

RECOVERY STRATEGY FOR THE NORTHERN SPOTTED OWL (*Strix occidentalis caurina*) IN BRITISH COLUMBIA



Jared Hobbs ©

Prepared by
The Canadian Spotted Owl Recovery Team

April 19, 2004

Recommended Citation

Chutter, M.J., Blackburn, I., Bonin, D., Buchanan, J., Costanzo, B., Cunnington, D., Harestad, A., Hayes, T., Heppner, D., Kiss, L., Surgenor, J., Wall, W., Waterhouse, L., and Williams, L. 2004. Recovery Strategy for the Northern Spotted Owl (*Strix occidentalis caurina*) in British Columbia. Prepared for the BC Ministry of Environment, Victoria, BC. 74 pp.

Spotted Owl Recovery Team Members (as of April 2004)

Ian Blackburn
Wildlife Biologist
Ministry of Water, Land and Air Protection
10470 152nd St.
Surrey, BC, V3R 0Y3
Phone: 604-582-5240
Email: Ian.Blackburn@gems1.gov.bc.ca

Derek Bonin
Superintendent Watershed Planning
Greater Vancouver Regional District
4330 Kingsway
Burnaby, BC, V5H 4G8
Phone: 604-432-6415
Email: Derek.Bonin@gvrd.bc.ca

Joseph B. Buchanan
Wash. Dept. of Fish and Wildlife
Wildlife Diversity Division
600 Capitol Way North
Olympia, WA, 98501
Phone: 360-902-2697
Email: buchajbb@dfw.wa.gov

Michael J. Chutter (Chair)
Biodiversity Branch
Ministry of Water, Land and Air Protection
PO Box 9338 Stn Prov Govt
Victoria, BC, V8W 9M1
Phone: 250-387-9797
Email: Myke.Chutter@gems7.gov.bc.ca

David Cunningham
Endangered Species Biologist
CWS, Environment Canada
RR#1, 5421 Robertson Rd,
Delta, BC, V4K 3N2
Tel: 604.940.4687
Email: David.Cunnington@ec.gc.ca

Alton Harestad
Professor
Dept of Biological Sciences
Simon Fraser University
8888 University Drive
Burnaby, BC, V5A 1S6
Phone: 604-291-4809
Email: harestad@sfu.ca

Les Kiss
Vice President
Coast Forest & Lumber Association
Suite 1200, 1090 W. Pender
Vancouver, BC, V6E 2N7
Phone: 604-891-1237
Email: kiss@cfla.org

Louise Waterhouse
Wildlife Habitat Ecologist
Research Section,
Coast Forest Region
Ministry of Forests
2100 Labieux Rd.
Nanaimo, BC, V9T 6E9
Phone: 250-751-7123
Email: Louise.Waterhouse@gems1.gov.bc.ca

Liz Williams
Ecosystem/Habitat Planning Specialist
Ministry of Sustainable Resource
Management
1st Floor 780 Blanshard St.
Victoria, BC, V8W 9M3
Phone: 250-356-6605
Email: Liz.Williams@gems8.gov.bc.ca

Alternates and Coordinator

Trish Hayes
(alternate for David Cunnington)
CWS, Environment Canada
RR #1, 5421 Robertson Rd.
Delta, BC, V4K 3N2
Phone: 604-940-4658
Email: Trish.Hayes@ec.gc.ca

Don Heppner
(alternate for Louise Waterhouse)
Coast Forest Region
Ministry of Forests
2100 Labieux Road
Nanaimo, BC, V9T 6E9
Phone: 250-751-7107
Fax: 250-751-7101
Email: Don.Heppner@gems5.gov.bc.ca

John Surgenor
(alternate for Ian Blackburn)
Ministry of Water, Land and Air Protection
1259 Dalhousie Dr.
Kamloops, BC, V2C 5Z5
Phone: 250-371-6306
Fax: 250-828-4000
Email: John.Surgenor@gems6.gov.bc.ca

Wayne Wall
(alternate for Les Kiss)
Habitat Specialist
International Forest Products
#311-1180 Ironwood Road
Campbell River, BC, V9W 5P7
Phone: 250-286-5143
Fax: 250-286-5150
Email: Wayne.Wall@interfor.com

Brenda Costanzo
(FIA Recovery Team Coordinator)
Biodiversity Branch,
Ministry of Water, Land and Air Protection
PO Box 9338 Stn Prov Gov't
Victoria, BC, V8W 9M1
Phone: 250-387-9611
Fax: 250-356-9145
Email: Brenda.Costanzo@gems7.gov.bc.ca

RANGE JURISDICTIONS

Government of British Columbia
Ministry of Environment
Wildlife Act

Government of Canada
Canadian Wildlife Service
Species At Risk Act

DISCLAIMER

This recovery strategy has been prepared by the Canadian Spotted Owl Recovery Team (SORT) to identify reasonable actions required to protect and recover the Northern Spotted Owl in Canada. It does not necessarily represent the views of the individuals involved in the recovery strategy's formulation or the official positions of the organizations with which the individual SORT members are associated. The goals, objectives, and strategies identified in the recovery strategy are based on the best existing knowledge and subject to modifications resulting from changed objectives and new findings. This report considered and drew from relevant all published and unpublished materials listed in the Literature Cited section. We recognize that implementation of the recovery strategy will be subject to appropriations, priorities, and budgetary constraints imposed by participating jurisdictions and organizations.

ACKNOWLEDGEMENTS

Initial drafts of this recovery strategy were prepared on behalf of the SORT by John M. Cooper, William (Bill) L. Harper, and Stephen Godwin of Manning, Cooper and Associates. Subsequent revisions of this document involved collaboration of all members of the SORT. Andy Miller was a member of the SORT representing the environmental community in our discussions from January 2003 until January 2004. We appreciate his contributions to the team's deliberations. Additional reviewers include Dave Fraser, Jared Hobbs, and Kari Nelson. English and format editing was done by Fran Aitkens.

EXECUTIVE SUMMARY

The Northern Spotted Owl¹ (*Strix occidentalis caurina*) is among the most studied, high profiled owl species in the world because of its close association with old forests and the use of these forests by society for urbanization and resource extraction. In Canada, the Spotted Owl was designated Endangered in 1986 (renewed in 2000) by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC).

The Spotted Owl occurs in the Pacific Northwest region of North America. In Canada, it occurs only in the southwest mainland of British Columbia, accounting for about 8% of its global range. Spotted Owl populations throughout the Pacific Northwest are declining. In British Columbia, the number of Spotted Owls declined between 1992 and 2002 by as much as 67%, at an annual rate of 10.4%. The current Canadian population is estimated to be less than 33 breeding pairs, which is about 0.5–1% of the estimated global population. Small populations are highly vulnerable to extinction, and it is thought that the Spotted Owl population in British Columbia may become extirpated within a few years.

Spotted Owls in British Columbia are limited by diminished quantity and quality of habitat, reduced connectivity of habitat, and increased isolation from the larger population in the United States. Threats include further loss and fragmentation of habitat, competition and hybridization with Barred Owls, predation by Great Horned Owls and other predators, climate change, negative effects from environmental and genetic variables, and disease (e.g., West Nile virus). Combined, these factors influence the survival, reproductive, recruitment, and immigration rates of the species.

Challenges to recovery in Canada include the precipitous rate of population decline, isolation from larger populations to the south in the United States, and the high risk that the current small, sparsely distributed population will continue to decline and soon become extirpated. Other challenges include balancing society's needs for both economic opportunity and recovery of endangered species, the long time frame required to restore habitats and connectivity, and the high financial costs of monitoring, research, habitat restoration, and population augmentation efforts. Some threats pose challenges that may not be manageable, such as competition from Barred Owls, severe environmental events, and potential mortality from West Nile virus.

Despite all of these challenges, recovery of the Spotted Owl in British Columbia is biologically feasible. Habitat is currently available to support owls and opportunities exist to improve future habitat conditions. Recovery is not constrained by land ownership, and thus forested areas additional to those currently being managed for Spotted Owls are available, if needed, to increase the recovery potential of the owl population. Opportunities also exist to augment the population to increase recruitment rates.

The recovery goal is to down-list the Spotted Owl from its current Endangered status by establishing a stable or increasing, self-sustaining population that is distributed throughout the species' natural range. The long-term population goal is to increase the number of owls to at

¹ Unless specified, the term "Spotted Owl" in this document refers to the Northern Spotted Owl.

least 250 adult owls, so that the species meets the minimum COSEWIC population size requirement for down-listing from Endangered to Threatened.

Recovery objectives are to (1) stop the population decline to prevent extirpation, (2) increase the number of Spotted Owls to maintain a stable, self-sustaining population throughout its range, and (3) conserve and restore sufficient habitat throughout the species' range to support a self-sustaining population of Spotted Owls.

Strategies to stop the population decline include the immediate protection of all Spotted Owls and the habitat they occupy, and the conservation of sufficient survival habitat to maintain the current population.

Strategies to increase the owl population include population assessment, population augmentation (e.g., captive breeding, captive overwintering of juveniles, and translocation of solitary wild owls to territories with a potential mate), and other possible management actions to artificially increase survivorship and fecundity (e.g., supplementation of prey populations and removal of competitors).

Strategies to conserve and restore owl habitat include habitat supply modeling, identification and conservation of critical habitats (survival and recovery habitats), and development of habitat management guidelines to create, enhance, and maintain habitat.

Strategies to support recovery actions include promoting habitat and owl population stewardship, providing financial resource assistance, adaptive management and research, public awareness, and innovative solutions to address social and economic consequences.

Continued population inventory and monitoring is recognized as the highest priority recovery action on which all other aspects of recovery actions will be based. Comprehensive inventory followed by regular monitoring is needed to better understand the full distribution of the Spotted Owl in British Columbia, to identify critical habitats, to get more rigorous estimates of abundance and trend, and to identify sites where birds could be taken from for augmentation measures. Simply relying on past inventory data to develop recovery actions may negate the likelihood of recovering the population.

Recovery actions already underway include implementation of the Spotted Owl Management Plan, various analyses of the success of that plan, re-establishment of the Spotted Owl Recovery Team, preparation of an updated status report, limited ongoing inventory, new habitat and population modeling, experimental capture and release of a juvenile owl, voluntary deferment of logging by some forest companies, and development of conservation tools (e.g., Identified Wildlife Management Strategy) under the Forest Practices Code and *Forest and Range Practices Act*.

Evaluation criteria for the recovery strategy include several performance measures, such as prevention of extirpation, conservation of sufficient habitat to maintain a viable population, and preparation of various recovery action plans.

