied by these listed species.

Most wildlife tree users require breeding territories of several hectares (Appendix 4) and their needs are unlikely to be met based on the patch sizes (52% of all patches ≤1 ha) and retention levels under current practices. The extent to which individual species use reserve patches of a certain size (within the context of surrounding fragmentation levels and seral stage distributions) is unknown for British Columbia ecosystems, and risk ratings for patch size are not provided. The extent to which wildlife tree users will use small patches in fragmented landscapes for breeding. In particular requires detailed evaluation. Preliminary studies suggest that rates of nest success are lower in wildlife tree patches relative to adjacent intact forest (Machmer 2000a) and that these areas may represent population sinks (Pulliam 1988). Furthermore, because many wildlife tree users are territorial, there is an upper limit to the number of breeding territories that wildlife tree patch reserves can support. Territory size will be influenced by habitat quality and even large reserves devoid of critical wildlife tree habitat elements are unlikely to satisfy the needs of dependent species.

The wildlife tree policy adopts a coarse-filter approach to conserve habitat for dependent species in managed landscapes. The *Identified Wildlife Management Strategy* (IWMS) is a fine-filter mechanism designed to conserve habitat for species that are sensitive to forest and range practices, but are not adequately addressed through coarse-filter management. Our findings regarding the current lack of biological effectiveness of wildlife tree retention suggest the need for: (1) a greater emphasis on the IWMS to protect habitat for specific wildlife tree users, (2) consideration of IWMS designation for a greater number of wildlife tree-dependent species whose needs are unlikely being met through coarse- filter management, (3) an evaluation focusing on the implementation and biological effectiveness of the IWMS (to ensure that its intended objectives are being met), and (4) review and modification of the wildlife tree policy.

4.0 Recommendations

4.1 Options for Modifications of the Wildlife Tree Policy

Current practices of implementing the wildlife tree policy do not adequately meet the wildlife tree habitat requirements of the >70 dependent species they were designed to conserve. While improved implementation might lessen the impact on wildlife tree users to some extent, several modifications to the administrative and ecological guiding principles may also increase the biological effectiveness of the policy.

1. The policy adopts an *area-based approach* to retention (see Appendix 3 in the *Landscape Unit Planning Guide*; Province of British Columbia 1999). Although preliminary comparisons suggest that area-based retention targets were met or exceeded in four (CWH, ESSF, ICH, and IDF) of seven subzones sampled for Phase 1 (Province of British Columbia 2003), densities of functional wildlife trees were low to negligible in all BEC zones. To address this problem, retention could focus directly on functional wildlife trees (and in particular snags) using a *density-based approach*. Required densities should reflect the natural range of variability of wildlife trees by BEC subzone and stand type (for an example of this approach applied to BEC subzones and stand types of the southern interior, see Steeger and Machmer 2002). Note that British Columbia has datasets for establishing baseline values for wildlife trees (e.g., Provincial Ecology Program Data, Temporary Sampling Plot (TSP) data, and likely more). The latter could be refined or combined with regional or ecosystem-specific datasets to generate density-based targets. It is also important that density-based targets specify both live and dead tree components, to ensure that retained trees provide present as well as future habitat. The rationale for a density-based approach is based on the premise that most wildlife tree users are territorial, and that there is likely a redundancy in wildlife tree habitat elements in unmanaged stands. Removal of a portion of these elements should not render the habitat unsuitable as long as a sufficient numbers of functional wildlife trees are retained.

2. Achievement of more retention of snags and other wildlife tree habitat elements will require additional work to streamline Workers' Compensation Board (WCB) hazard tree regulations, biologically effective wildlife tree retention targets, and socially acceptable timber production targets. Currently, most trees deemed hazardous according to the Wildlife/Danger Tree Assessment process (i.e., trees with cavities, hollows, snags in moderate to advanced stages of decay, etc.) represent the habitat elements most critical to wildlife. Either many more of these hazardous trees need to be buffered in No-Work Zones (NWZs) (resulting in reductions in treatable area and an inability to meet timber supply impact caps) or the current assessment process needs to be reconsidered, to explore if more valuable snags can be retained without NWZs. Achieving the biological intent of the policy given current WCB regulations and the cap on timber supply impacts does not seem operationally possible.

3. Ecological guiding principle 2 states that "a diversity of wildlife tree retention strategies is recommended (e.g., a range of wildlife tree patch sizes, combined with dispersed trees [there will be ecosystem-dependent variances to this recommendation]). However, larger patches containing trees with valuable wildlife habitat attributes generally serve a greater number of ecological functions." In the southern interior, Gyug and Bennett (1995) evaluated the effectiveness of wildlife tree patch size and recommended a minimum size of 3 ha. Average patch sizes retained on the sampled cutblocks are too small to meet the requirements of most wildlife tree users. The policy could be modified to require larger patches approaching functional size (i.e., ≥2 or 3 ha). While larger patches have greater conservation value for wildlife tree users, smaller patches also contribute habitat if they result from establishment of NWZs designed to protect a hazardous but valuable wildlife tree.

4. The 500 m maximum interpatch distance (ecological guiding principle 11) should be eliminated because it is not based on any biological principles. Optimal foraging theory suggests that animals reject habitats that require excessive travel time and energy to reach; wildlife tree patches that are too isolated on the landscape will become population sink habitats, negating the desired goals of this policy.

5. The section on "salvage of wildlife tree patches" should emphasize that salvage is generally not desirable. Small-scale salvage of beetle-killed trees is often unnecessary if habitat for the natural beetle predators (woodpeckers and allies) is retained (i.e., the goal of the policy). Salvage will reduce or eliminate the value of wildlife tree reserves and may even increase forest health risk in surrounding forests by affecting the habitat of natural biological control agents. Forests affected by natural disturbances are known to provide source habitats for wildlife tree user populations (Machmer and Steeger 1995). Large-scale salvage operations should therefore include provisions for wildlife tree users.

6. Recommended changes/comments to the wording and intent of the ecological guiding principles in the policy are shown in bold:

Principle 1: Wildlife tree retention should, as a first priority, protect trees with valuable wildlife tree attributes (see **high** and **medium** trees below). Where there are few trees with valuable attributes, wildlife tree retention should be located in areas most suitable for long-term wildlife tree recruitment. Where neither objective is attainable, wildlife tree retention should be reflective of the pre-harvest stand.

Wildlife Tree Value	Characteristics
HIGH A high-value wildlife tree has at least two of the characteristics listed in the adjacent column.	• Internal decay (heartrot or natural/excavated cavities present) • Crevices present (loose bark or cracks suitable for bats) • Large brooms present • Active or recent wildlife use • Current insect infestation • Tree structure suitable for wildlife use (large nest, hunting perch, bear den, etc.) • Largest trees on site (height and/or diameter) and/or veterans • Locally important wildlife tree species
MEDIUM	• **Largest** trees that will likely develop two or more of the above attributes for High
LOW	• **A low-value wildlife tree does not contribute to wildlife tree habitat and should not be used to meet wildlife tree requirements.**

Principle 7: Selection of appropriate WTR areas **should be achieved through pre-harvest surveys for valuable wildlife trees and wildlife tree patches by trained personnel.** Selection should consider existing wildlife trees on the site—planning for a diversity of wildlife tree classes will better meet future large wildlife tree and CWD objectives (including recruitment and longevity).

Principle 8: How the characteristics of individual trees may affect the potential to achieve or maintain a particular stand structure (shade tolerance, tree longevity, disease/pest resistance, etc.) should be considered when selecting appropriate retention areas. Ensure that the trees being retained have the potential to achieve the desired stand structure.

Comment: *The desired stand structure resulting from wildlife tree retention should be defined from a biological perspective (i.e., representative species, combination of dead trees, defective trees, large trees, recruits, trees susceptible [not "resistant"] to disease and insects, etc.). The policy should explicitly discourage excessive sanitization and simplification of the forested land base.*

Principle 9. It is important to consider the dynamic nature (caused by succession and other natural factors such as wind) of both individual trees and forest stands—individual and patch reserves will not remain in the same condition forever, and therefore may not provide the same habitat attributes over a rotation.

Comment: *This recommendation could include suggestions on how to mitigate potential loss of wildlife tree habitat values during the rotation. If habitat values are lost, they should be replaced at the closest ecologically appropriate location. This, as well as other wildlife tree planning considerations, requires tracking and periodic monitoring of wildlife tree retention, at a feasible scale (e.g., cutting permit).*

Principle 10: The most windfirm reserves, and therefore the most likely to remain standing after harvesting, are reserves that consider the site, stand and individual trees during layout. For individual trees, size (low height/diameter ratio) is generally a much more reliable indicator of wind-firmness than species.

Comment: *If this principle is interpreted such as to promote retention of short trees, it could be counterproductive, considering the biological requirements of wildlife and the evolutionary pressures that have resulted in selection for tall trees and use of upper parts of the bole. Studies suggest that wildlife species select tall trees because they experience lower rates of nest predation, nest failure, and parasitism (Li and Martin 1991). If forced to use trees of low height, they will likely experience higher mortality and nest failure rates. The policy should therefore encourage retention of tall (and big) trees and discourage stub creation (unless the intent is to protect habitat elements at the base of trees, such as ant hills or cavities).*

4.2 Recommendations for Future Implementation and Effectiveness Monitoring

Policy implementation and effectiveness should continue to be monitored as part of an adaptive management approach, and preliminary monitoring results should be used to modify practices and policies accordingly. Only a subset of the monitoring data gathered from the Phase 1 Project could be used in our analysis. We make the following recommendations to improve the "fit" of the data gathered for evaluating biological effectiveness:

1. Strategically select forest districts and BEC zones for effectiveness evaluation projects that support the majority of species that are of conservation risk. Seven listed wildlife tree-dependent species/subspecies (i.e., Northern Saw-whet Owl *brooksi* subsp., Williamson's Sapsucker *nataliae* subsp., Hairy Woodpecker *picoides* subsp., White-headed Woodpecker, Northern Long-eared Myotis, Pallid Bat, and Black Bear *emmonsii* subsp.) did not occur in any of the forest districts sampled as part of the Phase 1 project. Similarly, seven species occurred in only one of the forest districts and 17 species in only one of the BEC zones sampled. Objectives for policy implementation monitoring may not necessarily be useful for biological effectiveness monitoring or risk assessments.
2. Effectiveness monitoring should focus on measurements of habitat elements with relatively high biological value for wildlife tree users. A minimum tree size threshold of ≥10 m height and ≥20 cm dbh is recommended. While retention of smaller trees provides some benefits for biodiversity, larger trees will more effectively sustain populations of wildlife tree-dependent species.
3. Use, if possible, quantitative variables to evaluate the biological value of individual trees and reserves. This is best done relative to pre-harvest levels or to adjacent intact habitat, potentially using a "paired" statistical approach. Examples of quantitative variables include: sph of live and dead trees in different tree species, diameter, height and decay classes; sph of live and dead trees with hollows, natural and excavated cavities, open nests, dens, roosts and perches; sph of live and dead trees with fresh feeding sign; sph of trees with insect infestation, conks, mistletoe, loose bark, root disease, stem disease, dead tops, and large live branches. Incorporate

CWD measurements into future monitoring. CWD sampling should use a line transect approach, with emphasis on larger pieces (e.g., >25 cm dbh) that have higher biological value for wildlife species.

4. Incorporate a system for assessors to evaluate the biological effectiveness of wildlife tree retention within a landscape context (i.e., the percent retention relative to surrounding available habitat and availability of wildlife tree attributes—see step 5B of the wildlife tree policy) into future evaluations. For many of the territorial species in Table 3, the landscape context in which trees are retained is just as important to defining suitable habitat as the presence of wildlife tree attributes at the stand level. The only variable in the Phase 1 project that touched on the landscape context was the "estimated distance to mature forest habitat" (to address the 500 m rule). However, to fully address point 5 in the policy, one would have to consider the spatial distribution and pattern of retention over a larger scale using a systematic approach (air photo interpretation, forest cover analysis, etc.).

5. Future evaluations should focus on a random selection of pre-harvest blocks. The few blocks for which pre- and post-harvest information was collected provided a much clearer picture of what was selected for retention relative to what was there pre-harvest (in terms of habitat quality, wildlife use, and overall representativeness). A lesser number of pre-harvest evaluations would therefore provide a better and more cost-effective overview of biological effectiveness than a greater number of only post-harvest evaluations.

6. Future biological effectiveness evaluations would benefit from directly addressing the performance of wildlife tree users in managed stands. Research could address questions such as:
   - Are the majority of wildlife tree users able to successfully use the retained habitat or are only particularly adaptable species able to persist in managed stands?
   - Are wildlife tree users breeding successfully in patches and how does their reproductive success compare with reproductive success rates in unmanaged stands?
   - Are wildlife tree users producing sufficient viable offspring to maintain existing populations in managed stands over time?

7. In addition to the broad-based monitoring that the Phase 1 project conducted, more in-depth research will be required to answer questions about the behaviour and population dynamics of wildlife tree users in managed forests. The latter will require pre- and post-treatment inventories of wildlife tree user guilds in representative BEC zones, coupled with intensive evaluation of their habitat use (breeding, foraging, other) patterns, breeding activity and reproductive success. Ideally, such evaluation should include both summer and winter monitoring (since many wildlife tree users are resident species and will face different pressures during breeding and overwintering periods). Control areas in unmanaged forests should be included for comparison.

8. Wildlife tree retention is practiced at the stand or cutblock level, where policy and management guidelines are translated into treatment prescriptions. However, a larger spatial context is required to address the requirements of wildlife populations, which are naturally sensitive to the magnitude and variability in habitat supply over time and over landscapes (e.g., watershed or sub-basin level).

Several recent pilot projects have addressed ecosystem sustainability indicators for managed forests including wildlife tree supply (Wilson et al. 2002, 2003; Hamilton et al. 2003). At the level of a TSA (Arrow), modelling projections suggested that stands dominated by relatively low densities of wildlife trees will increase over the next 250 years, with most of the changes coming in the next 100 years as late-seral stands are converted to shorter-rotation stands. High-quality habitat for Pileated Woodpecker, for example, is expected to decline. At the level of a TFL (#14 in Invermere Forest District), modelling projections suggested that the abundance of snags will decline over time, and the decline will be relatively insensitive to small changes in snag retention in harvested stands. Stands retaining higher snag densities will become increasingly isolated on the timber harvesting land base.

These results suggest consideration of an effectiveness-monitoring component that addresses both the effectiveness of wildlife tree retention at the stand level and the effectiveness of the provincial targets at the landscape level.

4.3 Recommendations to Address Information Gaps

1. Information on the characteristics (tree species, diameter, height, decay class, etc.) of wildlife trees required for breeding, foraging, and other life requisites is still lacking for many wildlife tree-dependent species in British Columbia) (Appendix 2). This is particularly the case with certain bat species (e.g., Yuma Myotis and Keen's Long-eared Myotis), secondary cavity–using birds (e.g., owls), and small mammals (mice, voles, and mustelids). wildlife tree user requirements for foraging are poorly known and may be limiting some populations, especially in winter. These information gaps make it difficult to address the adequacy of wildlife tree retention for these species and to develop retention targets that are biologically based. Additional literature from the Pacific Northwest should be gathered and summarized to address species-specific information gaps on wildlife tree habitat requirements in the short term, and more empirical data should be gathered in British Columbia ecosystems.
2. Information gaps related to the structural composition of breeding territories (i.e., minimum densities of wildlife trees and CWD to satisfy the overall needs of breeding pairs), home range and territory sizes, and species-specific breeding densities with different levels of wildlife tree retention should be addressed. For example, are reserves large enough to support one or more breeding territories, do they contain densities of wildlife trees with particular characteristics sufficient for successful breeding/foraging, and are patches spatially arranged to permit movement and dispersal among them and to adjacent habitats? Additional literature review from the Pacific Northwest should be undertaken to address these questions, coupled with empirical studies in British Columbia ecosystems. Theoretical evaluations combining GIS mapping and habitat supply analysis for listed/focal species (in particular forest districts/BEC zones) could also address these questions in the short term, until empirical information is available for representative BEC zones.
3. CWD-dependent species should be incorporated into future effectiveness evaluations and a similar literature review of their requirements, characteristics, dependency levels, etc., is needed—the Columbia Basin WHR Database could provide an efficient tool for gathering information and a framework (i.e., CWD habitat elements, dependency levels, etc.) for future CWD effectiveness evaluations.

5.0 Literature Cited

Akenson, J.J. and M.G. Henjum. 1994. Black bear den site selection in the Starkey study area. Natural Resource News. La Grande, OR: Blue Mountains Natural Resources Institute. 4(2): 1–2.

Backhouse, F. and J.D. Lousier. 1991. Silviculture systems research: wildlife tree problem analysis. BC Min. of Environment, Wildlife Tree Committee, Victoria, BC.

Betts, B.J. 1996. Roosting behaviour of silver-haired bats (*Lasionycteris noctivagans*) and big brown bats (*Eptesicus fuscus*) in northeast Oregon. *In* R.M.R. Barclay and R.M. Brigham (eds.). Bats and Forests Symposium, October 19–21, 1995, Victoria, B.C; Working Paper 23; Res. Br., BC Min. For., Victoria, BC. pp. 55–61.

Bondrup-Nielson, S. 1978. Vocalization, nesting, and habitat preferences of the Boreal Owl (*Aegolius funereus*) in North America. M.Sc. thesis, Univ. Toronto, Toronto, Ont.

Brigham, R.M., M.J. Vonhof, R.M.R. Barclay, and J.C. Gwilliam. 1997. Roosting behavior and roost-site preferences of forest-dwelling California bats (*Myotis californicus*). Journal of Mammalogy 78(4): 1231–1239.

Brown, C.R., A.M. Knott, and E.J. Damrose. 1992. Violet-green Swallow (*Tachycineta thalassina*). *In* A. Poole and F. Gill (eds.) The birds of North America. No. 14. Philadelphia, PA: the Academy of Natural Sciences and Washington, DC: the American Ornithologists' Union.

Buehler, D.A. 2000. Bald eagle (*Haliaeetus leucocephalus*). *In* A. Poole and F. Gill (eds.). The birds of North America. No. 506. Philadelphia, PA: the Academy of Natural Sciences and Washington, DC: the American Ornithologists' Union.

Bull, E.L. 1987. Ecology of the pileated woodpecker in northeastern Oregon. Journal of Wildlife Management 51(2): 472–481.

Bull, E. L., and C.T. Collins. 1993. Vaux's swift (*Chaetura vauxi*). *In* A. Poole and F. Gill (eds.). The birds of North America. No. 77. Philadelphia, PA: the Academy of Natural Sciences and Washington, DC: the American Ornithologists' Union.

Bull, E.L. and T.W. Heater. 2000. Resting and denning sites of American Martens in northeastern Oregon. Northwest Science, Vol. 74 (3):179–185.

Bull, E.L., C.G. Parks, and T.R. Torgerson. 1997. Trees and logs important to wildlife in the Interior Columbia River Basin. U.S. Dept. Agric. Gen. Tech. Rep. PNW-GTR-391. 55 p.

Bull, E.L., S.R. Peterson, and J.W. Thomas. 1986. Resource partitioning among woodpeckers in northeastern Oregon. U.S. Dept. Agric. USFS Res. Note PNW 444.

Bunnell, F.L., E. Wind, M. Boyland, and I. Houde. 2002. Diameters and heights of trees with cavities: their implications to management. *In* W.F. Laudenslayer, Jr., P.J. Shea, B.E. Valentine, C.P. Weatherspoon, and T.E. Lisle (tech. coord.). Proceedings of the symposium on the ecology and management of dead wood in western forests. 1999 November 2–4; Reno, NV. Albany, CA: Pacific Southwest Research Station, Forest Service, U.S. Dept. Agric. Gen. Tech. Rep. PSW-GTR-181. pp. 717–737.

Campbell, R.W., N.K. Dawe, I. McTaggert-Cowan, J.M. Cooper, G.W. Kaiser, and M.C.E. McNall. 1990a. The birds of British Columbia. Volume 1: Nonpasserines, loons through waterfowl. Royal British Columbia Museum, Victoria, BC.

______. 1990b. The birds of British Columbia. Volume 2: Nonpasserines, diurnal birds of prey through woodpeckers. Royal British Columbia Museum, Victoria, BC.

Campbell, R.W., N.K. Dawe, I. McTaggert-Cowan, J.M. Cooper, G.W. Kaiser, M.C.E. McNall, and G.E.J. Smith. 1997. The birds of British Columbia. Volume 3: Passerines, flycatchers through vireos. Royal British Columbia Museum, Victoria, BC.

______. 2001. The birds of British Columbia. Volume 4: Passerines, wood-warblers through old world sparrows. Royal British Columbia Museum, Victoria, BC.

Cannings, S.G., L.R. Ramsay, D.F. Fraser, and M.A. Fraker. 1999. Rare amphibians, reptiles and mammals of British Columbia. Resources Inventory Branch, BC Min. Environ., Lands and Parks, Victoria, BC. 190 p.

Cannings, R.J., and T. Angell. 2001. Western Screech-Owl (*Otus kennicotti*). *In* The Birds of North America, No. 597. A. Poole and F. Gill, (eds). The Birds of North America, Inc., Philadelphia, PA.

Carey, A.B., T.M. Wilson, C.C. Maguire, and B.L. Biswell. 1997. Dens of northern flying squirrels in the Pacific Northwest. Journal of Wildlife Management 61(3): 684–699.

Caton, E.L. 1996. Effects of fire and salvage logging on the cavity-nesting bird community in northwestern Montana. PhD dissertation, University of Montana, Missoula, MT.

Cooper, J.M. and S. Beauchesne. 2000. Inventory of Lewis's Woodpecker breeding population and habitat in the East Kootenay. BC Min. Environ., Lands and Parks, Wildl. Br.. Working Rep. WR-100. 38 p.

Corkran, C.C. and C.R. Thoms. 1996. Amphibians of Oregon, Washington and British Columbia. Lone Pine Publishing, Vancouver, BC.

Cowan, I.M. Taggert and C.J. Guiget. 1978. The mammals of British Columbia, 3rd ed. BC Provincial Museum Handbook No. 11, Dept. of Recreation and Conservation, Victoria, BC. 414 p.

Davis, T.M. and P.T. Gregory. 1993. Status of the clouded salamander in British Columbia. BC Min. Environ., Victoria, BC. Wildlife Working Report No. WR-53. 13 p.

Deal, J.A. and M. Setterington. 2000. Woodpecker nest habitat in the Nimpkish Valley, northern Vancouver Island. Report prepared for Canadian Forest Products Ltd., Woss, B.C. Unpubl.

Dixon, R.D. 1995. Ecology of white-headed woodpeckers in the central Oregon Cascades. MS thesis, University of Idaho, Moscow, ID.

Dixon, R.D. and V.A. Saab. 2000. Black-backed Woodpecker (*Picoides arcticus*). *In* A. Poole and F. Gill (eds.). The birds of North America. No. 509. Philadelphia, PA: the Academy of Natural Sciences and Washington, DC: the American Ornithologists' Union.

Doyle, F.I. and T. Mahon. 2000. Inventory of the Northern Goshawk (*Accipiter gentilis*). *In* the Kispiox Forest District. Unpubl. report. BC Min. Environ., Lands and Parks, Smithers BC.

Duncan, J.R. and P.A. Duncan. 1998. Northern Hawk Owl (*Surnia ulula*). *In* A. Poole and F. Gill (eds.). The birds of North America. No. 356. Philadelphia, PA: the Academy of Natural Sciences and Washington, DC: the American Ornithologists' Union.

Eadie, J.M., J.-P.L. Savard, and M.L. Mallory. 2000. Barrow's Goldeneye (*Bucephala islandica*). *In* A. Poole and F. Gill (eds.). The birds of North America. No. 548. Philadelphia, PA: the Academy of Natural Sciences and Washington, DC: the American Ornithologists' Union.

Forsman, E.D., E.C. Meslow, and H.M. Wight. 1984. Distribution and biology of the Spotted Owl in Oregon. Wildlife Monograph No. 87. The Wildlife Society, Bethesda, MD. 64 p.

Forsman, E.D. and A. Giese. 1997. Nests of northern spotted owls on the Olympic Peninsula, Washington. Wilson Bulletin. 109(1): 28–41.

Frederick, G.P. and T.L. Moore. 1991. Distribution and habitat of White-headed Woodpeckers (*Picoides albolarvatus*) in West-central Idaho. Cons. Data Center, Idaho Dept. Fish and Game, Boise, ID.

Gebauer, M.B. 1995. Status and productivity of Great Blue Heron (*Ardea herodias*) colonies in Howe Sound/Whistler, Sunshine Coast and Powell River Areas in 1993 and 1994. Unpubl. Rep., BC Min. Environ., Lands and Parks, Surrey, BC. 50 p.

Gebauer, M.B. and I.E., Moul. 2001. Status of the Great Blue Heron in British Columbia. Wildlife Working Report 102, BC Min. Environ., Lands and Parks, Wildl. Br., Victoria, BC. 66 p.

Gregory, P.T. and R.W. Campbell.1984. The reptiles of British Columbia. Royal BC Museum, Victoria, BC.

Gyug, L.W. and S.P. Bennett. 1995. Bird use of wildlife tree patches 25 years after clearcutting. *In* Bradford, P., T. Manning, and B. I'Anson. Wildlife Tree/Stand-level Biodiversity Workshop Proceedings, Victoria, BC.

Gyug, L.W. and A. Peatt 2004. Inventories of Sagebrush Northern Bog Lemming, Williamson's Sapsucker, and Mountain Beaver in the southern interior of British Columbia. *In* Proceedings of a Conference on the Biology and Management of Species and Habitats at Risk, Kamloops, BC. Feb. 15–19 1999. Volume One. BC Min. Environ., Lands and Parks, Victoria, BC and University College of the Cariboo, Kamloops, BC. pp. 417–425.

Hamilton, D., S.F. Wilson, and C. Steeger. 2003. A guide to habitat supply modelling. Unpubl. report; BC Min. Water, Land and Air Protect. and BC Min. For., Victoria, BC.

Harestad, A.S., and D.G. Keisker. 1989. Nest tree use by primary cavity-nesting birds in south central British Columbia. Canadian Journal of Zoology 67(4): 1067–1073.

Hayward G.D. and P.H. Hayward. 1993. Boreal Owl (*Aegolius funereus*). *In* A. Poole and F. Gill (eds.). The birds of North America. No. 63. Philadelphia, PA: the Academy of Natural Sciences and Washington, DC: the American Ornithologists' Union.

Huggard, D. 2001. Habitat attributes in the Arrow IFPA non-harvestable landbase. Unpubl. Report prepared for the Arrow IFPA. BC Min. For., Victoria, BC.

Jackson, J.A 1979. Tree surfaces as foraging substrates for insectivorous birds in forest ecosystems. *In* The role of insectivorous birds in forest ecosystems. J.G. Dickson, R.N. Conner, R.R. Fleet, J.A. Jackson, and J.C. Kroll (eds.). Academic Press, New York, NY. pp. 69–94.

Johnson, D.H. and T.A. O'Neil (managing directors). 2001. Wildlife-habitat relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR. 736 p.

Jordan, K.M. and S.K. Hughes. 1995. Characteristics of three Marbled Murrelet tree nests, Vancouver Island, British Columbia. *In* Biology of the Marbled Murrelet: Inland and at sea. (S.K. Nelson and S.G. Sealy, eds.). Northwest. Nat. 76. pp. 29–32.

Kalcounis, M.C., and R.M. Brigham. 1998. Secondary use of aspen cavities by tree-roosting big brown bats. Journal of Wildlife Management 62(2): 603–611.

Laudenslayer, W.F. Jr., P.J. Shea, B. Valentine, C.P. Weatherspoon, and T.E. Lisle. (tech. coord.). 2002. Proceedings of the symposium on the ecology and management of dead wood in western forests. 1999 November 2–4; Reno, NV. Albany, CA: Pacific Southwest Research Station, Forest Service, U.S. Dept. Agric. Gen. Tech. Rep. PSW-GTR-181. 949 p.