TABLE OF CONTENTS

SECTION I: BACKGROUND	1
1. COSEWIC Listing	1
2. Distribution	1
2.1 Global Range	1
2.2 Canadian Range	3
2.3 Proportion of Global Distribution in Canada	3
2.4 Distribution Trend	5
3. Population Abundance	5
3.1 Global Range	5
3.2 Canadian Range	6
3.3 Proportion of Global Abundance in Canada	6
3.4 Population Trend	6
4. Biologically Limiting Factors	7
4.1 Recruitment	7
4.2 Habitat Requirements	9
4.3 Prey Availability	10
4.4 Causes of Mortality	11
5. Threats to the Species	12
5.1 Loss and Fragmentation of Suitable Habitat	12
5.2 Range Expansion of Barred Owls	13
5.3 Climate Change	14
5.4 Environmental, Demographic, and Genetic Stochasticity	15
5.5 West Nile Virus	15
5.6 Human Disturbance	16
6. Habitat Identification	16
6.1 General Habitat	16
6.2 Critical Habitat	17
6.3 Habitat Protection	20
6.4 Habitat Trends	22
6.5 Recovery Habitat	23
6.6 Survival Habitat	23
6.7 Identification of Activities Likely to Result in Destruction of Critical Habitat	24
7. Ecological Role	24
8. Importance to People	24
9. Anticipated Conflicts or Challenges	24
10. Knowledge Gaps	25
10.1 Habitat Requirements	25
10.2 Inventory Requirements	26
10.3 Biological / Ecological Research Requirements	26
11. Ecological and Technical Feasibility of Species Recovery	26
12. Recommended Approach / Scale for Recovery	30
13. Socio-economic Considerations	31
14. Recovery Goal	36
15. Recovery Objectives	36

15.1 Immediate Objectives	36
15.2 Population Objectives	36
15.3 Habitat Objectives.....	37
15.4 Other Supporting Objectives.....	37
16. Strategies to Meet Recovery Objectives.....	37
16.1 Immediate Strategies.....	38
16.2 Population Strategies	39
16.3 Habitat Strategies	42
16.4 Other Supporting Strategies.....	43
17. Potential Impacts of the Recovery Strategy on Other Species and Ecological Processes..	47
18. Actions Already Completed Or Underway.....	47
18.1 Summary of Actions	47
18.2 Statement of When Action Plans will be Completed.....	53
18.3 Evaluation	54

LIST OF FIGURES

Figure 1. Current year-round range of Spotted Owls in North America. (Adapted from Gutiérrez et al. 1995)	2
Figure 2. Distribution of Spotted Owls in British Columbia. (MWLAP 2003)	4
Figure 3. Estimated number of occupied survey areas among the 40 survey areas, 1992 to 2002 (90% C.I.). (Blackburn and Godwin 2003).....	7
Figure 4. Total and actual capable forest area managed under the Spotted Owl Management Plan within the three land jurisdictions in the Chilliwack and Squamish forest districts.	20
Figure 5. Proportion of suitable habitat (forest older than 100 years) in the Chilliwack and Squamish forest districts. (Blackburn and Godwin 2003).....	22
Figure 6. Extent of the Spotted Owl Management Plan.	50

LIST OF TABLES

Table 1. Known Spotted Owl locations in British Columbia occupied at least once between 1992 and 2002. (Blackburn and Godwin 2003).....	21
Table 2. Summary of strategies needed to meet recovery objectives.*	46

LIST OF APPENDICES

Appendix 1: Interim Management Recommendations	62
Appendix 2: Preliminary List of Research Topics.....	64
Appendix 3: Conceptual Proposal: Spotted Owl Recovery Fund.....	67

Appendix 4: COSEWIC Criteria for Endangered and Threatened Species..... 70

Appendix 5: Suitable Spotted Owl Habitat Definitions for British Columbia (from SOMIT 1997)
..... 72

Appendix 6: Acronyms Used in Spotted Owl Recovery Strategy 73

SECTION I: BACKGROUND

1. COSEWIC Listing

Common Name: Northern Spotted Owl

Scientific Name: *Strix occidentalis caurina*

COSEWIC Status: Endangered

Last Examination and Change: May 2000 (No Change)

Canadian Occurrence: British Columbia

Reasons for Designation: Numbers of this habitat specialist are very small in Canada. It requires old growth coniferous forests, which are decreasing in extent and becoming highly fragmented.

Status History: Designated Endangered in April 1986. Status re-examined and confirmed in April 1999 and in May 2000. Last assessment based on an existing status report.

2. Distribution

2.1 Global Range

The Northern Spotted Owl², *Strix occidentalis caurina*, is the only subspecies of Spotted Owl found in Canada. This subspecies is distributed from the southwest mainland of British Columbia through western Washington, western Oregon and the coast ranges of California to San Francisco Bay (Figure 1). Although the current range is similar to the historic range, the distribution and abundance of Spotted Owls within this range has been significantly altered (USDI 1992).

² Unless specified, the term “Spotted Owl” in this document will refer to the Northern Spotted Owl.

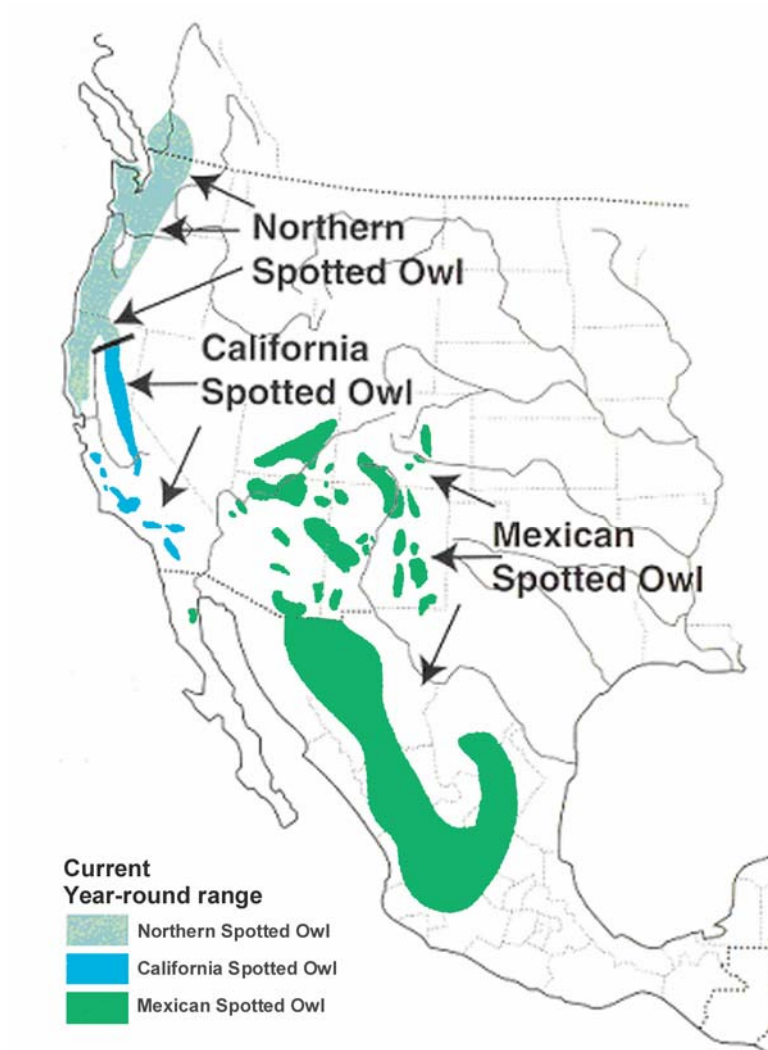


Figure 1. Current year-round range of Spotted Owls in North America. (Adapted from Gutiérrez et al. 1995)

2.2 Canadian Range

The entire known Canadian population of the Spotted Owl occurs in the southwest mainland of British Columbia, extending from the international border north about 200 km to Carpenter Lake, and about 160 km from Howe Sound in the west to the Cascade Range in the east (Figure 2). Changes in range are difficult to determine because of limited and poorly distributed inventory efforts in the past. For example, recent surveys have found Spotted Owls further north and east (e.g., Carpenter Lake) than previously known. However these areas were not previously surveyed and it is unknown if this represents a recent expansion or whether they have always occurred there. As all potential habitat has not been surveyed, the full extent of the range of Spotted Owls in British Columbia is still uncertain. Spotted Owls formerly occurred in much of the lower Fraser River valley, but are now absent because suitable habitat has been largely replaced by human development. Surveys conducted between 1992 and 1997 in the Squamish/Whistler area did not detect any Spotted Owls, suggesting that they were no longer present during that time despite historic records (Blackburn and Godwin 2003).

2.3 Proportion of Global Distribution in Canada

Approximately 8% of the global range of the Spotted Owl is located in Canada, and all of that lies within British Columbia (Figure 1).