Li, P. and T.E. Martin. 1991. Nest site selection and nesting success of cavity-nesting birds in high elevation forest drainages. Auk 108: 405–418.

Machmer, M.M 1999. Development of Northern Goshawk forest management guidelines for the Arrow Forest District. BC Min. For., Arrow Forest District, Castlegar, BC. 38 p.

______. Northern Goshawk nest area habitat assessment in the Arrow Creek drainage, Kootenay Lake Forest District. BC Min. Environ., Lands and Parks, Kootenay Region. 28 p.

______. The ecological role of fire for cavity nesting birds: final technical report. Unpubl. Report, Forest Renewal BC, Victoria. 55 p.

______. 2002. Northern Goshawk inventory and breeding habitat assessment in the Invermere Enhanced Forest Management Pilot Project Area: Project Summary Report No. 14. Invermere Forest District, BC Min. For., Invermere, BC.

Machmer, M.M and J. Dulisse. 2000. Northern Goshawk inventory and breeding habitat assessment in the Invermere Enhanced Forest Management Pilot Project Area: Final Report (1998–1999). BC Min. For., Invermere, BC. 54 p.

Machmer, M.M. and B. Korol. 1998. Assessment of wildlife tree habitat in the Revelstoke Forest District. Final Tech. Rep., Forest Renewal BC and BC Science Council. 92 p.

Machmer, M.M. and C. Steeger. 1995. The ecological roles of wildlife tree users in forest ecosystems. BC Min. of Forests Research Program Victoria, BC. Land Manage. Handb. No. 35.

______. 2003. Breeding inventory and habitat assessment of great blue herons in the Columbia Basin. Unpubl. report. Columbia Basin Fish & Wildlife Compensation Program, Nelson, BC. 56 p.

Mahon, T., F. Doyle, and M. Nelligan. 2002. Inventory of the Northern Goshawk in the Lakes and Morice Forest Districts. 2001/2002 Annual Report. BC Min. Environ., Lands and Parks, Skeena Region. Smithers, BC.

Manley, I.A. and J.D. Kelson. 1995. Description of two Marbled Murrelet nests in the Walbran Valley, British Columbia. *In* (S.K. Nelson and S.G. Sealy,) (eds.) Biology of the Marbled Murrelet: Inland and at sea. Northwest. Nat. 76. pp. 26–29.

Manning, E.T. and J.M. Cooper. 1996. An assessment of woodpecker foraging, home range, and patch utilization at Wallace Creek, British Columbia. BC Environ., Penticton, BC. Unpubl. rep.

Manning, E.T. and M.G. Shepard. 1999. An assessment of forest breeding birds and stand structure at Currie Creek, South Island Forest District, Vancouver Island, BC Unpubl. report. BC Min. For., South Island Forest District, Port Alberni, BC.

Mariani, J.M. and D.A. Manuwal. 1990. Factors influencing Brown Creeper (*Certhi americana*) abundance patterns in the south Washington Cascade Range. Studies in Avian Biology 13:53–57.

Miller, D. 1998. Proceedings of a workshop on the potential of woodpeckers in managing bark beetles. November 25, 1997. Unpubl. report to the BC Min. For., For. Prac. Br., Victoria, BC.

Nagorson, D.W. and R.M. Brigham. 1993. Bats of British Columbia. Volume 1. Mammals of British Columbia. Royal British Columbia Museum Handbook. University of British Columbia Press, Vancouver, BC. 164 p.

Ormsbee, P.C. 1996. Selection of day roosts by female long-legged myotis (*Myotis volans*). *In* Forests of the central Oregon Cascades. MS thesis, Oregon State University, Corvallis, OR.

Paige, K. (tech. ed.). 2002. Standards for managing identified wildlife, Version 2 Draft. Biodiversity Branch, BC Min. Water, Land and Air Protect., Victoria, BC.

Peterson, B. and G. Gauthier. 1985. Nest site use by cavity-nesting birds of the Cariboo Parkland, British Columbia. Wilson Bull. 97 (3):319–331.

Province of British Columbia. 1995. Biodiversity Guidebook, Forest Practices Code of British Columbia, BC Min. For. and BC Min. Environ., Lands and Parks, Victoria, BC.

______. Identified Wildlife Management Strategy, Forest Practices Code of British Columbia, BC Min. For. and BC Min. Environ., Lands and Parks, Victoria, BC.

______. 1999b. Landscape Unit Planning Guide. BC Min. For., Victoria, BC.

______. 2000. Provincial Wildlife Tree Policy and Management Recommendations. BC Min. For., and BC Min. Environ., Lands and Parks, Victoria, BC.

______. 2001. Mensuration data from the Provincial Ecology Program. BC Min. For., Forest Science Program, Victoria, BC. Working Paper 62.

______. 2002. Wildlife Danger Tree Assessor's Course, September 2002 Update. BC Min. For., BC Min. Environ., Lands and Parks, Victoria, BC.

______. 2003. Evaluation of wildlife tree retention for cutblocks harvested between 1996–2001 under the Forest Practices Code. BC Ministry Forests and BC Ministry Water, Land and Air Protect., Victoria, BC.

Pulliam, H.R. 1988. Sources, sinks and population regulation. American Naturalist 132: 652–661.

Rabe, M.J., T.E. Morrell, H.M. Green, J.C. Devos, Jr., and C.R. Miller. 1998. Characteristics of ponderosa pine snag roosts used by reproductive bats in northern Arizona. Journal of Wildlife Management 62(2): 612–621.

Rasheed, S.A. and S.L Holroyd. 1995. Roosting habitat assessment and inventory of bats in the Mica Wildlife Compensation Area. BC Hydro, Burnaby, BC and BC Min. Environ., Lands and Parks, Victoria, BC. Unpubl. rep.

Reynolds, R.T., E.C. Meslow, and H.M. Wight. 1984. Nesting habitat of coexisting *Accipiter* in Oregon. Journal of Wildlife Management 46(1):124–138.

Robertson, R.J., B.J. Stutchbury, and R.R. Cohen. 1992. Tree swallow (*Tachycineta bicolor*). *In* A. Poole and F. Gill (eds.). The birds of North America. No. 11. Philadelphia, PA: the Academy of Natural Sciences and Washington, DC: the American Ornithologists' Union.

Saab, V.A. and J.G. Dudley. 1998. Responses of cavity-nesting birds to stand-replacement fire and salvage logging in ponderosa pine/Douglas-fir forests of southwestern Idaho. USDA Forest Service, Rocky Mountain Research Station, Research Paper RMRS-RP-11, Boise, ID.

Schreiber, B. 1987. Diurnal bird use of snags on clearcuts in central coastal Oregon. MS thesis, Oregon State University, Corvallis, OR.

Steeger, C. and J. Dulisse. 1997. Ecological interrelationships of Three-toed Woodpeckers with bark beetles and pine trees. Nelson Forest Region Research Summary RS-035. BC Min. For., Nelson, BC.

______. 2001. Characteristics and temporal dynamics of cavity nest trees in Interior Cedar-Hemlock forests of southern British Columbia. Forest Renewal BC, Victoria, BC. Unpubl. rep. 20 p.

______. 2002. Characteristics and dynamics of cavity nest trees in southern British Columbia. *In* W.F. Laudenslayer, Jr., P.J. Shea, B.E. Valentine, C.P. Weatherspoon, and T.E. Lisle (tech. coord.). Proceedings of the symposium on the ecology and management of dead wood in western forests. November 2–4, 1999; Reno, NV. Albany, CA: Pacific Southwest Research Station, Forest Service, U.S. Dept. of Agric. Gen. Tech. Rep. PSW-GTR-181. pp. 275–289.

Steeger, C., J. Dulisse, and M.M. Machmer. 2001. Wildlife-Habitat relationships in the Columbia River Basin: a British Columbia database for terrestrial vertebrate species. BC Min. For., Victoria, BC.

Steeger, C. and M.M. Machmer. 1995a. Use of trees by cavity nesters in managed and unmanaged interior cedar-hemlock stands of southern British Columbia. *In* P. Bradford, T. Manning and B. I'Anson (eds.). Wildlife Tree/Stand-level Biodiversity Workshop Proceedings, October 1995, Victoria, BC. pp. 45–54.

______. 1995b. Wildlife trees and primary cavity nesters in selected stands of the Nelson Forest Region. BC Min. For., Nelson, BC. Tech. Rep. TR-010. 29 p.

Steeger, C. and M.M. Machmer. 2002. Field guide for wildlife tree retention in operational forestry. FRBC 2001/02 Research Program, Burnaby, BC. Unpubl. rep.

Steeger, C., M.M. Machmer, and B. Gowans. 1998. Impact of insectivorous birds on bark beetles: a literature review. BC Min. For., For. Prac. Br., Victoria, BC. Unpubl. rep.

Stevens, V. 1995. Wildlife diversity in British Columbia: distribution and habitat use of amphibians, reptiles, birds and mammals in biogeoclimatic zones. Research Br., BC Min. For., Wildl. Br., and BC Min. Environ., Lands and Parks, Victoria, BC. Working Paper. 288 p.

van Woudenberg, A.M. 1999. Status of the Flammulated Owl in British Columbia. BC Min. Environ., Victoria, BC. Wildlife Working Report No. WR-95.

Vonhof, M.J. 1996. A survey of the abundance, diversity, and roost-site preferences of bats in the Pend D'Oreille Valley, British Columbia. Columbia Basin Fish and Wildlife Compensation Program, Nelson, BC. Unpubl. rep.

Walters, E.L. 1996. Habitat and space use of the Red-naped Sapsucker, *Sphyrapicus nuchalis*, in the Hat Creek valley, south-central British Columbia. MSc thesis, University of Victoria, Victoria, BC.

Weir, R.D. 1995. Diet, spatial organization, and habitat relationships of fishers in south-central British Columbia. MA thesis, Simon Fraser University, Burnaby, BC.

Wiebe, K.L. 2001. The microclimate of tree cavity nests: is it important for reproductive success of flickers? Auk 118: 412–421.

Wilson, S.F., C. Steeger, and D. Hamilton. 2002. Habitat supply modelling: TFL 14 pilot project. BC Min. Water, Land and Air Protect., Victoria, BC and Tembec Industries, Inc., Cranbrook, BC. Unpubl. rep.

______. 2003. Habitat supply modelling for the Arrow Timber Supply Area. BC Min. Water, Land and Air Protect., Victoria, BC and Arrow Forest License Group, Castlegar, BC. Unpubl. rep.

APPENDICES

Appendix 1. Summary of the conservation status, wildlife tree dependency rankings, comments on wildlife tree use, and occurrence by ecoprovince for all candidate WT users.

Scientific Name	Common Name	CDC Listing	COSEWIC Rank	IWMS Status	CR Database	B and L	Reproduction	Foraging	Other	Shortlist	General Comments on Wildlife Tree Use	NBM	TAP	SBI	BOP	COM	CEI	SIM	SOI	GED
Aneides ferreus	Clouded Salamander				1	1	2	2	2	Y	found under loose bark of logs or stumps (Corkran and Thoms, 1996; restricted to Vancouver Island CDF and CWH; logs with loose bark most important habitat element (Davis and Gregory 1993)					X				X
Ardea herodias	Great Blue Heron	B	SC (*fannini*)	x (*fannini* and *herodias*)	1	1	2	0	0	Y	ON; nests in large live and recently dead trees near water	X		X	X	X	X	X	X	X
Aix sponsa	Wood Duck				1	1	1	0	0	Y	SCU; uses natural or excavated cavities usually in mature deciduous trees near water				X	X	X	X	X	X
Bucephala albeola	Bufflehead				1	1	1	0	0	Y	SCU; uses excavated (NOFL) or natural cavities usually in live or dead deciduous or coniferous trees near water	X	X	X	X	X	X	X	X	X

CDC listing: B = blue-listed; R = red-listed; parentheses indicate the listing of only one population or subspecies (SOI = Southern Interior; GD = Georgia Depression).

COSEWIC ranking: DD = taxa reviewed for listing but data deficient; SC = special concern; T = threatened; E = endangered; parentheses indicate the listing of only one population or subspecies.

IWMS status: x = included in Version 2003 of IWMS; parentheses indicate the listing of only one population or subspecies.

Columbia River Database: 1 = WT-user in US and Canada; 2 = WT-user in Canada only.

Backhouse and Lousier 1991: 1 = included on list of vertebrate WT-users; 0 = not included on list of vertebrate WT-users.

Reproduction: level of dependency for reproduction (1= highly dependet on wildlife trees; 2 = commonly uses wildlife trees; 3 = occasionally uses wildlife trees; 0 = not known to use wildlife trees).

Foraging: level of dependency for foraging (1= highly dependet on wildlife trees; 2 = commonly uses wildlife trees; 3 = occasionally uses wildlife trees; 0 = not known to use wildlife trees).

Other: level of dependency for other life requisites (1= highly depende on wildlife trees; 2 = commonly uses wildlife trees; 3 = occasionally uses wildlife trees; 0 = not known to use wildlife trees).

Short-listed species (Y = yes; N = no) criteria: (i) either listed by the CDC and ranked high [1] or moderate [2] users for at least one life requisite category; (ii) ranked high [1] or moderate [2] users for reproduction; or (iii) ranked high [1] users for at least one life requisite category.

Occurrence by ecoprovince: BOP = Boreal Plains; CEI = Central Interior; COM = Coast and Mountains; GED = Georgia Depression; NBM = Northern Boreal Mountains; SBI = Sub-Boreal Interior; SIM = Southern Interior Mountains; SOI = Southern Interior; TAP = Taiga Plains.

Scientific Name	Common Name	CDC Listing	COSEWIC Rank	IWMS Status	CR Database	B and L	Reproduction	Foraging	Other	Shortlist	General Comments on Wildlife Tree Use	NBM	TAP	SBI	BOP	COM	CEI	SIM	SOI	GED
Bucephala clangula	Common Goldeneye				1	1	1	0	0	Y	SCU; nests mainly in natural cavities of dead deciduous and coniferous trees near water; may use excavated PIWO and NOFL cavities	X	X	X	X	X	X	X	X	X
Bucephala islandica	Barrow's Goldeneye				1	1	1	0	0	Y	SCU; nests mainly in natural cavities of dead deciduous and coniferous trees near water; may use excavated PIWO and NOFL cavities	X	X	X	X	X	X	X	X	X
Lophodytes cucullatus	Hooded Merganser				1	1	1	0	0	Y	SCU; nests mainly in natural cavities of live and dead deciduous and coniferous trees near water	X	X	X	X	X	X	X	X	X
Mergus merganser	Common Merganser				1	1	2	0	0	Y	SCU; nests mainly in natural cavities of large live and dead deciduous and coniferous trees near water	X	X	X	X	X	X	X	X	X
Pandion haliaetus	Osprey				1	1	2	2	2	Y	ON; uses snags, dead parts of live trees, and live remnant legacy trees for nest placement, hunting perches, and roosts	X		X	X	X	X	X	X	X
Haliaeetus leucocephalus	Bald Eagle				1	1	2	2	2	Y	ON; uses snags, dead parts of live trees, and live remnant legacy trees for hunting perches, roosts, and nest placement	X	X	X	X	X	X	X	X	X
Accipiter gentilis	Northern Goshawk	R (*laingi*)	T (*laingi*)	x (*laingi*)	1	1	2	2	0	Y	ON; uses mistletoe brooms for nesting platforms and snags for plucking posts	X	X	X	X	X	X	X	X	X
Falco sparverius	American Kestrel				1	1	2	2	0	Y	SCU; uses abandoned woodpecker holes and natural cavities for nesting; snags and dead parts of live trees for hunting perches	X	X	X	X	X	X	X	X	X
Brachyramphus marmoratus	Marbled Murrelet	R	T	x (*marmotus*)	1	0	2	0	0	Y	mistletoe, large live tree branches (CB database)					X				X
Otus flammeolus	Flammulated Owl	B	SC	x (*idahoensis*)	1	1	1	0	0	Y	SCU; nests in abandoned woodpecker (NOFL) holes in large Douglas-fir and ponderosa pine snags; snags *used as hunting perches*	X	X							

Scientific Name	Common Name	CDC Listing	COSEWIC Rank	IWMS Status	CR Database	B and L	Reproduction	Foraging	Other	Shortlist	General Comments on Wildlife Tree Use	NBM	TAP	SBI	BOP	COM	CEI	SIM	SOI	GED
Otus kennicottii	Western Screech-owl	B (*saturatus*) R (*macfarlanei*)	DD	x (*macfarlanei*)	1	1	1	0	2	Y	SCU; nests in abandoned woodpecker (NOFL, PIWO) holes of coniferous and deciduous trees					X		X	X	X
Bubo virginianus	Great Horned Owl				1	1	2	2	0	Y	ON; nests in large coniferous and deciduous trees; used old open nests and also snags with broken tops or natural cavities; will nest on large Fd brooms	X	X	X	X	X	X	X	X	X
Surnia ulula	Northern Hawk Owl				2	1	2	2	0	Y	SCU; nests in natural cavities and woodpecker (PIWO, NOFL) holes; dead parts of live trees and live remnant/legacy trees used for hunting perches	X	X	X	X	X	X	X	X	X
Glaucidium gnoma	Northern Pygmy-owl	B (*swarthi*)		x (*swarthi*)	1	1	1	0	0	Y	SCU; nests in abandoned woodpecker holes in coniferous trees; roosts in woodpecker or natural cavities	X		X	X	X	X	X	X	X
Strix occidentalis	Spotted Owl	R	E	x (*caurina*)	1	1	1	0	0	Y						X				X
Strix varia	Barred Owl				1	1	2	0	0	Y	SCU; nests in natural cavities or old open nests in large coniferous or deciduous trees	X	X	X	X	X	X	X	X	X
Strix nebulosa	Great Gray Owl				1	0	2	0	0	Y	ON; nests in abandoned raptor nests (NOGO, RTHA), on broken-top snags, or on mistletoe brooms	X	X	X	X	X	X	X	X	X
Aegolius funereus	Boreal Owl				1	1	1	0	0	Y	SCU; nests in natural and abandoned woodpecker cavities	X	X	X	X	X	X	X	X	X
Aegolius acadicus	Northern Saw-whet Owl	B (*brooksi*)		x (*brooksi*)	1	1	1	2	0	Y	SCU; nests in abandoned woodpecker (NOFL, PIWO) cavities; roosts in natural and woodpecker cavities and mistletoe brooms.	X		X	X	X	X	X	X	X
Chaetura vauxi	Vaux's Swift				1	1	1	0	0	Y	SCU; uses hollow trees for nesting and roosting and old cavities excavated by PIWO			X	X	X	X	X	X	X

Scientific Name	Common Name	CDC Listing	COSEWIC Rank	IWMS Status	CR Database	B and L	Reproduction	Foraging	Other	Shortlist	General Comments on Wildlife Tree Use	NBM	TAP	SBI	BOP	COM	CEI	SIM	SOI	GED
Melanerpes lewis	Lewis' Woodpecker	R (GED pop); B (rest of BC)	SC	x	1	1	1	1	1	Y	PCE/SCU; often uses cavities excavated by other woodpeckers or natural cavities; snags used for roosting and hawking perches; aerial insectivore			X		X	X	X	X	X
Sphyrapicus thyroideus	Williamson's Sapsucker	R (*nataliae*); B (*thyroideus*)		x (*nataliae* and *thyroideus*)	1	1	1	1	1	Y	PCE; uses live trees or snags for nesting/roosting; may also use cavities excavated by PIWO; uses live remnant/legacy trees; bark forager and sapsucker	X	X							
Sphrapicus varius	Yellow-bellied Sapsucker				2	1	1	1	1	Y		X	X	X	X					
Sphyrapicus nuchalis	Red-naped Sapsucker				1	1	1	1	1	Y	PCE; uses live trees and snags for nesting/roosting; bark forager and sapsucker					X	X	X	X	X
Sphyrapicus ruber	Red-breasted Sapsucker				1	1	1	1	1	Y		X		X	X	X	X	X	X	X
Picoides pubescens	Downy Woodpecker				1	1	1	1	1	Y	PCE; uses snags for nesting and roosting, and will nest secondarily; bark forager; live remnant/legacy trees for nesting, roosting, feeding	X	X	X	X	X	X	X	X	X
Picoides villosus	Hairy Woodpecker	B (*picoides*)		x (*picoides*)	1	1	1	1	1	Y	PCE; will nest secondarily; bark forager	X	X	X	X	X	X	X	X	X
Picoides albolarvatus	White-headed Woodpecker	R	E	x	1	1	1	1	1	Y	PCE; will nest secondarily; seed and bark forager; uses pines for foraging and nesting							X	X	
Picoides tridactylus	Three-toed Woodpecker				1	1	1	1	1	Y	PCE; will nest secondarily; bark forager; uses live remnant/legacy trees for nesting, roosting, and feeding	X	X	X	X	X	X	X	X	X
Picoides arcticus	Black-backed Woodpecker				1	1	1	1	1	Y	PCE; will nest secondarily; bark forager; uses live remnant/legacy trees for nesting, roosting, feeding	X	X	X	X	X	X	X	X	

Scientific Name	Common Name	CDC Listing	COSEWIC Rank	IWMS Status	CR Database	B and L	Reproduction	Foraging	Other	Shortlist	General Comments on Wildlife Tree Use	NBM	TAP	SBI	BOP	COM	CEI	SIM	SOI	GED
Colaptes auratus	Northern Flicker				1	1	1	1	1	Y	PCE; uses live remnant/ legacy trees for nesting, roosting, feeding	X	X	X	X	X	X	X	X	X
Dryocopus pileatus	Pileated Woodpecker				1	1	1	1	1	Y	PCE; uses large, hard snags for nesting and roosting and softer snags for feeding; hollow living trees for winter roosting only; bark forager	X	X	X	X	X	X	X	X	X
Progne subis	Purple Martin	R			1	1	2	0	0	Y					X	X				X
Tachycineta bicolor	Tree Swallow				1	1	2	0	0	Y	SCU; nests in abandoned woodpecker holes and roosts in woodpecker and natural cavities	X	X	X	X	X	X	X	X	X
Tachycineta thalassina	Violet-green Swallow				1	1	2	0	0	Y	SCU; nests in abandoned woodpecker holes and roosts in woodpecker and natural cavities	X	X	X	X	X	X	X	X	X
Poecile atricapillus	Black-capped Chickadee				1	1	1	0	1	Y	weak PCE; needs softer, more decayed wood, but will use existing cavities in any decay class	X	X	X	X	X	X	X	X	X
Poecile gambeli	Mountain Chickadee				1	1	1	0	1	Y	weak PCE; needs softer, more decayed wood, but will use existing cavities in any decay class, especially sapsucker cavities (although BNA account says that cavity excavation remain unsubstantiated)	X		X		X	X	X	X	X
Poecile rufescens	Chestnut-backed Chickadee				1	1	1	0	0	Y	weak PCE; needs softer, more decayed wood, but will use existing cavities in any decay class			X		X	X	X	X	X
Poecile hudsonicus	Boreal Chickadee				1	1	1	0	1	Y	weak PCE; needs softer, more decayed wood, but will use existing cavities in any decay class	X	X	X	X	X	X	X	X	
Sitta canadensis	Red-breasted Nuthatch				1	1	1	0	0	Y	weak PCE; prefers larger snags, but uses a wide range of sizes; uses dead parts of live trees for bark foraging	X	X	X	X	X	X	X	X	X

Scientific Name	Common Name	CDC Listing	COSEWIC Rank	IWMS Status	CR Database	B and L	Reproduction	Foraging	Other	Shortlist	General Comments on Wildlife Tree Use	NBM	TAP	SBI	BOP	COM	CEI	SIM	SOI	GED
Sitta carolinensis	White-breasted Nuthatch				1	1	1	0	0	Y	SCU/ weak PCE; uses dead parts of live trees for bark foraging						X	X	X	X
Sitta pygmaea	Pygmy Nuthatch				1	1	1	0	1	Y	PCE/SCU; excavates in decayed conifers or nests in abandoned holes; uses dead parts of live trees for foraging						X	X	X	
Certhia americana	Brown Creeper				1	1	1	0	0	Y	SCU; places nests behind loose bark; forages in deep, fissured bark		X	X	X	X	X	X	X	X
Thyrothorus ludovicianus	Bewick's Wren				1	1	1	0	0	Y						X				X
Troglodytes aedon	House Wren				1	1	2	0	0	Y	SCU; sometimes nests behind loose bark		X	X	X	X	X	X	X	X
Sialia mexicana	Western Bluebird	R (GED pop)			1	1	1	0	0	Y	SCU; nests and roosts in abandoned woodpecker holes (NOFL, HAWO) or natural cavities; uses hollow living trees for winter roosting	X	X	X	X	X				
Sialia currucoides	Mountain Bluebird				1	1	1	0	0	Y	SCU; nests and roosts in abandoned woodpecker holes (NOFL, HAWO) or natural cavities	X	X	X	X	X	X	X	X	X
Myotis californicus	California Myotis				1	1	2	0	2	Y	SCU; breeds and roosts in tree cavities and under loose bark					X	X	X	X	X
Myotis yumanensis	Yuma Myotis				1	1	2	0	2	Y	SCU; breeds and roosts in tree cavities					X	X	X	X	X
Myotis lucifugus	Little Brown Myotis				1	1	2	0	2	Y	SCU; breeds and roosts in tree cavities and under loose bark	X	X	X	X	X	X	X	X	X
Myotis volans	Long-legged Myotis				1	1	2	0	2	Y	SCU; breeds and roosts in tree cavities and under loose bark; live remnant/legacy trees that project above the canopy are particularly important	X		X		X	X	X	X	X
Myotis keenii	Keen's Long-eared Myotis	R	SC	x	1	1	2	0	2	Y						X				X
Myotis evotis	Western Long-eared Myotis				1	1	2	0	2	Y	SCU; breeds and roosts in tree cavities and under loose bark	X		X		X	X	X	X	X
Myotis septentrionalis	Northern Long-eared Myotis	B			2	1	2	0	2	Y	SCU; breeds and roosts in tree cavities and under loose bark			X	X					

Scientific Name	Common Name	CDC Listing	COSEWIC Rank	IWMS Status	CR Database	B and L	Reproduction	Foraging	Other	Shortlist	General Comments on Wildlife Tree Use	NBM	TAP	SBI	BOP	COM	CEI	SIM	SOI	GED
Lasionycteris noctivagans	Silver-haired Bat				1	1	1	0	1	Y	SCU; breeds and roosts in tree hollows and spaces underneath bark; snag height is the key within or around surrounding canopy	X	X	X	X	X	X	X		
Eptesicus fuscus	Big Brown Bat				1	1	2	0	2	Y	SCU; breeds and roosts in tree hollows and spaces underneath loose bark			X	X	X	X	X	X	X
Antrozous pallidus	Pallid Bat	R	T		1	1	2	0	3	Y	SCU; may breed or roost in tree cavities								X	
Tamias amoenus	Yellow-pine Chipmunk					1	2	0	2	Y	SCU; nests may occur in tree cavities.					X	X	X	X	
Tamiasciurus hudsonicus	Red Squirrel				1	1	2	3	2	Y	SCU; nests may occur in tree cavities or on brooms; may nest secondarily in abandoned woodpecker holes	X	X	X	X	X	X	X	X	X
Tamiasciurus douglasii	Douglas' Squirrel				1	1	2	3	2	Y						X				X
Glaucomys sabrinus	Northern Flying Squirrel				1	1	2	3	2	Y	SCU; nests in abandoned woodpecker holes (TTWO, BBWO) and on mistletoe or rust brooms	X	X	X	X	X	X	X	X	
Ursus americanus	Black Bear	B (*emmonsii*)			1	1	2	0	2	Y	SCU; uses hollow living trees for denning; feeds on cambium layer in early spring	X	X	X	X	X	X	X	X	X
Procyon lotor	Raccoon				1	1	2	0	2	Y	SCU; uses cavities or hollow trees for denning					X		X	X	X
Martes americana	American Marten				1	1	2	0	2	Y	SCU; may use cavities for denning if large enough; also checks cavities for prey	X	X	X	X	X	X	X	X	X
Martes pennanti	Fisher	B		x	1	1	1	0	2	Y	SCU; uses cavities or hollow trees as nest or den sites	X	X	X	X	X	X	X	X	
Rangifer tarandus	Caribou	R (southern pop)	T (southern pop)	x (*caribou* subsp.)		1	0	1	0	Y	forages on lichen growing on remnant/legacy trees, large live tree branches, and snags	X	X	X	X		X	X		
Ensatina eschscholzii	Ensatina				1	0	0	0	3	N	often uses debris piles at the bottom of snags (CB data, Corkran and Thoms 1996)									
Plethodon vehiculum	Western Red-backed Salamander					0	0	0	3	N	may be found in crevices of down and standing dead trees									