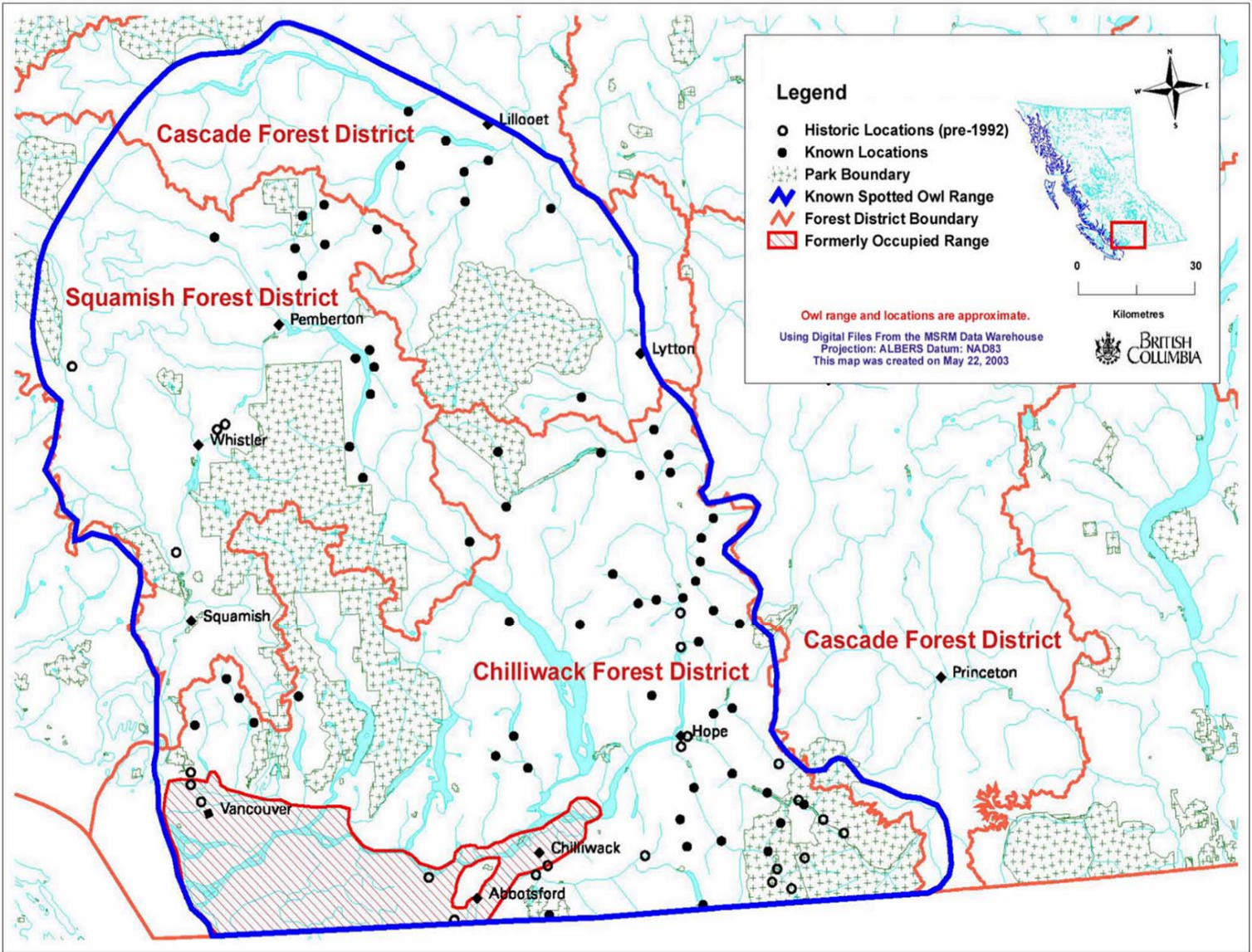


Figure 2. Distribution of Spotted Owls in British Columbia. (MWLAP 2003)

2.4 Distribution Trend

The overall distribution of the Spotted Owl in British Columbia is unknown because inventories have not been conducted to determine the full extent of either the original or current ranges. Two early published auditory records (Laing 1942, cited in Campbell et al. 1990) of Spotted Owls in the Powell River area are well outside its current range to the west, which suggests a decrease in their range. But these records were considered unconvincing and not accepted as confirmed records in *The Birds of British Columbia* (Campbell et al. 1990) or by the Spotted Owl Recovery Team (SORT; Dunbar and Blackburn 1994). Yet there is some concern for a current decline in the range of Spotted Owls because they have not been detected in the most southwestern portion of their range (e.g., Capilano watershed) since 2000. On the other hand, in recent years, new detections of Spotted Owls have been confirmed northeast of their previously known range. However, these detections do not necessarily support a range expansion because earlier inventories for this area are not available for comparison. In summary, the overall distribution trend of the range of the Spotted Owl in British Columbia appears relatively unchanged. There is potential for further expansion of the known range as the owls expand into new areas, but at the same time, the risk of collapse remains in other portions of the range where owls are no longer being detected.

3. Population Abundance

Owl abundance is reported differently by different authors. Some authors report the total number of individuals, but, in addition to breeders, this includes single territorial adult owls, floaters (non-territorial owls), and those younger than breeding age (typically less than 3 years old) and thus not contributing to recruitment. COSEWIC uses the number of mature birds that are capable of reproduction, but this can include non-breeders and/or floaters. The number of potential breeding pairs is most frequently used because it represents the portion of the population that contributes to recruitment. The term *potential* is used because paired owls do not necessarily reproduce every year.

In the following sections, cited owl abundance estimates are given in terms of the number of potential breeding pairs. Simply extrapolating between COSEWIC's counts of mature birds and the number of potential breeding pairs is not recommended because the COSEWIC's count also includes non-breeders and/or floaters.

3.1 Global Range

The global population of Spotted Owls was estimated at 3778 potential breeding pairs in the early 1990s (Gutiérrez et al. 1995). A more recent estimate is about 6000 pairs (2300, northern California; 2900, Oregon; 860, Washington; 33, British Columbia; Forsman 2003). Most reports now use a range of 3000 to 6000 potential breeding pairs. The higher numbers reported in recent years reflect more comprehensive inventory and are, therefore, more accurate than earlier estimates.

3.2 Canadian Range

Within the Chilliwack and Squamish forest districts before European settlement, the Spotted Owl population in Canada was estimated at approximately 500 potential breeding pairs (Blackburn et al. 2002). In 1991, the Canadian population was estimated at fewer than 100 potential breeding pairs, based on low response rates during field inventories conducted from 1985 to 1988 (Dunbar et al. 1991; Dunbar and Blackburn 1994). The most recent estimate of the size of the Canadian population, based on analysis of trend data, is less than 33 potential breeding pairs in 2002 (Blackburn and Godwin 2003).

3.3 Proportion of Global Abundance in Canada

The Canadian population of Spotted Owls represents approximately 0.5 to 1% of the global population of 3000 to 6000 potential breeding pairs. Because the Canadian portion of the owl's range is approximately 8%, these population estimates appear far below a level of abundance that would be expected if the population were equally represented across the species' range. However, this can partly be explained by the owl's use of larger home range sizes in northern portions of its range. This would typically result in lower owl densities relative to geographic extent here than in areas where home ranges are smaller.

3.4 Population Trend

Between 1992 and 2001, at least 64 occupied sites were detected in British Columbia within the Squamish, Chilliwack, and Cascade forest districts. Analysis of the occupancy of owls at 40 of these sites in the Chilliwack and Squamish forest districts between 1992 and 2001 suggests a population decline of about 49% (90% C.I., 40 to 57%) at an average annual rate of 7.2% (90% C.I., 5.5% to 8.9%, Blackburn et al. 2002). Results from 2002 suggest that the population declined an additional 35% between 2001 and 2002. Overall, based on a linear multiplicative model, the Spotted Owl population in British Columbia declined by 67% between 1992 and 2002 at an average rate of 10.4% per year (Figure 3; Blackburn and Godwin 2003). Based on the 100 pairs of Spotted Owls in British Columbia estimated by Dunbar et al. (1991), the observed 67% decline between 1992 and 2002 suggests that the current Spotted Owl population in British Columbia may be fewer than 33 breeding pairs of owls (Blackburn and Godwin 2003). Based on a historic population estimate of about 500 potential breeding pairs of owls (Blackburn et al. 2002), the current population estimate suggests that the population may have declined by as much as 90% since European settlement.

The observed large decline in Spotted Owl numbers is not exclusive to British Columbia. In the United States, monitoring of Spotted Owls at 15 different demographic study areas between 1985 and 1998 suggests a range-wide annual population decline of 3.9% (95% C.I., $\pm 3.6\%$) for female Spotted Owls (Franklin et al. 1999). The Cle Elum demographic study area in Washington exhibited a decline of about 60% between 1992 and 2002 (Forsman et al. 2002c), although populations elsewhere in the United States showed less dramatic declines.

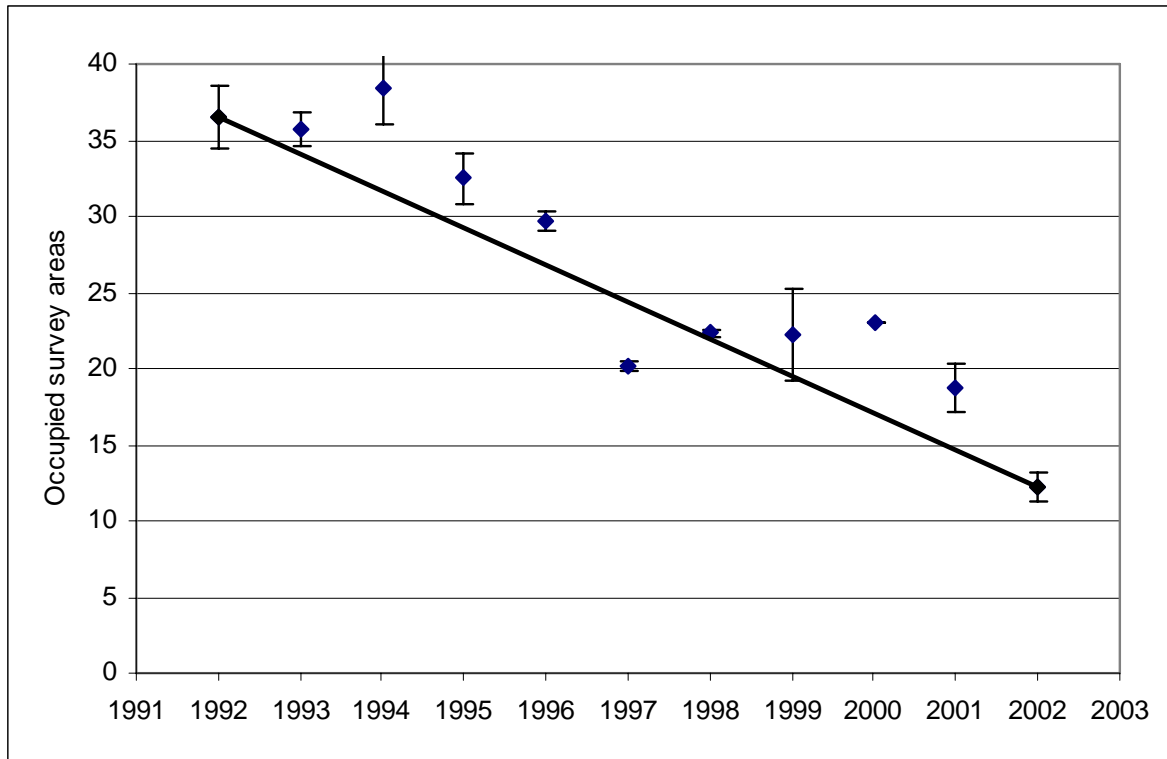


Figure 3. Estimated number of occupied survey areas among the 40 survey areas, 1992 to 2002 (90% C.I.). (Blackburn and Godwin 2003)

4. Biologically Limiting Factors

4.1 Recruitment

Spotted Owl populations naturally have low fecundity and low juvenile survivorship that are offset by high survivorship of adults. Inter-annual variation in these processes are less critical in large populations and across large spatial scales. However, effects of low recruitment on population growth rate may be exaggerated because of the small population and its increasingly fragmented distribution found currently in British Columbia. These effects may hinder chances of the population's recovery. Despite banding and monitoring efforts, there is no evidence of successful recruitment in recent years and the adult population is aging. Without recruitment, the population will continue to decline as adult birds age and die. In British Columbia, causes of low recruitment are unknown but likely include nesting and dispersal habitat issues, competition and predation, and availability of prey. Recruitment must be increased to achieve a self-sustaining Spotted Owl population.

4.1.1 Reproductive Rate

Annual reproductive output of a population is largely influenced by the number of pairs that breed each year. There is substantial inter-annual variation in the number of pairs that breed, with few owls breeding in “poor” years and most owls breeding in “good” years (Franklin et al. 2002). Most Spotted Owls do not breed every year (Gutiérrez et al. 1995). In one study area in Oregon, the percentage of breeding females each year averaged 56% (range, 18 to 82%) over 18 years from 1985 to 2002 (Forsman et al. 2002b). Clutch sizes typically range from 1 to 3 eggs. Of 2113 broods examined from 1984 to 1994, 42%, 56%, and 2% contained 1, 2, and 3 fledged young, respectively (Gutiérrez et al. 1995). Reproductive rates may be influenced by prey abundance, environmental conditions, and predator effects.

4.1.2 Age of First Breeding

Although some Spotted Owls breed as 1- or 2-year-olds, most breed beginning as 3-year-olds. Between 1.5 and 8.4% of 1-year-old birds and 2.6% to 33.3% of 2-year-old birds will breed (Forsman et al. 2002a). Despite this infrequent incidence of sub-adult breeding, 20 to 83% of first-year and 57 to 74% of second-year birds may be paired (Forsman et al. 2002b). It seems that breeding is delayed for a year or more after initial pair formation. In Oregon, the average age of pair formation was 2.4 years for males and 1.9 years for females, and the average age of first breeding was 3.9 years for males and 3.4 years for females (Forsman et al. 2002b).

4.1.3 Dispersal and Survival

Juvenile Spotted Owls disperse from the natal area at the end of the breeding period. Dispersal generally refers to the movement of juveniles away from the natal territory and includes all subsequent movements until territory acquisition or death (Miller et al. 1997). This movement begins in September and October. The latest date for juveniles observed with their parents in British Columbia is 28 September (Blackburn and Godwin 2003). Some owls do not find permanent territories until 2 to 5 years of age. About 6% of non-juveniles disperse as well. These birds tend to be females, or owls that did not breed the previous year or had lost their mate (Forsman et al. 2002a).

Juveniles exhibit two distinct phases of dispersal behaviour. The first is characterized by rapid movement away from the natal area and is referred to as transience (Miller et al. 1997). This phase of dispersal is typically followed by the colonization phase wherein the owl settles in a general area (e.g., an area of 2.4 km² or less) for more than a few days (Miller et al. 1997). The overall dispersal period may consist of multiple occurrences of transience and colonization and, in the United States, the dispersal direction is generally random (Miller et al. 1997; Forsman et al. 2002a).

Dispersal involves substantial movements across the forested landscape. Dispersal of juveniles tends to occur in random directions and juveniles travel variable distances before settling on territories (Forsman et al. 2002a). Final dispersal distances ranged from 0.6 to 111 km, median distances were about 14 km for males and 24 km for females, and only 8.7% of the owls dispersed more than 50 km ($n = 940$; Forsman et al. 2002a). Breeding-age owls also occasionally disperse, especially those who have lost their mates. These movements may be to new territories, or back and forth movements between alternate territories (Forsman et al. 2002a). Most studies

did not follow the subject owls frequently enough to measure all of the movements that constituted the dispersal phase. Consequently, the measure of movement reported in the literature is the straight-line distance between natal site and the site of death or territory establishment; the published values do not represent the total distance traveled.

Spotted Owl dispersal behaviour may be influenced by the presence of potential barriers such as high-elevation terrain, large bodies of water, and large open areas of unsuitable habitat (Thomas et al. 1990; Miller et al. 1997; Forsman et al. 2002a). Miller et al. (1997) found that although dispersing juveniles selected equally between less fragmented forest and more fragmented forest, net dispersal distance decreased with the increased area of clearcuts, suggesting that clearcuts may represent a partial barrier to dispersal (Miller et al. 1997). The quality of dispersal habitat is likely an important factor in survival of dispersing birds. Dispersing owls are found in both continuous older forest and fragmented landscapes containing mosaics of various-aged forests, clearcuts, roads, and non-forested areas (Forsman et al. 2002a). Large non-forested valleys are known barriers to dispersal in western Oregon between the Coastal and Cascade ranges, but owls did disperse through broad, forested foothills between those areas (Forsman et al. 2002a).

Survival of juveniles is low and is typically considered a major limiting factor in population recruitment (Gutiérrez et al. 1995). About 50% of fledglings die before or during dispersal (Forsman et al. 2002a), whereas older owls (2+ years old) are longer lived, averaging an 84% annual survival (Gutiérrez et al. 1995; Franklin et al. 1999). Some banded individuals are known to have survived to at least 16 to 17 years in the wild (Gutiérrez et al. 1995).

4.2 Habitat Requirements

Throughout its range, the Spotted Owl is strongly associated with mature and old, late-successional coniferous and mixed-coniferous forests. These forests are typically characterized by an uneven-aged cohort of trees; a multi-layered, relatively closed canopy; numerous large trees with broken tops, deformed limbs, and large cavities; and numerous large snags and accumulations of logs and downed woody debris (Thomas et al. 1990; USDI 1992). In moist parts of the range, these habitat characteristics are found naturally in late seral and old forests (see Appendix 5). In drier parts of their range (i.e., east of the Cascade Range), owls have been observed in younger forest stands where similar structural complexity was created by fire, wind events, selective logging, or disease factors such as root rot or mistletoe infections (Dunbar and Blackburn 1994; Buchanan et al. 1995).

4.2.1 Nest Structures

Territory establishment may be determined by the availability of nesting structures. Spotted Owls do not build their own nests, but depend on naturally occurring or previously constructed nest sites that typically possess nest platforms that are at least 50 cm in diameter. Nest sites include broken treetops, tree cavities, abandoned raptor nests, mistletoe brooms, and debris accumulations captured in clusters of branches (Forsman et al. 1984; Dawson et al. 1986). In general, cavities are used in moist climates, platforms are used in drier climates, particularly where cavities larger than 50 cm in diameter are not available. A variety of different trees are used for nesting throughout North America, suggesting, to a certain extent, that the presence of structures (i.e., cavities or platforms) is more important than the species of tree in nest site

selection (Forsman and Giese 1997). Pairs may re-use the same nest each year or use alternate nest sites (Gutiérrez et al. 1995).

4.2.2 Home Ranges

Spotted Owls are non-migratory, and their home ranges, particularly in the northern parts of their distribution, are very large (Gutiérrez et al. 1995). Home ranges tend to increase in size from south to north, from drier to wetter ecosystems, and with increasing fragmentation (Forsman et al. 1984; Carey et al. 1990; Thomas et al. 1990). Home range sizes are smaller in the breeding season, when owls concentrate activities closer to their nests, than in the non-breeding season (Carey et al. 1990). Although Spotted Owls are site-faithful in most parts of their range, shifting among sites is not uncommon in the eastern Cascade Range in Washington (Herter and Hicks 1995).

In Washington, median annual home ranges of Spotted Owl pairs were larger in the moister western forests (3321 ha, 67% suitable habitat) than the drier eastern forests (2675 ha, 71% suitable habitat; Hanson et al. 1993). Other studies in Washington found home ranges varied from 2100 to 4000 ha (reviewed by Gutiérrez et al. 1995). Preliminary home range size estimates from telemetry studies in British Columbia appear to be consistent with estimates from Washington (Blackburn and Godwin 2003). The large home ranges used by Spotted Owls may be a response to the low density of the owl's principal prey species and the amount of habitat needed to find sufficient food (Carey et al. 1992).

Territory establishment by Spotted Owls appears to be limited by the amount, quality, and distribution of habitat found within the landscape. Higher fecundity and adult survivorship is associated with larger amounts of suitable habitat in areas surrounding the nest area (Bart 1995; see Meyer et al. 1998).

4.2.3 Thermal Requirements

Spotted Owls are easily subjected to heat stress and behaviourally thermoregulate through their choice of roosting habitats (Barrows 1981). Owls respond to variations in temperature by moving within the canopy to more favourable microclimates. In summer, when temperatures are warmer, roosts tend to be in cool, shady areas. Their narrow preferred range of ambient temperature may be one of the reasons they strongly select mature and old forest habitats (Gutiérrez et al. 1995).

4.3 Prey Availability

Spotted Owls feed primarily on arboreal and semi-arboreal small mammals. They forage primarily at night, typically by perching and waiting to detect prey by sight or sound (Gutiérrez et al. 1995). A recent study of three areas in western Washington confirmed that Northern Flying Squirrels (*Glaucomys sabrinus*), which are also nocturnal, were the most frequently taken prey (29 to 54% numbers of prey) and made up the highest percentage of diet by weight (45 to 59% biomass). Other primary prey were Snowshoe Hares (*Lepus americanus*), Bushy-tailed Woodrats (*Neotoma cinerea*), Red-backed Voles (*Clethrionomys* sp.), and mice (Forsman et al. 2001). Observed differences between years and areas were thought to be mainly related to variation in abundance of prey species (Forsman et al. 2001).

In British Columbia, Northern Flying Squirrels, Bushy-tailed Woodrats, and deer mice (*Peromyscus* sp.) are the most common prey of Spotted Owls (Horoupian et al. in prep), similar to diets in Washington. Tree squirrels comprise 64.6% of the biomass consumed (Northern Flying Squirrels contribute 41.2%, other tree squirrels [*Tamiasciurus* sp.] contribute 0.8%, and unidentified squirrel-sized prey a further 22.6%). Deer mice contribute little energetically, because of their small size. The percentages of prey species based on numbers of prey consumed do not differ between the wet coastal forests and dry interior forests of British Columbia (Horoupian et al. in prep.), although woodrats were more important food at one nest in the Cascade Forest District (Hilton and Hilton 2002).

Numbers of Spotted Owls may fluctuate in response to prey availability. Prey may become limited through natural fluctuations in climatic conditions, suppression by other predators (e.g., Barred Owls), or by the amount and quality of habitat types found in the landscape. Carey et al. (1992) reported that Northern Flying Squirrels tend to be more abundant in old forests than in young forests; but their density in old forests is also low. In British Columbia, Ransome and Sullivan (2003) found the density of Northern Flying Squirrels in old forest in the wet coastal ecosystem to be 1.5 +/-1.8 squirrels/ha (range, 0.3 to 2.9), and in 80-year-old second-growth stands to be 1.0 +/-1.4 squirrels/ha (range, 0.06 to 1.8). They concluded that although quality of habitat provided by old forests can be better than that in second-growth forests, Northern Flying Squirrels are not consistently more abundant in old forests than in 80-year-old forests. However, their results support a pattern of increasing numbers of Northern Flying Squirrels in old forests. As well, the 0.5-squirrel difference between habitat types may have biological importance to the survival of the Spotted Owl. Because of the low density of this principal prey species, Carey et al. (1992) hypothesized that the Spotted Owl's use of large home ranges may be in response to the amount of habitat needed to search and find enough food to sustain itself.