Scientific Name	Common Name	CDC Listing	COSEWIC Rank	IWMS Status	CR Database	B and L	Reproduction	Foraging	Other	Shortlist	General Comments on Wildlife Tree Use	NBM	TAP	SBI	BOP	COM	CEI	SIM	SOI	GED
Cathartes aura	Turkey Vulture				1	1	0	0	2	N										
Histrionicus histrionicus	Harlequin Duck					0	3	0	0	N	will nest in natural tree cavities.									
Accipiter cooperii	Cooper's Hawk					0	3	3	0	N	likes nesting on mistletoe (Reynolds et al. 1984)									
Buteo swainsoni	Swainson's Hawk	R			1	0	3	0	0	N	nests in trees with defects									
Buteo jamaicensis	Red-tailed Hawk				1	1	0	2	0	N										
Aquila chrysaetos	Golden Eagle				1	1	3	0	0	N										
Falco columbarius	Merlin				1	1	3	0	0	N										
Falco peregrinus	Peregrine Falcon	B (*pealei*) R (*anatum*)	SC (*pealei*) T (*anatum*)		1	0	0	3	0	N	uses snags as perch trees (CB database)									
Falcipennis canadensis	Spruce Grouse				1	0	0	2	0	N	mistletoe as food source (CB database)									
Dendragapus obscurus	Blue Grouse				1	0	0	2	2	N	mistletoe as food and winter cover for young (CB database)									
Cerorhinca moncerata	Rhinocerus Auklet					0	3	0	0	N	nests among roots of trees (Birds of BC)									
Tyto alba	Barn Owl	B	SC		1	1	3	0	3	N										
Asio otus	Long-eared Owl				1	0	1	0	0	N	ON; nests on mistletoe brooms									
Ceryle alcyon	Belted Kingfisher					1	0	2	0	N	prefers dead hunting perches (Backhouse and Lousier 1991)									
Contopus cooperi	Olive-sided Flycatcher				1	0	0	2	0	N	snags used as hunting perches; snags that project above the surrounding canopy are particularly important (CB data)									
Contopus sordidulus	Western Wood-pewee				1	0	0	3	0	N	live remnant legacy trees in early successional stages and riparian sites CB data)									
Empidonax difficilis	Pacific-slope Flycatcher				1	1	3	2	0	N										
Troglodytes troglodytes	Winter Wren				1	0	3	0	0	N	will nest in tree cavities (pers. obs.); tree cavities, bark (CB database)									
Piranga ludoviciana	Western Tanager				1	0	?	?	?	N	live remnant legacy trees (CB data)									
Quiscalus quiscula	Common Grackle				2	1	3	0	0	N										

Scientific Name	Common Name	CDC Listing	COSEWIC Rank	IWMS Status	CR Database	B and L	Reproduction	Foraging	Other	Shortlist	General Comments on Wildlife Tree Use	NBM	TAP	SBI	BOP	COM	CEI	SIM	SOI	GED
Carpodacus mexicanus	House Finch					1	3	0	0	N	SCU (Backhouse and Lousier)									
Myotis ciliolabrum	Western Small-footed Myotis	B			1	1	0	0	3	N										
Myotis thysanodes	Fringed Myotis	B	SC	x (*thysanodes*)	1	0	0	0	3	N	snags, snag size, hollow living trees, tree cavities, bark (CB database); not a WT user according to *Bats of BC*									
Lasiurus cinereus	Hoary Bat				1	1	0	0	2	N										
Corynorhinus townsendii	Townsend's Big-eared Bat	B			1	0	0	0	3	N	hollow living trees considered important but unstudied, live remnant legacy trees (CB data)									
Tamias minimus	Least Chipmunk	B (*oreocetes*); R (*selkirki*)			1	1	3	0	3	N										
Tamias townsendii	Townsend's Chipmunk					1	3	0	3	N										
Tamias ruficaudus	Red-tailed Chipmunk	B (*simulans*); R (*ruficaudus*)				1	3	0	3	N										
Marmota monax	Woodchuck				2	0	3	0	3	N	dens in base of hollow living trees (pers. obs.)									
Peromyscus maniculatus	Deer Mouse				1	1	3	0	2	N										
Peromyscus oreas	Columbian Mouse					1	3	0	2	N	Nagorsen goups Columbian and Sitka into one species: Keen's mouse.									
Peromyscus sitkensis	Sitka Mouse					1	3	0	2	N										
Peromyscus keeni	Keen's Mouse					0	3	0	3	N	nests in tree cavities (*Mammals of BC*)									
Clethrionomys gapperi	Southern Red-backed Vole	B (*galei*); R (*occidentalis*)				1	3	0	3	N										
Clethrionomys rutilus	Northern Red-backed Vole					0	3	0	3	N	nests in rotten trees (*Mammals of BC*)									
Phenacomys ungava	Eastern Heather Vole					0	3	0	3	N	nests at base of trees (*Mammals of BC*)									

Scientific Name	Common Name	CDC Listing	COSEWIC Rank	IWMS Status	CR Database	B and L	Reproduction	Foraging	Other	Shortlist	General Comments on Wildlife Tree Use	NBM	TAP	SBI	BOP	COM	CEI	SIM	SOI	GED
Neotoma cinerea	Bushy-tailed Woodrat				1	1	3	0	3	N										
Erethizon dorsatum	Porcupine					0	0	3	0	N	feeds on mistletoe infected twigs (Bull et al. 1997)									
Mustela erminea	Ermine	B (*anguinae*); R (*haidarum*)	T (*haidarum*)			1	3	0	3	N										
Mustela frenata	Long-tailed Weasel	R (*altifrontalis*)			1	1	3	0	3	N										
Spilogale gracilis	Western Spotted Skunk				1	1	3	0	3	N										
Mephitis mephitis	Striped Skunk				1	0	0	0	3	N	snags, snag size, hollow living trees, tree cavities (CB database)									
Felis concolor	Mountain Lion				1	0	0	0	3	N	large live tree branches (CB data)									
Cervus elaphus	Elk	B (*roosevelti*)			1	0	0	3	0	N	eats mistletoe shoots (CB data)									
Odocoileus hemionus	Mule Deer					0	0	3	0	N	eats mistletoe shoots (Bull et al. 1997)									
Odocoileus virginianus	White-tailed Deer					0	0	3	0	N	eats mistletoe shoots (Bull et al. 1997)									

Appendix 2. Summary of empirical information on the characteristics (tree species, diameter, height, and decay class) of nest, den, and roost trees used by wildlife tree-dependent vertebrate species in British Columbia (data presented by study area/BEC zone).

Common Name	Study Area (BEC Zone)[a]	Source	n	Nest/Den Tree Species (% total sample n)[b]	Mean (SE)	Range	Mean (SE) Height	Height Range	Median Decay Class (Range)	Comments
Clouded Salamander										
Great Blue Heron	BC coast	Campbell et al. 1990a	926	Dr (33), Fd, Mb, Cw, Ss				7–70		colonial nester
Great Blue Heron	BC interior	Campbell et al. 1990a	926	Act (70), At, Pw, Py				7–70		
Great Blue Heron	Fraser Valley	Gebauer 1995	787	Dr (48), Act (30), Mb (8), Ss (9), Fd (2), Ep (1), Hw (1)						
Great Blue Heron	BC coast	Gebauer and Moul 2001	104	Dr	35					
Great Blue Heron	BC coast	Gebauer and Moul 2001	68	Fd	45					
Great Blue Heron	BC interior (PP/IDF/ICH/MS/SBS)	Machmer and Steeger 2003	64	Act (54), Fd, Pw, Sx, Py, Cw, Hw	61.7	26–109	29.5	22–42	1 (1–3)	54% of nest trees were cottonwood; remaining 46% were conifers
Wood Duck	BC	Campbell et al. 1990a	9	Act, At, Dr, Mb		30				uses PIWO and natural cavities within 2 km of water (96% of BC nest records are from nest boxes); prefers nest trees >30 cm and closer to 60 cm dbh
Bufflehead	BC	Campbell et al. 1990a		At (58), Fd (25), Pl, Py, Sx, Act						usually uses NOFL cavities; nests near edges of wetlands
Common Goldeneye	(ICH)	Steeger and Dulisse 2001	1	Lw (100)	74.9		27.9		4	
Common Goldeneye	BC	Campbell et al. 1990a		Act, Fd						close to water
Barrow's Goldeneye	BC	Eadie et al. 2000		At, Fd						nests in PIWO cavities, sometimes enlarged NOFL cavities and in natural cavities close to water

a BEC zone: CDF = Coastal Douglas-fir; CWH = Coastal Western Hemlock; ESSF = Engelmann Spruce–Subalpine Fir; ICH = Interior Cedar–Hemlock; IDF = Interior Douglas-fir; MS = Montane Spruce; PP = Ponderosa Pine; SBS = Sub-Boreal Spruce; SBPS = Sub-boreal Pine–Spruce.

b Tree species: Act = black cottonwood; At = trembling aspen; Bg = grand fir; Bl = balsam fir; Cw = western red cedar; Yc = yellow cedar; Dr = red alder; Ep = paper birch; Fd = Douglas-fir; Hm = mountain hemlock; Hw = western hemlock; Lw = western larch; Mb = bigleaf maple; Ra = arbutus; Pl = lodgepole pine; Pw = western white pine; Py = ponderosa pine; Se = Engelmann spruce; Ss = Sitka spruce; Sx = hybrid white spruce.

Common Name	Study Area (BEC Zone)[a]	Source	n	Nest/Den Tree Species (% total sample n)[b]	Mean (SE)	Range	Mean (SE) Height	Height Range	Median Decay Class (Range)	Comments
Barrow's Goldeneye	BC	Campbell et al. 1990a		At, Act, Fd, Py, Sx, Pl						PIWO is only suitable wood-pecker cavity
Hooded Merganser	BC	Campbell et al. 1990a	7	Act, Cw, Fd		20–90				near water
Common Merganser	BC	Campbell et al. 1990a	31					1.5–24		nests in both live and dead coniferous trees; uses natural cavities or PIWO cavities
Osprey	BC	Campbell et al. 1990b	395	Act and many conifer species						most nests at or near the top of dead (64%) or live trees (36%), near permanent water
Bald Eagle	North America	Buehler 2000				50–190		20–60		uses dominant canopy tree usually within 2 km of water with foraging habitat
Northern Goshawk	(IDF/MS/ESSF)	Machmer and Dulisse 2000	27	Fd (52), Lw (41), At (4), Se (4)	52.7 (2.7)	36.3–85.5	29.4 (5.7)	22–37	1 (1–2)	
Northern Goshawk	(ICH)	Machmer 1999 2000a	7	Fd (43), Pl (14), Py (14), Pw (14), Ep (14)	56.4 (7.5)	33.5–80.0	30.9 (8.1)	20.0–46.0	2 (1–3)	
Northern Goshawk	(SBS)	Mahon et al. 2002	61	Pl (51), At (36), Sx (11), Ba (2)	29.7 (1.2)	17.0–63.0	23.9 (0.6)	10.5–35.1	1 (1–4)	
Northern Goshawk	(ICH/CWH)	Doyle and Mahon 2000	48	Hw (94), Bl (6)	58.8 (2.2)	39.0–72.0	27.6 (0.9)	15.3–37.8	1 (1–3)	
Northern Goshawk	(CWH)	McClaren, unpubl. data	89		84.4 (7.9)	25–418.9	37.9 (2.0)	14–112	1 (1–3)	decay class: 1 (n = 92); 3 (n = 4)
American Kestrel	(ICH)	Steeger and Dulisse 2001	1	At (100)	47		27.9		2	
American Kestrel	BC	Campbell et al. 1990b		Py, Fd, Act, At						conifers (59%) used more that deciduous (41%)
American Kestrel	southwest ID	Saab and Dudley 1998	52		58.7 (4.6)					nest snags more decayed than random trees
Marbled Murrelet	(CWH)	Jordan and Hughes 1995; Manley and Kelson 1995; Burger and Manley, unpubl.	51	Cy (73), Ss (12), Hw (10), Fd (4), Hm (2)	119.4 (8.2)	60.0–370.0	33.2 (1.9)	16.5–79.4		will use mistletoe, deformed branching

Common Name	Study Area (BEC Zone)[a]	Source	n	Nest/Den Tree Species (% total sample n)[b]	Mean (SE)	Range	Mean (SE) Height	Height Range	Median Decay Class (Range)	Comments
Flammulated Owl	(IDF)	Quesnel and Steeger, unpubl.	1	Py (100)	39		48		2	presumably nest tree characteristics are the same as for PIWO and NOFL where ranges overlap
Flammulated Owl	BC	Campbell et al. 1990b		Fd, Py						usually uses NOFL cavities
Flammulated Owl	BC interior	van Woudenberg 1999		Py, Fd						nests in PIWO and NOFL cavities; 75% of nests in dead trees and 25% in live trees with broken tops
Western Screech-owl	BC	Campbell et al. 1990b	43			>25 cm dbh				nests in NOFL, PIWO, and natural cavities; cottonwood seems to be favoured (Cannings and Angell 2001)
Great Horned Owl	BC	Campbell et al. 1990b	75	Fd (37), Act (21), Sw (12), At (9), Py, Bg, Cw, Dr, Ep, willow						
Northern Hawk Owl	North America and Alaska	Duncan and Duncan 1998								nests located in decayed trees with cavities, hollow trees, burnt out stumps, and woodpecker cavities
Northern Pygmy-owl	BC	Campbell et al. 1990b	3	Fd (2 nests), Hw, Lw						uses old woodpecker cavities
Spotted Owl	OR	Forsman et al. 1984	44		125.5 (5.8)					
Spotted Owl	WA	Forsman and Giese 1997	110		136.6 (5.9)					53% of nests in side cavities; 37% in top cavities; 10% on platform nests (esp. NOGO nests)
Barred Owl	BC	Campbell et al. 1990b	8	Fd (50), Act (50)						uses all natural cavities
Great Gray Owl	BC	Campbell et al. 1990b	6	At (2 abandoned NOGO nest, 1 abandoned RTHA nest), Sx (1 in stick nest, 2 in witch's broom)						most frequently uses abandoned raptor nests but also mistletoe platforms
Boreal Owl	North America	Hayward and Hayward 1993								uses PIWO and NOFL cavities (Hayward and Hayward 1993)