4.4 Causes of Mortality

Although many Spotted Owls have been known to succumb to starvation due to low prey availability, there are other natural causes of mortality on juveniles and adult Spotted Owls.

4.4.1 Predation

Although predation has not been identified as a limiting factor causing declines in Spotted Owl populations (Gutiérrez et al. 1995), predation accounts for most (68.0%) juvenile deaths, mainly attributed to avian predators (81%). Great Horned Owls (*Bubo virginianus*) are suspected to be the major cause (Forsman et al. 2002a). Other avian predators include Northern Goshawks (*Accipiter gentilis*), Red-tailed Hawks (*Buteo jamaicensis*), Common Ravens (*Corvus corax*), and possibly Barred Owls (*Strix varia*) (Forsman et al. 2002a). The remaining juvenile mortality is due to mammalian predators. Adults also fall victim to predators. The effects of predation may be more significant for small populations of Spotted Owls, such as those found in British Columbia, because the loss of individuals may have a relatively higher impact than in the larger populations in the United States.

4.4.2 Disease and Parasites

Little is known about diseases and parasites that affect Northern Spotted Owls (Gutiérrez et al. 1995). It is thought that disease or parasites may contribute to the cause of death because 99% of the juveniles that starved to death were infected with either parasites or disease (Forsman et al. 2002a). It has been well documented that high parasite loads may reduce individual fitness in birds (Moller 1993; Loye and Carroll 1998), but because parasites are ubiquitous in wildlife populations, it is likely that mortality resulting from parasites is related to the extent of infestation.

Several diseases or parasites have been documented in Spotted Owls. Avian cholera (Forsman et al. 2002a) and acute septicemic spirochetosis (Thomas et al. 2002) have been documented from the Pacific Northwest. Other parasites include blood parasites (hematozoans), helminths (nematodes, cestodes, and acanthocephalans), and louse flies (*Hippoboscidae*) (Gutiérrez et al. 1995). Of 105 Spotted Owls sampled from all three subspecies, all were infected with hematozoan parasites and multi-species infections were common (Gutiérrez et al. 1995). Most dead owls examined by Forsman et al. (2002a) were infested with blood or intestinal parasites. In addition to the importance of parasites to individual fitness, parasite presence may influence nest site selection in some birds (Loye and Carroll 1998), although this has not been demonstrated in Spotted Owls. Although West Nile virus has not been reported in the Spotted Owl this virus has the potential to impact Spotted Owls at the population level in British Columbia.

5. Threats to the Species

Although a few new territories have been discovered in recent years (e.g., Hobbs 2002), recruitment of young into the now small, fragmented British Columbia population is likely infrequent. Areas known to have been previously occupied, as well as surveyed areas of suitable habitat where owls have not been recorded in the past, have not been reoccupied by owls over the last few years, and no banded juveniles have been relocated in following years (Blackburn et al. 2002). Small populations are extremely vulnerable to extirpation. If the population is unable to stabilize and become resilient to the factors that caused the decline, the population will become extirpated.

Threats to the species can be divided into primary and secondary factors (Blackburn and Godwin 2003). Primary factors are those that cause long-term sustained effects that limit the carrying capacity or total capable population size. Primary factors include habitat loss and fragmentation, competition with Barred Owls and, possibly, climate change. Secondary factors can cause short-term effects in population size, but populations would normally recover soon after the influence of the factor changes to a more favourable condition. Secondary factors include stochastic environmental, demographic, and genetic events. Although primary factors generally limit population size and may ultimately cause extirpation, secondary factors are often the proximal cause of extirpation of small populations (Blackburn and Godwin 2003).

5.1 Loss and Fragmentation of Suitable Habitat

Loss and fragmentation of habitat is widely thought to be the primary threat to the Spotted Owl throughout the Pacific Northwest (USDI 1992; Dunbar and Blackburn 1994; Gutiérrez et al.

1995). More than 10% of the historic range of the owl within the Chilliwack and Squamish forest districts has been converted to urban and agricultural areas, roads, pipelines, reservoirs, hydroelectric dams and associated reservoirs, recreational developments, and utility corridors. Continued habitat loss will likely decrease the total amount of habitat available to the owl and further fragment habitat. As well, natural disturbances (e.g., from fire, insects, blowdown) may also result in further habitat losses if they are extensive enough. Decreasing amounts of habitat and increasing fragmentation within the landscape is associated with decreased occupancy, fewer potential territories, lower productivity, lower survivorship, and lower dispersal success. Patches of suitable habitat must be close enough to allow owls to use and move among them. If fragmentation is too great, owls may be unable to efficiently use the suitable habitat that may be available to them. In addition to habitat loss, conversion of old stands to young stands may impede dispersal of owls, depending on the spatial configuration of the landscape, because young stands may act as barriers. If such constraints on dispersal occur, then some areas of suitable habitat, although they are large enough to support owls, may not be occupied.

In British Columbia, clearcut logging typically has reduced stand level structural diversity in logged areas. More recent forest management practices may provide better management of biodiversity values, including provisions for maintaining more structural diversity in logged areas both at the stand-level (e.g., Wildlife Tree Patches and Riparian Management Areas), and at the landscape level (Old Growth Management Areas, Ungulate Winter Ranges, and indirectly through Visual Quality Objectives). However, these management practices do not provide large enough habitat patches to support breeding pairs of Spotted Owls. As well, rotation lengths between successive harvests may be shorter than is currently thought to be required to achieve suitable habitat conditions for owls (i.e., shorter than 100 years). This could result in the equivalent of a permanent loss of habitat because the habitat would be retained as unsuitable over the long term

Connectivity among subpopulation clusters is considered essential to maintain a population's viability (Lamberson et al. 1994.) Connectivity with populations in the United States has been compromised by human development of the lower Fraser River valley. Large unforested valleys are known to act as barriers to dispersal (Forsman et al. 2002a); therefore, dispersal of owls between the United States and Canada is no longer likely in the lower Fraser River valley from Vancouver to close to Chilliwack. Any dispersal between owl subpopulation clusters in British Columbia and Washington is likely restricted to the Skagit River Valley.

5.2 Range Expansion of Barred Owls

In the 1960s, the Northern Barred Owl (*Strix varia varia*) expanded its range westward and southward and began to overlap the range of the Spotted Owl in British Columbia (Campbell et al. 1990; Dunbar et al. 1991) and the United States (Hamer 1988; Gutiérrez et al. 1995). Barred Owls thrive in a variety of forest types and seral stages and can adapt to more varied food sources than Spotted Owls.

Competition with Barred Owls is thought to be a primary threat to Spotted Owls through increased competition for habitat and prey, and perhaps as a consequence of hybridization and predation (Wilcove 1987; Carey et al. 1992; SOMIT 1997a). Territorial interactions have been observed between Barred Owls and Spotted Owls, and Barred Owls have been found at nest sites

formerly occupied by Spotted Owls (Hamer et al. 2001; Kelly et al. 2003). Kelly et al. (2003) suggested that Barred Owls sometimes displaced Spotted Owls from their territories if Barred Owls occurred within 0.8 km of a Spotted Owl territory centre. Those Spotted Owls that were not displaced continued to maintain their normal reproductive output, but regional reproductive output was lower because there were fewer Spotted Owls (Kelly 2002). However, a study in Oregon found that although Barred Owls had taken over some Spotted Owl territories, the population of Spotted Owls had not declined (Forsman et al. 2002b).

Competition for food between Barred Owls and Spotted Owls seems likely because diets greatly overlap (76% in one study in western Washington), food is limiting in some years, and Barred Owls have moved into much of the Spotted Owl's range (Hamer et al. 2001).

In British Columbia, the extent of the potential for competition is illustrated by the discovery in the early 1990s that Barred Owls were four times more abundant than Spotted Owls within the range of the latter species (Dunbar and Blackburn 1994). Most Barred Owls detected during Spotted Owl surveys in the province tended to occur along valley bottoms near riparian habitats; Spotted Owls tended to occur at mid- and upper-elevation areas where most of old forest remains (Blackburn and Harestad 2002). A preliminary analysis of Barred Owl territory occupancy within Spotted Owl survey areas between 1992 and 2001 indicated a decline in Barred Owl numbers similar to that recorded for the Spotted Owl (Blackburn and Harestad 2002). The authors suggested several scenarios to explain the similar population declines, including a lack of displacement competition, because the similar declines suggest other factors were simultaneously affecting both species. Conversely, the results may suggest that both species were declining due to competition for the same resources.

To further complicate the issue, hybridization between Barred Owls and Spotted Owls has been recorded (Hamer et al. 1994). Spotted Owls are closely related to Barred Owls (Gutiérrez et al. 1995). In Washington and Oregon, a total of 50 hybrids were observed between 1974 and 1999 (Kelly 2002). The frequency of interspecific matings is extremely low when compared to the total number of Northern Spotted Owl matings within the demographic study areas in Washington and Oregon (Kelly 2002). Despite the extensive sympatry of these two species, the genetic isolating mechanisms that separate Spotted Owls and Barred Owls are thought to be effective enough to maintain hybridization at this very low incidence (Hamer et al. 1994).

Kelly et al. (2003) suggested two possible scenarios if present trends continue: (1) Barred Owls displace Spotted Owls and the latter species becomes extirpated, or, (2) some form of equilibrium is reached where both species coexist. Currently, the potential impact of Barred Owls on Northern Spotted Owls in British Columbia is unknown. Potential for competition and/or hybridization between the species is of particular concern in British Columbia because both could have serious consequences by reducing the already small pool of breeders.

5.3 Climate Change

Climate change may threaten Spotted Owls if it negatively affects prey species (e.g., declining abundance and availability), weather (e.g., more rain or colder mean temperatures), vegetation (e.g., changing composition and structure), environmental stochasticity (e.g., increased fire rates and intensity if less rain, more insect outbreaks due to less severe winters), and disease. For

example, insect outbreaks are strongly affecting forest health in Special Resource Management Zones near Lillooet Lake (D. Heppner, pers. comm.). Recent increases in insect outbreaks have been linked with climate change (Dale et al. 2001).

On the other hand, climate change may improve habitat and other environmental conditions for Spotted Owls if conditions change to mimic those now found in southern parts of its range where owl densities are higher. Therefore, the level of threat from climate change remains undetermined as it relates to Spotted Owls in British Columbia.