Common Name	Study Area (BEC Zone)[a]	Source	n	Nest/Den Tree Species (% total sample n)[b]	Mean (SE)	Range	Mean (SE) Height	Height Range	Median Decay Class (Range)	Comments
Boreal Owl	northern Canada	Bondrup-Nielson 1978	6	At (100)						80% in NOFL holes; 20% in natural cavities; 50% live and 50% dead trees
Northern Saw-whet Owl	BC	Campbell et al. 1990b	20	Cw, Fd, Lw, Act, Ac, At, Ep (not in order of importance)						will use natural cavities (Campbell et al. 1990b) and PIWO and NOFL cavities (Hayward and Hayward 1993); no nests of brooksi have ever been found; NOFL and PIWO do not occur on Queen Charlotte Islands
Vaux's Swift	northeast OR	Bull and Collins 1993	20	Bg (100)	67.5 (3.2)	45–96	25.4 (1.5)	15–37		all nests in PIWO cavities in trees with heartwood hollowed out by Indian Paint fungus; 86% of nest trees live and 14% dead
Lewis' Woodpecker	(IDF/PP)	Cooper and Beauchesne 2000	123	Py (48), Fd (34), At/Ep (12), Act (4), Lw (2)	52 (20.3)	20.0–120.0	13.0 (6.5)	1.6–28.0	4.2 (2–7)	
Lewis' Woodpecker	southwest ID	Saab and Dudley 1998	208		44.7 (1.8)					
Williamson's Sapsucker	(IDF/MS)	Gyug and Peatt 1999	16	Lw (65), Ep (15)		26.0–118.0		11.0–33.0		
Williamson's Sapsucker	(ICH)	Manning and Cooper 1996	4	Lw (100)	69.5 (5.3)	54.0–77.0	22.7 (4.4)	12–30	2 (2–6)	
Williamson's Sapsucker	northeast OR	Bull et al. 1986	86	Lw (41), Py (40), Fd (10), Bg (9),	70 (2.8)		24 (1.1)			51% of nests in dead trees; 49% in live trees; 64% of nest trees had broken tops
Yellow-bellied Sapsucker	BC	Campbell et al. 1990b	27	At (81), Ac (15), Ep (4)		25–31				most nest trees are live trees
Red-naped Sapsucker	(IDF)	Harestad and Keisker 1989	159		32.8 (0.6)	20.1–60.8	18.4 (0.4)	5.4–31.2		
Red-naped Sapsucker	(ICH)	Machmer and Korol 1998	27	At (40), Hw (30), Sx (19), Act (7), Ep (4)	60.7 (5.9)	24.5–140.5	30.7 (1.4)	18.4–48.4	2 (2–5)	
Red-naped Sapsucker	(IDF/MS)	Quesnel and Steeger, unpubl.	22	Lw (77), At (14), Ep (5), Fd (5)	40.8 (2.7)	21–64.9	27.4	6.1–53	2 (2–6)	
Red-naped Sapsucker	(PP)	Machmer 2000b	1	At (100)	18.3		14.6		2	

Common Name	Study Area (BEC Zone)[a]	Source	n	Nest/Den Tree Species (% total sample n)[b]	Mean (SE)	Range	Mean (SE) Height	Height Range	Median Decay Class (Range)	Comments
Red-naped Sapsucker	(ICH)	Steeger and Dulisse 2001	141	At (50), Ep (37), Fd (8), Lw (3), Py (1)	37.7 (1.1)	15.0–82.1	23.2 (.7)	6.1–45.9	2 (2–6)	
Red-breasted Sapsucker	(CDF/CWH)	Manning and Shepard 1999	4	Dr (50), Bg (25), Hw (25)	42.7 (6.6)	29–56	10.3 (1.1)	8–13	6 (4–7)	
Red-breasted Sapsucker	(CWH)	Deal and Setterington 1999	155	Hw (50), Pw (32), Ba (9), Fd (6)	84.6 (2.0)	36–181	29.5 (0.8)	9–56	most nests in 4 (2–7)	
Downy Woodpecker	(PP)	Machmer 2000b	1	At (100)	26.2		13		3	
Downy Woodpecker	(ICH)	Steeger and Dulisse 2001	2	At (50), Fd (50)	30.3 (9.1)	20.4–48.5	20.7 (8.0)	4.8–29.0	4	
Downy Woodpecker	(IDF)	Harestad and Keisker 1989	5		26.3 (2.4)	19.1–31.4	15.7 (3.2)	9.5–24.9		
Hairy Woodpecker	(ICH)	Machmer and Korol 1998	1	Cw (100)	33		28.5		2	
Hairy Woodpecker	(IDF/MS)	Quesnel and Steeger, unpubl.	3	Lw (100)	41.4 (3.0)	36.1–46.5	28.7 (2.3)	26.1–33.3	2	
Hairy Woodpecker	(PP)	Machmer 2000b	4	Lw (50), At (25), Py (25)	31.6 (3.5)	21.3–35.9	17.2 (4.6)	12.6–22.25	2	
Hairy Woodpecker	(ICH)	Steeger and Dulisse 2001	43	At (47), Lw (13), Ep (8), Fd (2), Py(2)	39.0 (1.8)	23.1–70.9	27.4 (1.1)	6.1–43.4	2 (2–5)	
Hairy Woodpecker	(IDF)	Harestad and Keisker 1989	8	At (100)	27.6 (3.0)	17.4–44.5	18.3 (2.3)	6.1–27.7		
Hairy Woodpecker	(CWH)	Deal and Setterington 1999	78	Hw (60), Fd (20), Ba (10), Dr (4), Pw (3)	79.6 (3.1)	34–167	26.7 (1.3)	3–65	6 (2–7)	
Hairy Woodpecker	northeast OR	Bull et al. 1986	59	Py (68), Pl (17), Lw (10), Fd (5)	42 (2.8)		15 (1.3)			93% of nests in dead trees; 51% had broken tops
Hairy Woodpecker	southwest ID	Saab and Dudley 1998	91		34.5 (2.3)					
White-headed Woodpecker	west-central ID	Frederick and Moore 1991	6	Py (83), Fd (17)	56	37–87	5.2	2.2–19.0		prefers broken-top trees more than other cavity nesters
White-headed Woodpecker	central OR	Dixon 1995	43	Py (91), At (7), Bg (2)	65		14			most nest in moderately decayed snags
White-headed Woodpecker	southwest ID	Saab and Dudley 1998	6		37.3 (4.6)					select heavily decayed snags

Common Name	Study Area (BEC Zone)[a]	Source	n	Nest/Den Tree Species (% total sample n)[b]	Mean (SE)	Range	Mean (SE) Height	Height Range	Median Decay Class (Range)	Comments
Three-toed Woodpecker	(ICH)	Machmer and Korol 1998	6	Hw (67), Pw (17), Sx (17)	38.1 (6.9)	23.5–61.5	23.7 (6.0)	7.9–48.2	3 (2–4)	
Three-toed Woodpecker	(IDF/MS)	Quesnel and Steeger, unpubl.	11	Lw (100)	33.4 (1.7)	23–41	23.3 (2.4)	7.6–32.5	2 (2–6)	
Three-toed Woodpecker	(ICH)	Steeger and Dulisse 2001	24	Pl (42), Lw (29), At (12), Fd (8), Cw (4)	26.2 (1.7)	16.5–51.8	20.6 (1.7)	3.0–35.1	2 (2–4)	
Black-backed Woodpecker	(ICH)	Steeger and Dulisse 2001	6	Lw (77), Fd (33)	31.4 (4.9)	19.7–52.9	24.5 (2.6)	16.1–32.8	2.5 (2–3)	
Black-backed Woodpecker	southwest ID	Dixon and Saab 2000	35	Py (54), Fd (46)	39		21.7			all dead trees
Black-backed Woodpecker	northwest MT	Caton 1996	11	Lw (82), Fd (18)	40		28			all dead trees
Black-backed Woodpecker	northeast OR	Bull et al. 1986	15	Py (67), Pl (27), Lw (7)	37		19			60% live trees, 40% dead trees
Black-backed Woodpecker	southwest ID	Saab and Dudley 1998	17		32.3 (2.8)					select hard snags
Northern Flicker	(IDF/MS)	Machmer and Korol 1998	2	Act (50), At (50)	42.5	37.5–47.5	19.6 (4.6)	15.24.1	3 (2–4)	
Northern Flicker	(IDF/MS)	Quesnel and Steeger, unpubl.	7	Fd (43), Lw (43), Ep (14)	49.9 (6.8)	24.9–70.1	26.3 (6.9)	4.5–57	3 (2–7)	
Northern Flicker	(PP)	Machmer 2000b	10	Py (50), At (20), Lw (20), Fd (10)	37.7 (3.1)	25.7–50	9.4 (1.5)	3–16.6	4.5	
Northern Flicker	(ICH)	Steeger and Dulisse 2001	33	At (48), Lw (15, Py (15), Fd (12), Ep (9)	50.0 (2.6)	20.3–81.7	25.0 (1.9)	3.0–41.5	2 (2–6)	
Northern Flicker	(IDF)	Harestad and Keisker 1989	17		31.9 (2.4)	19.8–48.7	14.7 (1.9)	2.1–26.8		
Northern Flicker	(CWH)	Deal and Setterington 1999	85	Hw (47), Fd (18), Ba (15), Pw (9), Hm (7), Dr (4)	73.7 (3.4)	27–195	22.6 (1.1)	5–47	4 (2–6)	
Northern Flicker	(IDF)	Wiebe 2001	159		33.9 (0.82)					
Northern Flicker	southwest ID	Saab and Dudley 1998	99		42.7 (2.0)					
Northern Flicker	northeast OR	Bull et al. 1986	68	Py (81), Fd (13), Lw (3), Pl (3)	56 (2.1)		15.0 (1.1)			95% dead trees (most dead >5 years); 71% of nest trees had broken tops

Common Name	Study Area (BEC Zone)[a]	Source	n	Nest/Den Tree Species (% total sample n)[b]	Mean (SE)	Range	Mean (SE) Height	Height Range	Median Decay Class (Range)	Comments
Pileated Woodpecker	(IDF/MS)	Machmer and Korol 1998	1	Act (100)	73		35.8		4	
Pileated Woodpecker	(IDF/MS)	Quesnel and Steeger, unpubl.	1	Py (100)	61.5		56		5	
Pileated Woodpecker	(PP)	Machmer 2000b	1	Lw (100)	38		22.2		2	
Pileated Woodpecker	(ICH)	Steeger and Dulisse 2001	9	At (78), Py (22)	65.2 (6.3)	41.5–122.0	36.7 (1.4)	31.0–51.0	2 (2–4)	
Pileated Woodpecker	(IDF)	Harestad and Keisker 1989	20	At (100)	40.5 (1.6)	25.8–53.7	19.2 (1.4)	7.7–25.9		
Pileated Woodpecker	(CDF/CWH)	Manning and Shepard 1999	1	Bg (100)	66.5		50.4		2	
Pileated Woodpecker	northeast OR	Bull 1987	105	Py (75), Lw (25), Bg (2),	84		28			104 of 105 trees were dead
Pileated Woodpecker	WA	Aubrey and Raley								
(unpubl. data)	22	Hw (68), Ba (27), Dr (5)	97		41			45% in live trees		
Purple Martin	BC	Campbell et al. 1997								most nests in nest boxes
Tree Swallow	(IDF)	Peterson and Gauthier 1985	31		27.3 (.2)		9.1 (0.2)			all natural sites are in dead trees but also uses nest boxes
Tree Swallow	North America	Robertson et al. 1992	48		83.4 (3.5)	36–138	4.3 (.3)	1.3–10.3		all natural sites are in dead trees but also uses nest boxes
Violet-green Swallow	North America	Brown et al. 1992		Py, At						natural sites are usually in hollow parts of trees or old woodpecker cavities; also uses nest boxes, cliffs, and occasionally sandbanks
Black-capped Chickadee	(ICH)	Machmer and Korol 1998	3	Ep (33), Hw (33), Sx (33)	48.1 (20.4)	15.2–85.5	20.5 (9.2)	3–34.2	5 (2–6)	
Black-capped Chickadee	(IDF/MS)	Quesnel and Steeger, unpubl.	5	Ep (40), Fd (40), Lw (20)	33.0 (9.2)	14.0–66.2	14.8 (5.8)	3.5–33.1	5 (2–7)	
Black-capped Chickadee	(PP)	Machmer 2000b	1	At (100)	18.2 (-)	18.2	15.1	15.1	2	
Black-capped Chickadee	(ICH)	Steeger and Dulisse 2001	15	Ep (53), At (33), Fd (13)	22.1 (2.6)	15–44.9	13.8 (2.3)	1.6–31.1	3 (2–6)	

Common Name	Study Area (BEC Zone)[a]	Source	n	Nest/Den Tree Species (% total sample n)[b]	Mean (SE)	Range	Mean (SE) Height	Height Range	Median Decay Class (Range)	Comments
Black-capped Chickadee	BC	Campbell et al. 1997		Ep (interior); Dr (coast)						
Mountain Chickadee	(IDF/MS)	Quesnel and Steeger, unpubl.	37	Fd (38), Lw (38), Py (16.2), At (5), Ep (3)	36.7 (2.5)	14.4–76	27.5 (2.8)	1.3–62	4 (2–7)	
Mountain Chickadee	(PP)	Machmer 2000b	28	At (50), Fd (25), Py (18), Lw (7)	24.6 (1.7)	15–38.7	9.4 (1.2)	0.6–23.1	2 (2–8)	
Mountain Chickadee	(ICH)	Steeger and Dulisse 2001	13	At (46), Lw (38), Ep (8), Pl (8)	30.2 (2.6)	16.5–52.6	24.0 (2.4)	3.0–36.4	2 (2–4)	
Mountain Chickadee	BC	Campbell et al. 1997		At, Fd, Py, Pl, Ep, willow, Sx, Act, Bl, Lw						
Chestnut-backed Chickadee	(ICH)	Machmer and Korol 1998	6	At (50), Act (17), Cw (17), Hw (17)	43.9 (10.2)	14.0–80.5	18.2 (14.9)	9.9–34.9	3 (2–5)	
Chestnut-backed Chickadee	(ICH)	Steeger and Dulisse 2001	10	At (40), Ep (20), Cw (10), Fd (10), Lw (10), Pl (10)	40.7 (5.8)	21.5–82.1	25.7 (3.4)	5.0–45.9	3 (2–5)	
Chestnut-backed Chickadee	BC	Campbell et al. 1997		Garry oak, Fd. willow, Cw, Ep, Mb, Hw, Act						
Boreal Chickadee	BC	Campbell et al. 1997	7	Sx, Ep, Bl, willow, At						softness of wood more important than tree species for nesting
Red-breasted Nuthatch	(ICH)	Machmer and Korol 1998	12	Hw (33), Sx (33), Fd (25), Pw (8)	53.7 (8.1)		20.3 (3.3)	7.6–43.2	5 (2–6)	
Red-breasted Nuthatch	(IDF/MS)	Quesnel and Steeger, unpubl.	56	Fd (66), Lw (11), Py (11), Ep (5), At (5) Sx (2)	35.4 (2.1)	15.4–86.8	21.5 (2.0)	3.9–65	4 (2–7)	
Red-breasted Nuthatch	(PP)	Machmer 2000b	24	At (79), Py (17), Fd (4)	20.4 (1.8)	15–56.2	8.5 (1.0)	1.9–22	4 (2–6)	
Red-breasted Nuthatch	(ICH)	Steeger and Dulisse 2001	114	Fd (54), Ep (21), Lw (17), At (7), Py (3), Pl (2)	38.4 (1.8)	14–96.2	16.3 (.8)	2.5–44	4 (2–7)	
Red-breasted Nuthatch	(IDF)	Harestad and Keisker 1989	24		26.4 (1.0)	17.3–36.2	12.1 (1.1)	4.5–25.1		
White-breasted Nuthatch	(PP)	Machmer 2000b	6	Fd (50), Lw (33), At (17)	35.0 (6.7)	15.4–56.6	22.7 (1.9)	16.8–28.8	2	
White-breasted Nuthatch	BC	Campbell et al. 1997	18	At, Py, Fd, Ep, Lw, Act						94% of nests in dead trees

Common Name	Study Area (BEC Zone)[a]	Source	n	Nest/Den Tree Species (% total sample n)[b]	Mean (SE)	Range	Mean (SE) Height	Height Range	Median Decay Class (Range)	Comments
Pygmy Nuthatch	BC	Campbell et al. 1997		Py, At, Fd, Ep, Act						69% of nests in coniferous trees
Brown Creeper	(ICH)	Machmer and Korol 1998	11	Pw (64), Cw (27), At (14)	51.7 (11.1)	17.2–127	27.9 (2.6)	12.0–40.0	4 (2–4)	
Brown Creeper	(IDF/MS)	Quesnel and Steeger, unpubl.	13	Lw (77), Fd (15), Sx (8)	39.7 (3.1)	26–60.8	17.9 (3.8)	1.5–49	5 (2–8)	
Brown Creeper	(ICH)	Steeger and Dulisse 2001	18	Lw (56), Pl (22), Pw (11), Py (11)	39.9 (4.1)	18.5–96.2	25.6 (1.9)	7.9–40.4	3 (2–4)	
Brown Creeper	BC	Campbell et al. 1997		Fd, Cw, Hw, Ss, Py, Pl						
Bewick's Wren	BC	Campbell et al. 1997		Fd, Garry Oak, Cw, Ep, Dr, Act						40% of nests found in dead trees
House Wren	BC	Campbell et al. 1997								15% of nests in natural cavities
Western Bluebird	BC	Campbell et al. 1997	94					0.6–16.5		53% of nests in natural cavities; uses woodpecker cavities, natural cavities, and spaces under loose bark in dead trees
Western Bluebird	OR	Schreiber 1987	18		71 (7.8)	25–137	6.6 (2.1)	2.4–10.5		100% in dead trees
Western Bluebird	southwest ID	Saab and Dudley 1998	103		34.8 (1.5)					
Mountain Bluebird	(PP)	Machmer 2000b	6	Lw (33), Py (33), At (17), Fd (17)	33.2 (3.3)	22–43	13.6 (3.6)	0.9–19	3 (2–4)	
Mountain Bluebird	(ICH)	Steeger and Dulisse 2001	3	Lw (67), Fd (33)	51.9 (16.2)	19.7–70.9	30.3 (3.6)	24.0–36.5	2 (2–3)	
Mountain Bluebird	southwest ID	Saab and Dudley 1998	98		32.5 (3.6)					
California Myotis	(ICH)	Vonhof 1995, 1996	4	Fd (100)	53.4 (4.4)	44–64.5	24.9 (2.7)	44–64.5	5 (4–5)	50% in cracks; 25% each in woodpecker cavity and under loose bark
California Myotis	(ICH, IDF)	cited in Bunnell et al. 2002	2 live 23 dead		34 (-) live 55.5 (-) dead		- (-) live 26.6 (-) dead			
California Myotis	southern BC and AB	Brigham et al. 1997	19	Conifer (100)	56.0 (16.8)		27.0 (7.9)			all roosts in snags with intermediate decay levels
Yuma Myotis										
Little Brown Myotis	(ICH)	Rasheed and Holroyd 1995	6	Cw (83); Hw (17)	52.9 (7.4)	32–85	11.5 (3.4)	1.8–25.7	5 (2–8)	50% under loose bark; 50% in cracks

Common Name	Study Area (BEC Zone)[a]	Source	n	Nest/Den Tree Species (% total sample n)[b]	Mean (SE)	Range	Mean (SE) Height	Height Range	Median Decay Class (Range)	Comments
Little Brown Myotis	BC and AB	cited in Bunnell et al. 2002	16 live 3 dead		68.5 live 40.3 dead		21.4 live 11.2 dead			
Little Brown Myotis	northern Arizona	Rabe et al. 1998	21	Py (100)	69.2 (14.6)	31.2–101.6	17.8 (7.9)			all roosts in snags with loose bark
Long-legged Myotis	OR and BC	cited in Bunnell et al. 2002	4 live 37 dead		- (-) live 95.5 (-) dead		40 (-) live 37.5 (-) dead			
Long-legged Myotis	(MS)	Rasheed and Holroyd 1995	1	Fd (100)	41.9 (-)		20.3		4 (-)	in tree cracks
Long-legged Myotis	central OR	Ormsbee 1996	40	Fd (73), Hw (15), Cw (12)	100.2 (6.1)	34–194	40.0 (2.5)	13.4–71.5		snags comprised 90% of tree roosts
Long-legged Myotis	northern Arizona	Rabe et al. 1998	13	Py (100)	69.2 (14.6)	31.2–101.6	17.8 (7.9)			all roosts in snags with loose bark
Keen's Long-eared Myotis										
Western Long-eared Myotis	(ICH)	cited in Bunnell et al. 2002	2		72.7 (-)		49.0 (-)			
Northern Long-eared Myotis	(ICH)	cited in Bunnell et al. 2002	4 live 3 dead		102 (-) live 67.7 (-) dead		35.5 (-) live 30.5 (-) dead			
Silver-haired Bat	northeast OR	Betts 1996	11	Py (86), Act (14)	59.6 (13.9)		24.0 (9.2)			82% in dead trees; 18% in live trees
Silver-haired Bat	(ICH)	Vonhof 1995, 1996	12	At (58), Fd (33), Py (22), Pl (11)	40.4 (3.1)	29–46	20.1 (2.8)	5.4–37.6	4 (2–7)	67% in woodpecker cavities; 33% in branch holes
Silver-haired Bat	OR, BC and AB	cited in Bunnell et al. 2002	18 live 8 dead		37.1 (-) live 39.0 (-) dead		24.3 (-) live 15.5 (-) dead			
Big Brown Bat	northeast OR	Betts 1996	7	Py (55), Bg (36), Lw (9)	76.3 (12.2)		18.0 (6.5)			43% in dead trees; 57% in live trees
Big Brown Bat	northeast OR and BC interior	cited in Bunnell et al. 2002	13 live 8 dead		44.6 (-) live 54.8 (-) dead		24.6 (-) live 25.8 (-) dead			
Big Brown Bat	(ICH)	Vonhof 1995, 1996	15	At (87), Py (7), Fd (7)	48.4 (4.0)	23–84	26.9 (3.0)	13.7–59.6	3 (2–6)	55% in woodpecker cavities; 36% in branch hole; 9% in cracks
Big Brown Bat	northern Arizona	Rabe et al. 1998	6	Py (100)	69.2 (14.6)	31.2–101.6	17.8 (7.9)			all roosts in snags with loose bark

Common Name	Study Area (BEC Zone)[a]	Source	n	Nest/Den Tree Species (% total sample n)[b]	Mean (SE)	Range	Mean (SE) Height	Height Range	Median Decay Class (Range)	Comments
Big Brown Bat	AB	Kalcounis and Brigham 1998	27	At (100)	35.8 (7.2)	22.8–57.1	25.6 (7.7)	13.6–51.8		all roosts in live and dead At with cavities
Pallid Bat	northern Arizona	Rabe et al. 1998	3	Py (100)	69.2 (14.6)	31.2–101.6	17.8 (7.9)			all roosts in snags with loose bark
Yellow-pine Chipmunk										
Red Squirrel	(ICH)	Machmer and Korol 1998	1	At (100)	41.4		38.8		2	
Red Squirrel	(IDF/MS)	Quesnel and Steeger, unpubl.	11	Lw (55), Py (27), Fd (18)	37.8 (3.6)	24.6–66.5	32.3 (4.7)	8.5–59	2 (2–7)	
Red Squirrel	(PP)	Machmer 2000b	22	Fd (32), At (32), Lw (18), Py (9), Pl (5)	33.1 (2.5)	15.4–56.7	12.9 (1.6)	2.2–27	3 (2–8)	
Red Squirrel	(ICH)	Steeger and Dulisse 2001	22	Lw (45), Ep (27), Fd (14), Pl (9), Cw (5)	36.5 (3.2)	23.2–81.0	17.9 (1.8)	5.1–36.6	3 (2–6)	
Douglas' Squirrel										
Northern Flying Squirrel	(IDF/MS)	Quesnel and Steeger, unpubl.	4	Lw (75), Fd (25)	45.4 (6.5)	31–62.4	20.9 (7.1)	5.2–36	3.5 (2–6)	
Northern Flying Squirrel	(PP)	Machmer 2000b	5	At (60), Pl (20), Lw (20)	26.3 (3)	21–38	10.5 (3.4)	2.5–22.2	2 (2–6)	
Northern Flying Squirrel	(ICH)	Steeger and Dulisse 2001	41	At (39), Ep (29), Lw (19), Pl (7), Fd (5)	30.3 (1.2)	18.9–61.2	20.2 (1.2)	2.1–36.6	3 (2–6)	
Northern Flying Squirrel	OR (old-growth)	Carey et al. 1997	93	Fd (97), Bg (3)	108 (5) live 93 (7) dead		40 (2) live 22 (2) dead			68% in live trees; 73% were conifers > 50 cm dbh
Northern Flying Squirrel	OR (second-growth)	Carey et al. 1997	12	Fd (83), Cw (17)	66 (22) live 77 (12) dead		27 (8) live 23 (6) dead			86% in snags
Northern Flying Squirrel	WA (second-growth)	Carey et al. 1997	294	Fd (65)	49 (1) live 63 (4) dead		33 (1) live 35 (1.4) dead			63% in live trees; 37% in snags
Northern Flying Squirrel	Washington (second-growth)	Carey et al. 1997	196	Fd (7), Dr (30)	66 (22) live 77 (12) dead		27 (8) live 23 (6) dead			60% in live trees; 40% in snags
Black Bear	OR, WA and BC	cited in Bunnell et al. 2002	5 live 16 dead 43 pooled		161.8 live 84.1 dead 78.9 pooled		19.0 dead			

Common Name	Study Area (BEC Zone)[a]	Source	n	Nest/Den Tree Species (% total sample n)[b]	Mean (SE)	Range	Mean (SE) Height	Height Range	Median Decay Class (Range)	Comments
Black Bear	northeast OR	Akenson and Henjum 1994		Bg (80)	109 (-)		18 (-)			all dens in hollow trees
Raccoon										
American Marten	(ICH)	Machmer and Korol 1998	1	Cw (100)	75		29.8		2	
American Marten	northeast OR	Bull and Heater 2000	13	Bg (84), Lw (8), Bl (8)	83		23			for Bg and Lw: PIWO cavities, or broken tops; for Bl: natural cavity in base of tree; also nest underground, in hollow logs, and in slash piles
American Marten	northeast OR	Bull and Heater 2000	271	Bg (58), Lw (35), Se (5), Bl (3), Fd (1), Py (1)	78.9 (1.29)		19.7 (0.6)			
American Marten	northeast OR	Bull and Heater 2000	517	Bg (11), Lw (10), Se (43), Bl (25), Fd (9), Py (1), Pl (1)	51.7 (0.92)		26.4 (0.34)			
American Marten	pacific north-west	cited in Bunnell et al. 2002	218 live 152 dead 36 pooled		84.0 live 84.1 dead 78.9 pooled		10.6 dead 23 pooled			
Fisher	southwest OR and BC	cited in Bunnell et al. 2002	28		71.3 (-)					
Fisher	(SBS/SBPS)	Weir 1995	5	Act (100)	103.0 (5.6)					maternal den sites in BC are almost entirely found in large declining Act
Fisher	(SBS/SBPS)	Weir, in prep.	14		106.1 (7.1)					

Appendix 3. Summary of forage tree characteristics of selected wildlife guilds, based on data from BEC zones in the southern interior (n = number of individual forage trees).