5.4 Environmental, Demographic, and Genetic Stochasticity

Populations are vulnerable to extinction from many factors. When populations become small or isolated, for whatever reason, they can become vulnerable to extirpation through environmental, demographic, or genetic stochastic (random) events (Caughley and Gunn 1995). Stochastic events, therefore, tend to be additive in that they may contribute to factor(s) that originally caused the population's decline.

Environmental stochasticity refers to periodic variation in conditions (e.g., wildfires, wind, forest diseases, and floods) and the effect these have on a population. Typically, environmental factors are of concern if they have the potential to eliminate habitats and the populations that they support. Catastrophic loss of habitat due to fire is a pertinent example of an environmental factor that has the potential to affect a small population or subpopulation of Spotted Owls. This issue is particularly relevant because fire suppression in some dry-site forests has changed the structure and species composition of forests in such a way that they are vulnerable to stand-replacement events. Although environmental stochasticity can affect all sizes of populations, the effects are higher in smaller populations or those already affected by other factors.

Demographic stochasticity in small populations means that changes in population size from one year to the next are more related to pure chance than age-specific survival and reproduction. That is, population size varies between years, but when the population is small, this variation has more chance of causing extirpation.

The third way random events negatively affect small populations is through loss of genetic variability. Once a population is reduced to below a certain threshold, random genetic drift will result in some alleles being lost by chance in the transfer of genetic material from one generation to the next (Caughley and Gunn 1995). The lost alleles may be related to adaptation to certain conditions; their loss would increase the species' risk of extinction.

5.5 West Nile Virus

The West Nile virus is a disease of concern throughout the owl's range. Originally the West Nile virus was known only from Africa, West Asia, and the Middle East. This virus was first isolated in the Western Hemisphere in New York in 1999, and has since spread rapidly across North America (Canadian Cooperative Wildlife Health Centre 2003). The geographic range of the West Nile virus may already include British Columbia because it was documented in Washington and Saskatchewan in 2002, and Alberta in 2003 (Helen Schwantje, pers. comm.).

Wild birds are the usual host of this virus; currently it has been detected in 138 species of dead birds in North America. Infected birds include several species of owls, although not the Spotted Owl as yet. Although birds infected with West Nile virus can become ill or die, most infected birds survive and become carriers of the virus (Centers for Disease Control and Prevention 2003).

The effect West Nile virus will have on Spotted Owl populations in British Columbia is difficult to predict. However, given the current low population, any added negative factor could significantly increase the chance of extirpation.

5.6 Human Disturbance

This owl's docile nature and low density suggests that most recreational activities are probably not a threat. Only those activities directed specifically at the birds or very close to active nests are likely to disturb the birds. In southern Utah, Mexican Spotted Owls (*Strix occidentalis lucida*) were unlikely to flush at distances of 24 m or more from hikers (Swarthout and Steidl 2003).

The most likely human disturbance of Spotted Owls in British Columbia is related to activities that produce very loud noises. These sources of potential disturbance might include logging activity, blasting (e.g., during road construction or operation of a rock quarry), or low flight of jets or helicopters. Delaney et al. (1999) reported substantial rates of flushing in response to chainsaw and helicopter noise in close proximity to Mexican Spotted Owls during the nesting and non-nesting seasons in New Mexico. At all distances less than 60 m, chainsaws caused a higher flushing rate than helicopter noise at the same distance. Spotted Owls did not flush when these disturbances occurred more than 105 m away. Measures of Spotted Owl productivity did not differ significantly between control sites and those exposed to chainsaw or helicopter noise, although productivity was slightly lower at noisy sites (Delaney et al. 1999).

6. Habitat Identification

6.1 General Habitat

Spotted Owls use a wide variety of habitat types and forest stand structures throughout their range (USDI 1992). Habitat selection by Spotted Owls is likely influenced by prey abundance and accessibility, availability of nest and roost structures, and thermoregulation and protective cover from predators and inclement weather (Barrows and Barrows 1978; Forsman et al. 1984; Carey et al. 1992; Hanson et al. 1993; Forsman and Giese 1997). In general, the Spotted Owl is closely associated with mature and old coniferous forests that exhibit uneven-aged, multi-layered, multi-specied canopies that contain numerous large trees with broken tops, deformed limbs, and large cavities; numerous large snags; large accumulations of large woody debris; and canopies open enough to allow owls to fly within and beneath (Forsman et al. 1984; Thomas et al. 1990; USDI 1992).

Forest structure is a more reliable variable than actual forest age when defining suitable Spotted Owl habitat. Comparatively younger forests (less than 100 years old) with residual elements (e.g., snags, legacy trees) from previous stands may be used by Spotted Owls, whereas stands of similar age that lack the residual elements appear to be marginal or unsuitable (Buchanan et al. 1999). As a general descriptor, high-quality habitat in British Columbia tends to be in forests older than 140 years and moderate quality habitat occurs in forests 100 to 140 years old (SOMIT 1997a,b).

Within their range on the southwestern British Columbia mainland, Spotted Owls are found in the Coastal Western Hemlock (CWH) and Interior Douglas-fir (IDF) biogeoclimatic zones, and at the lower extent of the Mountain Hemlock (MH) and Engelmann Spruce–Subalpine Fir (ESSF) biogeoclimatic zones (Meidinger and Pojar 1991; SOMIT 1997a). Within this range, Spotted Owl habitat shifts from a wetter maritime ecosystem in the southwest to a drier subarctic ecosystem in the northeast (SOMIT 1997a; See Appendix 5). The elevational limit of suitable Spotted Owl habitat is thought to be below 1370 to 1500 m, depending on geographic location.

Limited research has been done on the habitat requirements of the Spotted Owl in British Columbia. For the most part, habitat definitions for British Columbia have been extrapolated from research conducted in Washington State (SOMIT 1997a).

6.2 Critical Habitat

Under the federal *Species At Risk Act* (SARA), critical habitat means “the habitat that is necessary for the survival or recovery of a listed wildlife species...”(SARA, 2003). Studies to define and describe critical habitat should be conducted consistent with SARA. These studies should include reviewing definitions of suitable habitat (nesting, roosting, foraging, and dispersal), developing habitat supply models, and assessing the amount and spatial configuration of habitat needed to recover the species. Current provincial standards for the Spotted Owl identify a surrogate definition for nesting, roosting, and foraging habitat as coniferous forest stands older than 100 years with dominant trees taller than 19 m, which are found below elevations of 1370 to 1500 m, depending on geographic location (SOMIT 1997a).

The amount and spatial distribution of critical habitat for Spotted Owls have not yet been defined by the SORT. Recommendations regarding the amount and distribution of critical habitat required to recover the population in British Columbia will be included in the Habitat Action Plan. During development of recovery action plans, the SORT has made interim management recommendations designed to retain options for recovery planning (Appendix 1). Although a final and complete definition of critical habitat has not been developed, critical habitat comprises several components, and some of these components are known. Thus, the SORT recommends that a partial definition of critical habitat be employed to approximate the minimum requirements for survival habitat. Survival habitat is defined as the habitat thought to be the minimum amount and distribution needed to maintain the current population size (ROMAN 2003). Given the extremely low number of Spotted Owls left in British Columbia and the risk of extirpation occurring prior to implementation of the recovery action plans, it would be prudent to consider all suitable habitat within currently occupied Long-term Activity Centers (see section 18.1.3) to be critical habitat. Our rationale is that maintaining all known birds will be crucial to recovery

efforts and that suitable habitat in these areas will more than likely be included in the final critical habitat designation. This partial definition of critical habitat should be extended to all known currently occupied sites and any newly discovered sites found during recovery planning. For this purpose, and this purpose only, “currently occupied” is defined as having Spotted Owls (pairs or singles) present during the immediately previous or current breeding season. This definition is premised on the assumption that well-designed, scientifically defensible inventories are conducted.

Until critical habitat is fully defined, for planning and management purposes, habitat should be characterized according to the surrogate definition of suitable habitat (SOMIT 1997 a). If a Spotted Owl is confirmed as occupying a site that does not meet the surrogate suitable habitat definition, the area should be considered suitable Spotted Owl habitat. This partial definition uses best current information and applies the precautionary approach as stated in the 1996 Accord for the Protection of Species at Risk, signed by the provinces (in ROMAN 2003).

6.2.1 Nesting Habitat

Spotted Owls do not build their own nests, but depend on naturally occurring or previously constructed nest sites. Nest sites include broken treetops, tree cavities, abandoned raptor nests, mistletoe “brooms,” and debris accumulations captured in clusters of branches (Forsman et al. 1984; Dawson et al. 1986). Spotted Owl nests are found primarily in large-diameter trees (e.g., more than 50 cm dbh). In Oregon, most nests were in tree cavities (64%), with the remainder on broken-top platforms (Forsman et al. 1984). In Washington, cavities tend to be used for nests west of the crest of the Cascade Range (Forsman and Geise 1997), and platforms and abandoned hawk nests tend to be used more frequently in the drier interior (Buchanan et al. 1993). In British Columbia in 2002, two nests on the east side of the Cascade Range were located in the lower crowns of Douglas-firs; one in an abandoned Northern Goshawk nest and the other in an abandoned nest of either a Red-tailed Hawk or Common Raven (Hobbs 2002).

A variety of trees are used for nesting throughout North America, suggesting, to a certain extent, that the presence of structures (i.e., cavities or platforms) is more important than tree species in nest site selection (Forsman and Geise 1997). In British Columbia, Spotted Owl nests have been found in the cavities of living western redcedar (*Thuja plicata*), western hemlock (*Tsuga heterophylla*), and living and dead Douglas-fir (*Pseudotsuga menziesii*) (C. Lenihan, pers. comm.). Pairs may re-use the same nest each year or use alternate nest sites (Gutiérrez et al. 1995).

6.2.2 Foraging Habitat

Spotted Owl foraging habitat is characterized by high canopy closure and complex forest structures (Gutiérrez et al. 1995). Owls tend to concentrate their foraging in old or mixed-age stands of mature and old trees, but use a wider variety of habitat for foraging than for nesting or roosting (Thomas et al. 1990). Telemetry studies in Oregon and Washington indicate that old forests are superior habitat for Spotted Owl foraging and roosting. Mature stands were found to be less suitable habitat than old forests, young stands provided marginal habitat, and clearcuts were unsuitable habitat (Thomas et al. 1990). Telemetry studies in Oregon suggest that old forest was the only stand type selected for foraging and roosting out of proportion (1.5 times more) to

its general availability in the landscape (Forsman et al. 1984; Carey et al. 1990; Carey et al. 1992).

Although for flying squirrels, the quality of old forest habitat compared with 80-year-old second growth is uncertain in British Columbia (Ransome and Sullivan 2003), Spotted Owls forage mainly in older stands (Hamer et al. 1989; Forsman et al. 1984; Carey et al. 2002). This is likely because of structural characteristics of the stands, such as the multi-storied canopy that provides thermoregulation opportunities and stand openness that makes prey more available.

In Washington, median annual home ranges of Spotted Owl pairs were larger in the moister western forests (3321 ha, 67% of the suitable habitat) than the drier eastern forests (2675 ha, 71% of the suitable habitat; Hanson et al. 1993). Other studies in Washington found home ranges of 2100 to 4000 ha (reviewed by Gutiérrez et al. 1995). Preliminary home range size estimates from telemetry studies in British Columbia appear to be consistent with home range size estimates from Washington (Blackburn and Godwin 2003). The large home ranges used by Spotted Owls may be a response to the low density of the owl's principal prey species and the amount of habitat needed to find sufficient food to sustain the owl (Carey et al. 1992).

6.2.3 Roosting Habitat

Roost sites in Washington and Oregon are mainly (88%) in old-forest stands (Carey et al. 1992). Roosts are typically in areas of relatively dense vegetation with high canopy closure and a multi-layered canopy. During summer, roosts are usually in cool, shady areas on the lower third of slopes (Blakesley et al. 1992). Owls respond to variation in temperature by moving within the canopy to find favourable microclimates (Barrows 1981). Roost site selection varies seasonally, with cooler aspects (north, northeast, and east) favoured in the summer, and warmer aspects (south and southwest) favoured in the spring and fall (Carey et al. 1992). Forsman (Stan Sovern, pers. comm.) found that, in the East Cascades, some owls will move upslope to upper ridge areas in winter to escape (apparently) cold air trapped in drainages.

6.2.4 Dispersal Habitat

Spotted Owls in British Columbia evolved in a landscape that contained large amounts of structurally complex forest habitat. The fact that the landscapes have changed means that landscape-level dispersal conditions have also changed. The quality of dispersal habitat present on the landscape is likely an important factor in the survival of dispersing birds (see section 4.1.3). Clearly, high-quality dispersal conditions will facilitate dispersal, whereas poor conditions may impede the dispersal process. Habitat-related factors that influence the suitability of dispersal conditions include both stand-level (e.g., snag abundance, canopy closure, coarse woody debris) and landscape-level (habitat amount and distribution, topography, presence and types of barriers) attributes. Large non-forested valleys are known to act as barriers to dispersal in western Oregon between the Coastal and Cascade ranges, but dispersal does occur in some broad, forested foothills between the same ranges (Forsman et al. 2002a). Although dispersing owls used a fragmented mosaic of various-aged forests, clearcuts, roads, and non-forested areas (Forsman et al. 2002a), there is no information available on the minimal conditions needed to facilitate dispersal. A number of definitions of dispersal habitat (both stand- and landscape-level) have been developed, but none of these have been evaluated (J. Buchanan, pers. obs.). An

evaluation of a simulated dispersal landscape on private industrial forestlands in Washington indicated a number of conditions that would likely result in ineffective dispersal (WFPB 1996).

6.3 Habitat Protection

In British Columbia, the majority of Spotted Owl habitat is located on lands within Provincial Crown Forests and protected areas. The Spotted Owl Management Plan (SOMP) provides habitat protection for Spotted Owls within the Chilliwack and Squamish forest districts. When SOMP was approved in 1997 (SOMIT 1997a), the extent of the species’ range in the Cascades Forest District was unknown, and therefore, this forest district was not included in the original plan.

Within the Chilliwack and Squamish forest districts, approximately 1 170 000 ha currently exist as forested area capable of supporting Spotted Owls (MSRM Database, 2003). Capable forest includes both currently suitable habitat and unsuitable habitat that could grow over time into suitable habitat conditions. Of the total currently capable forested area, approximately 33% falls within areas under SOMP. This includes 16% (184 000 ha) as protected areas; 13% (152 700 ha) as Crown Forests (in Resource Management Zones – RMZs); and 4% (46 200 ha) as Greater Vancouver Regional District (GVRD) watersheds (Figure 4). Collectively, these three jurisdictional areas are referred to as Special Resource Management Zones (SRMZs) under SOMP. Within protected areas and GVRD, forests are typically managed under SOMP to maintain 100% of the area as suitable habitat over the long term. Within 15 of 17 RMZs (141 100 ha) on Crown Forests, forests are managed under SOMP to maintain 67% of the area as suitable habitat over the long term. The other two RMZs (about 11 600 ha) are not currently managed for Spotted Owls, but are to be considered in the future for full inclusion under SOMP. Within significant portions of these three jurisdictional areas, the habitat retention targets have not been attained and will require many more decades of forest growth.

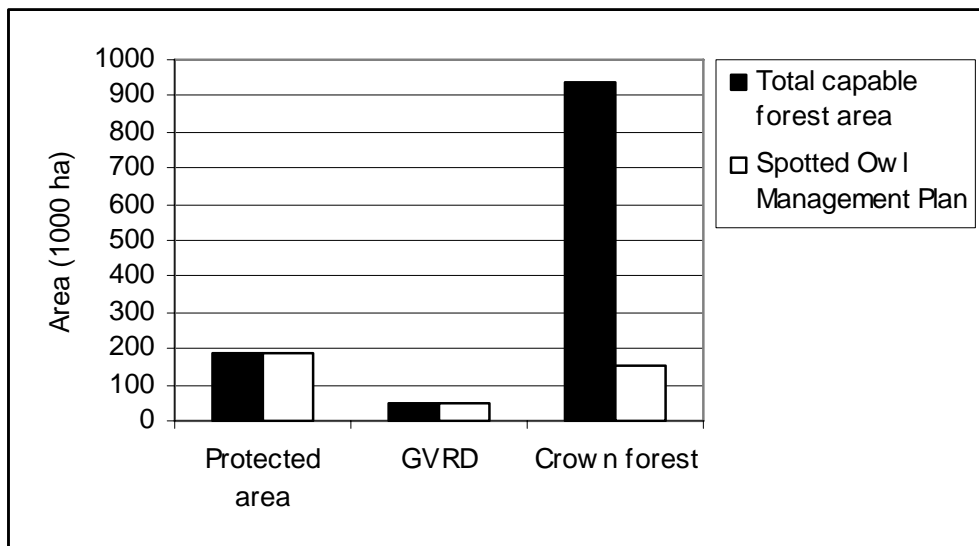


Figure 4. Total and actual capable forest area managed under the Spotted Owl Management Plan within the three land jurisdictions in the Chilliwack and Squamish forest districts.

Approximately 939 800 ha of currently capable forested area in the Chilliwack and Squamish forest districts falls within Crown Forests. Of this, 477 300 ha (51%) is considered as “contributing” to the Timber Harvesting Land Base (THLB) on which timber resource extractions may occur. RMZs for Spotted Owls overlap 81 800 ha (17%) of this total “contributing” THLB, of which 36 900 ha (45%) falls within Forest Management Area under SOMP where heavy Volume Removal may eventually occur (clearcuts with some structural retention). The other 44 900 ha (55%) of “contributing” THLB falls within Long-Term Owl Habitat Areas under SOMP where Light Volume Removal (about one-third volume) may occur to create and/or enhance suitable habitat. On the remaining THLB outside of RMZs, forests are managed to integrate resource extraction with other resource values (e.g., Old Growth Management Areas) that will benefit Spotted Owls mostly by providing dispersal habitat.

Under SOMP, the provincial government decided that Spotted Owls found after June 1995 would receive no formal protection unless they were located within SRMZs. Between 1992 and 2002, at least 64 occupied Spotted Owl territories were discovered (Table 1). Thirty-seven (58%) of these fall within the protection of SRMZs. Eight of them (that were found before June 1995) are called Matrix Activity Centres (MACs) and are managed to be phased out over the next 50 years at a rate similar to habitat recruitment within SRMZs. These MACs are managed to offset predicted timber supply and forestry employment impacts. Since 1995, 19 new Spotted Owl territories have been discovered outside of SRMZs within the Chilliwack, Squamish, and Cascades forest districts. These 19 territories remain unprotected. Of the 64 Spotted Owl territories discovered since 1992, the recent population decline suggests that one-third, or possibly fewer, are thought to be currently occupied by the species.

Table 1. Known Spotted Owl locations in British Columbia occupied at least once between 1992 and 2002. (Blackburn and Godwin 2003)

Known Owl Locations	Squamish Forest District	Chilliwack Forest District	Cascade Forest District	Total
SRMZs	10	27	0	37
MACs	2	6	0	8
Not Managed by SOMP	2	9	8	19
Total	14	42	8	64

6.4 Habitat Trends

It is estimated that approximately 67% (about 881 000 ha) of the total historic capable forested areas (about 1.32 million ha) occurred historically as suitable habitat (forests older than 100 years) in the Chilliwack and Squamish forest districts (Blackburn and Godwin 2003). Since the mid-1800s, timber harvesting for urbanization, agriculture, and resource extraction has occurred in the Chilliwack and Squamish forest districts, with almost the entire area of former forest lands in the lower Fraser River Valley converted to non-forest uses (approximately 150,000 ha). At present, it is estimated that about 639 000 ha (48% of total historic capable forested area) of suitable habitat currently exists within the two forest districts. This represents a 242 000 ha (28%) reduction in the amount of suitable habitat thought to occur historically, of which about one-third of this has been permanently lost from the lower Fraser River Valley (Blackburn and Godwin 2003). The overall impact of habitat loss has been somewhat offset by the recruitment of suitable habitat from maturing young forests (Figure 5).

In the future, the amount of suitable habitat is predicted to stabilize at about 565 000 ha (43% of total historic capable forested area) within the two forest districts. In comparison to historic levels, the future level of suitable habitat represents a 316 000 ha (36%) decline in the total amount of habitat once thought to be available to the Spotted Owl (Blackburn and Godwin 2003). Although the amount of total habitat will continue to decline, habitats within SRMZs and some protected areas will increase over time and could provide better habitat conditions for Spotted Owls than is currently available.