Wildlife Guild	BEC Zone	Source	n	Tree Species (% of total sample n)	cm mean ± se	Height (m) mean ± se	Median Decay Class (range)
Bark-foragers	PPdh2/IDFdm2	Machmer 2000b	106	Py (31); Lw (26); Fd (17); At (11); Pl (11); Ep (1)	28.0 ± 13.49	13.3 ± 5.15	1 (1–9)
Foliage-gleaners	PPdh2/IDFdm2	Machmer 2000b	46	Py (35); Pl (24); Fd (9); Lw (90); At (2)	34.4 ± 18.11	15.6 ± 0.80	1 (1–2)
Bark-foragers	IDFdm2/MSdk	Steeger and Machmer, unpublished	473	Fd (40); Lw (24); Sx (15); Ep (10); At (5); Py (4)	20–30	10–20	2 (1–9)
Sapsuckers	IDF	Walters 1996	281	Fd (56.5); At (25.2); Act (10.2); juniper (8.1)	34.5 ± 31.01	–	–
Bark-foragers	ICHdw/mw2	Steeger and Machmer 1995	748	Fd (54); Pl (28); Lw (8); Py (4); Ep (2); At (1); Bg (1); Act (1), Bl (1)	20–30	10–20	3 (2–7)
Three-toed Woodpecker	ICHdw/mw2	Steeger and Dulisse 1997	275	Pl (79); Fd (11); Sx (5); Lw (4); Pw (2); Hw (1)	26.1 ± 6..90	–	3 (3–4)
Sapsuckers	ICHmk1	Manning and Cooper 1996	117	Fd (64); Lw (27); Sx (3); Bl (3); Pl (3)	32.4 (-)[a]	21.6 (-)[a]	2.7 (mean)[a]
Bark-foragers	ICHvk1/wk1	Machmer and Korol 1998	243	Sxw (41); Pw (18); Cw (12); Fd (10); Hw (8); At (6); Act (5); Pl (1)	42.3 ± 37.72	22.5 ± 17.3	5 (1–7)
Sapsuckers	ICHvk1/wk1	Machmer and Korol 1998	75	Ep (47); Hw (25); Act (16); At (11); Pw (2)	30.7 ± 17.40	19.3 ± 9.44	1 (1–5)

a Weighted mean calculated on reported means for individual animal species.

Appendix 4. Information on estimated home range size, breeding territory size, and breeding density for wildlife tree-dependent vertebrates in BC (based on data reported in the Columbia River WHR Database).

Wildlife Species Common Name	Comments on Home Range/Territory Size and Use	Home Range Size Class (ha)	Breeding Territory Size (ha)	Breeding density low (pairs/ha)	Breeding density high (pairs/ha)
Clouded Salamander	movements of 10 m were rare (British Columbia); they do not seem to be territorial	<1			
Great Blue Heron	mean distance flown from colony to principal foraging sites ranged from 2.3 to 6.5 km, but will forage up to 30 km from colony	1000–10 000			
Wood Duck	home range of a wintering male and female was 42 ha and 12 ha, respectively; home range was 169 ha for a breeding pair and 87 ha for an incubating female	10–500			
Bufflehead	no data regarding the size of the home ranges; buffleheads defend their territory; estimated territory size is 0.52 ha for brood territory and 0.56 ha for male breeding territory	unknown	0.52–0.56		
Common Goldeneye	wintering individuals moved up to 43 km between foraging and roosting areas in MN; territorial while breeding and breeding territories are 1 pair/ha or less	unknown	<1		
Barrow's Goldeneye	home range sizes depend on the size and shape of the water areas; of 38 pairs on two large lakes, each pair had a home range of 40 to 60 yards of shoreline (lower population density resulted in less defined home ranges)	1–10			
Hooded Merganser	densities of brooding pairs in NB were 1.4 pairs/100 km^2 in 1989	unknown		1.4	
Common Merganser	no data on home ranges; no apparent territorial behaviour though males may defend loafing and roosting rocks close to nest sites; densities were 0.4 to 1.4 breeding pairs/km on streams on Vancouver Island and densities were higher on streams with more fish	unknown			
Osprey	flew an average of 2.6 km from nest while foraging in MN; routinely fly 14 km to foraging areas in NC, up to 10 km in ID, and 10 to 12 km in NS	1000–10 000			
Bald Eagle		1000–10 000			
Northern Goshawk	home ranges varied from 570 to 3 500 ha during nesting season and from 1000 to 8360 ha in non-breeding season (CA); home ranges may overlap	500–10 000			
American Kestrel	females tend to have larger home ranges than males	1–50			
Marbled Murrelet	can travel as much as 75 km from nests to foraging areas, but usually less than 20 km; densities in summer were from 0.01 to 5.62 km in WA, and from 12.5 to 130.52 km in OR	unknown			
Flammulated Owl	15.9 ha (during incubation in OR); 7.9 ha (nestling period in OR); 3.6 ha (fledgling period in OR); 8.52 to 24 ha (male territory in CO)	1–50			
Western Screech-owl	3 to 9 ha (75% contour interval); 29 to 58 ha (95% contour interval; n = 2, ID); 2.5 to 10 ha BC	1–100			
Great Horned Owl	248 ha (September; YT; 10 territories); 483 ha (range 230 to 883 ha; Feb-April, YT, n = 16); 725 ha (non-territorial floaters, YT); 329 ha (annual home range, WI); range 70 to 152 ha, UT	50–1000			
Northern Hawk Owl	372 ha average in Norway; 50 ha for an immature male in southern MB	100–500			
Northern Pygmy-owl	home ranges of 265 ha (n = 8) for breeding males and 462 ha (n = 3) for non-breeders in WA	100–500			

Wildlife Species Common Name	Comments on Home Range/Territory Size and Use	Home Range Size Class (ha)	Breeding Territory Size (ha)	Breeding density low (pairs/ha)	Breeding density high (pairs/ha)
Spotted Owl	home ranges increase in size from south (CA) to north (BC); median home range sizes ranged from 565 to 5 708 ha in OR and WA, depending on study area	500–10 000			
Barred Owl	annual mean home range of 905 ha for 4 pairs; summer home ranges averaged 321.5 ha (n = 8) in WA for 4 pairs	100–1000			
Great Gray Owl	mean of 6 730 ha (range 400 to 31 200 ha) in OR; males hunted up to 3200 ha from nest while breeding	1000–10 000			
Boreal Owl		1000–10 000			
Northern Saw-whet Owl	125 to 150 in the Okanagan, BC	100–500			
Vaux's Swift	home range sizes are not known, but species is not territorial; nest trees found 30–94 m apart and spends majority of its time close to its nest; in an OR study, swifts spent 53% of their time less than 0.4 km away from the nest (foraging birds were found 0.4–1 km from their nest 60% of the time, 1.1–2 km from their nest 21% of the time, 2.1–3 km 7% of the time, and 3.1–5.4 km 11% of the time)	unknown			
Lewis' Woodpecker	territory sizes of 1.0–6.1 ha were recorded in 1979 in Blue Mountains of WA and OR	1–10		0.3	
Williamson's Sapsucker	territory sizes range from 4 ha to 6–7 ha; home ranges in CI ranged from 4 to 9 ha (average 6.75 ha, n = 10); one pair had a breeding season home range size of 40 ha in CA; they are intolerant of conspecifics in their territories	1–50			
Yellow-bellied Sapsucker	0.6 to 6 ha in northern CA	1–10			
Red-naped Sapsucker	territory sizes range from 0.6 to 6 ha (1952, CA); territory and home range sizes are considered to be comparable	1–10		0.045	
Red-breasted Sapsucker	home ranges are probably equivalent to territories; territories range from a minimum 45 m around the nest to 6.1 ha CA in 1985)	1–10			
Downy Woodpecker	territory and home range considered to be the same; breeding territories varied from 2.0 to 3.2 ha in ON (1967); home range sizes were 6.9 ha on average in OH during winter (1998 to 1990)	1–10	2.0–3.2	0.001	
Hairy Woodpecker	territories as large as 10 ha reported from eastern OR; males and females may maintain separate territories in the non-breeding season, with males joining females in spring	1–10		0.002	0.4
White-headed Woodpecker		100–500		0.0125	0.125
Three-toed Woodpecker	3 breeding ranges in OR were 300, 140, and 50 ha	10–500		0.0075	0.08
Black-backed Woodpecker	may vary widely with food availability	100–1000		0.00125	
Northern Flicker	nesting densities: 10 individuals/40 ha (AZ 1983); 4 pairs/40 ha (CA 1984); 0.36 pairs/40 ha (CA 1984)	1–50		0.004	0.3
Pileated Woodpecker	one study showed that home range size decreased as the number of snags and logs increased	100–1000		0.003	

Wildlife Species Common Name	Comments on Home Range/Territory Size and Use	Home Range Size Class (ha)	Breeding Territory Size (ha)	Breeding density low (pairs/ha)	Breeding density high (pairs/ha)
Purple Martin	unknown how far birds range from nest to forage; typically range over a very large area; western birds defend an area around nest box or cavity and sometimes include other unused boxes and cavities within 20 to 30 m	unknown			
Tree Swallow	highly variable and change with breeding phases; most are restricted when feeding nestlings; in CO, males traveled 4 to 5 km from nest site to forage and females traveled 2 to 3 km during the nestling stage; at other times, may forage up to 60 km from nest sites; defend a territory at least 10 to 15 m around the nest, and often defend more than one cavity	1000–10 000			
Violet-green Swallow		unknown			
Black-capped Chickadee	breeding territories are 8.8 ha (by minimum convex polygon, AB); winter territories are 5.7 to 39 ha in MI	1–50	8.8	0.01	0.025
Mountain Chickadee	activity centred on pair territory during breeding season and group territory the rest of the year; 16 groups occupied 260 ha area over 5 years in NM; breeding territories averaged 6.47 ha in AB (n = 8)	1–10	6.5	0.05	0.39
Chestnut-backed Chickadee	territory of 1.3 ha in oak woodland in CA	1–10			
Boreal Chickadee	up to 5 ha	1–10			
Red-breasted Nuthatch	snag density may influence territory sizes; territory likely the same size as home range in the breeding season; all populations are territorial during the breeding season and winter territoriality is highly variable (pairs that remain on breeding territory through the winter are more territorial than migratory birds); territory sizes averaged 0.2 ha in hemlock forests in PQ; up to 10 ha in subalpine forests in NH; 1 to 3 ha in mixed conifer forests in central AZ	1–10		0.006	0.3
White-breasted Nuthatch	territories/home ranges vary from 10 to 15 ha in wooded sites, and up to 20 ha in semi-wooded sites	1–50		0.05	
Pygmy Nuthatch	breeding territories vary from 1 to 2 ha; winter home ranges are presumably larger	1–10	1.5	0.18	
Brown Creeper	territory sizes are from 2.3 to 6.4 ha in MI; territories are probably the same as home ranges	1–10		0.0075	0.09
Bewick's Wren	territories are equivalent to home ranges; averaged 2.0 ha (range 1.2 to 3.8 ha) in dense vegetation and 3.8 ha (range 2.5 to 4.8 ha) in more open areas of OR where house wrens occur	1–10			
House Wren	defended territory in western OR study averaged 0.93 ha (range 0.45–1.78 ha); territories almost always contain more than 1 potential nest site (cavity); territory is equivalent to home range during breeding season	1–10			
Western Bluebird	mean of 0.46 ha, range of 0.3–0.8 ha	<1			
Mountain Bluebird	territories of 2 to 6.1 ha around nests; nesting females foraged over 2.6 ha at Mt. Rainier, WA	1–10	2–6.1		
California Myotis		unknown			
Yuma Myotis		unknown			
Little Brown Myotis		unknown			

Wildlife Species Common Name	Comments on Home Range/Territory Size and Use	Home Range Size Class (ha)	Breeding Territory Size (ha)	Breeding density low (pairs/ha)	Breeding density high (pairs/ha)
Long-legged Myotis		unknown			
Keen's Long-eared Myotis		unknown			
Western Long-eared Myotis		unknown			
Northern Long-eared Myotis		unknown			
Silver-haired Bat	one study measured a circular foraging range of 46 to 91 m	unknown			
Big Brown Bat	typically hunt in one area, along a 300 m stretch of river	unknown			
Pallid Bat	typically forage within 3 km of day roosts	unknown			
Yellow-pine Chipmunk	breeding females often have somewhat overlapping home ranges	1–10			
Red Squirrel	minimum home ranges in 2 areas were 0.63 and 0.88 ha in BC; very territorial, but females can tolerate weaned young within their home ranges, and may even sometimes relinquish their home ranges to their offspring	<1			
Douglas' Squirrel	convex polygon method: 9 females and 6 males during breeding season had home ranges (most) less than 0.6 ha, and some as small as 0.05 ha; species is highly territorial	<1			
Northern Flying Squirrel	86.6 m is the average maximum distance moved between points of capture in Cascade Range	1–10			
Black Bear	sizes of home ranges vary by sex, and quality and size of habitat; home ranges of both sexes overlap; average home ranges for females were 235 ha, and for males 505 ha in coniferous forest of western WA; home ranges were 112.12 km for males and 48.92 km for females in ID	1000–10 000			
Raccoon	home ranges of males overlap one or more female home ranges and up to 10% of home ranges of other males	500–10 000			
American Marten		100–500			
Fisher	female home ranges are smaller (1500 to 2600 ha) than male home ranges (4000–5000 ha)	1000–10 000			
Caribou	they do have large home ranges although they do not make huge migrations like barren ground caribou; annual home range was 36 to 70 square km in AB	>10 000			

Home range size classes	<1 ha	1–10 ha	1–50 ha	1–100 ha	10–500 ha	100–500 ha	50–1000 ha	100–1000 ha	500–10 000 ha	1000–10 000 ha	>10 000 ha
Number (%) of total species	4 (7.7%)	18 (34.6%)	6 (11.5%)	1 (1.9%)	2 (3.8%)	5 (9.6%)	1 (1.9%)	3 (5.8%)	3 (5.8%)	8 (15.4%)	1 (1.9%)