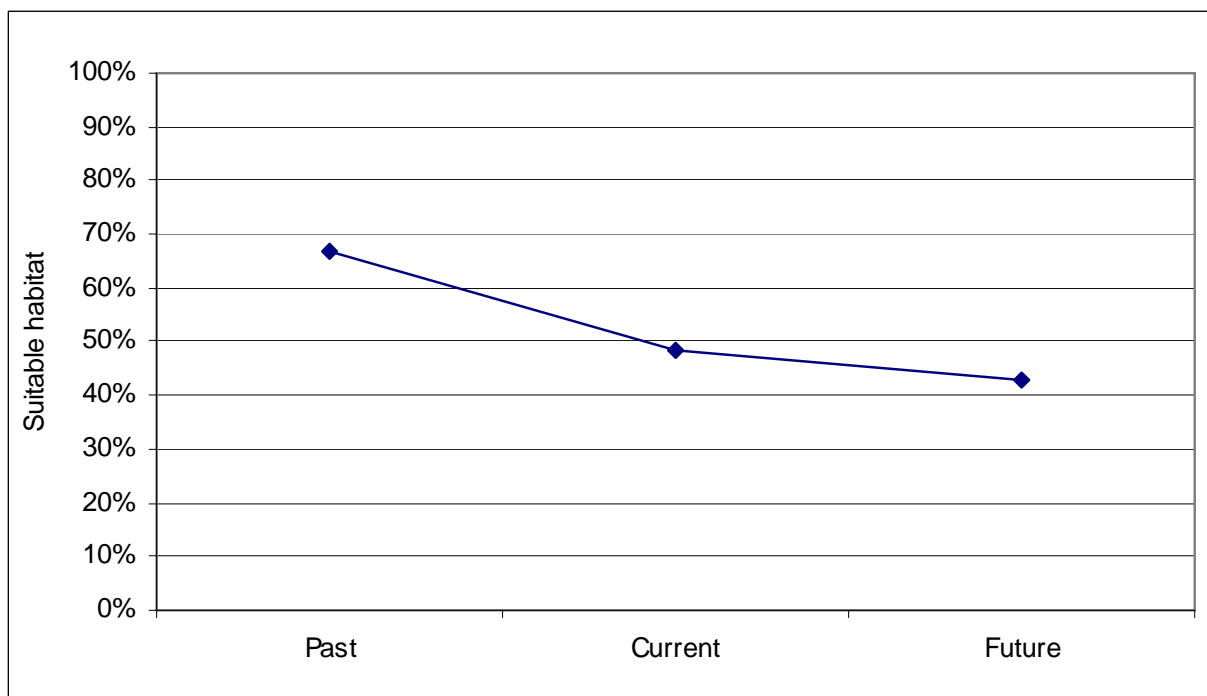


Figure 5. Proportion of suitable habitat (forest older than 100 years) in the Chilliwack and Squamish forest districts. (Blackburn and Godwin 2003)

6.5 Recovery Habitat

Recovery habitat is defined as the habitat required by a species to achieve and sustain a viable population (ROMAN 2003). The recovery goal for the Spotted Owl is to provide enough suitable habitat, spatially distributed in a way that it can support and sustain a minimum of 250 mature owls throughout its natural range (see section 13). For the Spotted Owl, recovery habitat includes both existing suitable habitat and potential habitat into which the species could recolonize. In addition, it includes dispersal habitat necessary to enable successful dispersal and establishment of young birds to new or vacant habitats.

The total amount and distribution of recovery habitat needed to meet the recovery goals is currently unknown, but its delineation will be one of the first priorities of the SORT in their development of a Habitat Action Plan. Theoretically, using 3200 ha per breeding territory and assuming that 250 mature owls is equivalent to 125 breeding pairs, about 400 000 ha of suitable habitat would be required. The existing Spotted Owl Management Plan currently manages 363 000 ha of habitat. It may appear that adding protection for an additional 37 000 ha outside of the current plan's coverage would be enough to meet the goal and fulfill the requirement for recovery habitat. However, this is a gross oversimplification because the number of individual adults cannot accurately be determined by doubling the number of breeding pairs, and the amount of habitat required for recovery cannot simply be a total number of hectares, but must address the issues of connectivity, fragmentation, and elevational constraints across the range of the owl. As well, numbers of owls may be influenced by percentages of habitat available in the landscape and by percentage of territory overlap between neighbouring owls. Furthermore, of the 363 000 ha in the current plan, only about half of it is currently suitable, with recruitment and enhancement of second growth stands required to increase this amount. The existing management plan (SOMIT 1997a) suggests that the amount of suitable habitat would not begin to increase for several decades, after which it is hoped that numbers of Spotted Owls would also begin to recover.

6.6 Survival Habitat

Survival habitat is defined as the habitat thought to be the minimum amount and distribution needed to maintain the current population size (ROMAN 2003). The minimum amount and distribution of habitat required to maintain the current estimated population of less than 33 pairs is unknown at this time, but its delineation will be one of the first priorities of the SORT in their development of a Habitat Action Plan.

Although 363 000 ha of forest have been identified for management of Spotted Owls (of which at least 50% is still suitable) and other additional areas of suitable habitat exist outside these areas, the population continues to decline precipitously toward extirpation (Blackburn et al. 2002). So, although it may appear that sufficient habitat exists to accommodate the current population of owls, it is likely that the fragmentation of habitats and sparse distribution of potential breeding owls, as well as other biological limitations (section 4) and threats (section 5), have contributed to the population decline. The identification of survival habitat will need to consider these threats and limitations to the population. Stopping the population decline will likely require a combination of survival habitat conservation and other recovery actions.

6.7 Identification of Activities Likely to Result in Destruction of Critical Habitat

In general, suitable habitat will continue to be lost or degraded through human activities such as logging, mining, other resource development, urban and rural development, and development of transportation and utility transmission corridors, as well as by natural disturbances such as major forest fires and insect outbreaks.

7. Ecological Role

The Spotted Owl is a high-level predator with specialized habitat requirements. It is at or near the top of the food chain in some late-successional and old coniferous forest ecosystems on the west coast of North America. The fate of threatened or endangered forest species can be thought of as indicators of ecosystem diversity and function (MELP 1998). When human activities threaten the viability of one species, as in the case of the Spotted Owl, it may indicate that ecosystems are being altered and that other species may be affected by the same activities. The Spotted Owl can also be viewed as an umbrella species, much like other wildlife that have large home ranges (e.g., Grizzly Bear, *Ursus arctos horribilis*, and Northern Goshawk). If sufficient habitat for these species can be conserved, then habitat for a multitude of species with smaller home ranges and similar habitat requirements can also be achieved.

If the Spotted Owl becomes extirpated, the consequences for ecosystem function and the scale of changes that may occur is unknown.

8. Importance to People

The Spotted Owl is among the most studied bird species in the world because of its association with commercially valuable old coniferous forests (Gutiérrez et al. 1995). It has become a high-profile species with the public and the media in Canada and the United States because it is the focus of much controversy between those concerned with the health of old forest ecosystems and those who want economic development of those forests.

9. Anticipated Conflicts or Challenges

Spotted Owls in North America face a number of daunting challenges to recovery. Populations continue to decline on both sides of the border despite efforts to conserve habitat.

Loss and fragmentation of habitat; predation; competition; low reproductive output, juvenile survival and dispersal success; and stochastic environmental, demographic, and genetic events threaten the persistence of the species in British Columbia. These threats are exacerbated by its current small population size and isolation from the larger populations to the south in the United States.

The primary short-term challenge is to stop the population decline and prevent extirpation. Difficulties and obstacles include the current rapid population decline of the owls, the time needed for recruitment of suitable habitat for connectivity, and uncertainties around competitors

and the genetic viability of the population. Recovery will continue to face challenges because the removal of some threats (section 5) and improvements in biologically limiting factors (section 4) may be extremely difficult.

Many of the solutions require further research and, in addition to those mentioned above, there are additional challenges to implementing research programs on Spotted Owls in British Columbia. These include logistics of investigating a nocturnal animal capable of flying long distances over inaccessible terrain, high between-year variation in biological processes, large time lag in owl population responses to some habitat management, and inherent ethical constraints associated with working intensively with an endangered species (Kurz and Greenough 1996). In addition, finding ways to fund these initiatives is a major ongoing problem.

Due to its dependence on commercially valuable old forests, a long-term challenge is to reconcile the habitat needs of the Spotted Owl with the economic impacts of recovery actions. For example, the cessation or slowing of forest harvesting of suitable habitat within the range of the Spotted Owl would have immediate economic impacts to companies, communities, and individuals dependent on the resource. Timber harvesting is the primary generator of jobs and revenue within some parts of the range of the Spotted Owl in British Columbia. On the other hand, a failure to recover the species could cause possible trade sanctions on wood products by the United States (e.g., use of the Pelly Amendment) and international boycotts of wood products led by environmental groups who are concerned about the declining status of Spotted Owls in British Columbia. Such actions could have longer term economic impacts in the province.

The conservation of the Spotted Owl involves many challenges because it is not simply a biological issue, but a more complex one involving myriad biological, political, social, and economic factors. The impacts of potential recovery actions may range from the costs of intensive population management to constraints on resource extraction in specific areas. Delaying recovery actions will reduce recovery options and push the species closer to extirpation, which will likely increase the costs of recovery. A more detailed account of potential socio-economic considerations is given in section 13.

10. Knowledge Gaps

A draft list of research topics (see Appendix 2) has been prepared by members of the SORT. These topics include research on demography, population trends, population modeling, genetics, competition, habitat maintenance, habitat enhancement, and relationships with prey. The SORT needs to set priorities for research topics based on the urgency of the need for information for recovery purposes. Challenges associated with implementing these research programs for Spotted Owls are referenced in section 9.

10.1 Habitat Requirements

Very little habitat research has been conducted to-date for Spotted Owls in British Columbia. Research conducted in the United States has been used as a surrogate. Although this is likely a legitimate exercise, especially using data from Washington where habitats are most similar, the complete applicability to British Columbia can always be questioned. It would be useful to

acquire local data to better define nesting, roosting, and dispersal habitat in the province, and to define how they relate to recovery planning. Some of this work is necessary to enable us to effectively define survival, recovery, and critical habitats, and to better understand how fragmentation affects the quality of these habitats for Spotted Owls. It will be important to model this information on both spatial and temporal scales to plan for the owl's recovery needs.

10.2 Inventory Requirements

In British Columbia, known Spotted Owl locations have been surveyed relatively intensively during the last 10 years. From 1992 to 2002, more than 150 potential locations thought to be capable of supporting owls were surveyed with various intensities to assess the current range, distribution, and abundance of Spotted Owls. Spotted Owls have been detected at 65 locations in the province, 40 of which were used to assess the population trend since 1992 (Blackburn et al. 2002). Most of the survey effort was performed in the mid 1990s, and most locations have not been revisited for 5 years or more. Other potential habitats remain unsurveyed in the province.

Further inventory effort for Spotted Owls is deemed the highest priority among recovery actions. A comprehensive inventory program is needed to find and confirm the current population estimate of 33 breeding pairs, to determine the full extent of their range, to assess the population's reproductive potential, and to support potential augmentation efforts. Only 15 of the 64 known locations (Table 1) are currently known to be active. Breeding status is unknown for most of them.

10.3 Biological / Ecological Research Requirements

Relatively little research has been conducted on the ecology of Spotted Owls in British Columbia. Most background information reported is from studies conducted in the United States. Of particular immediate importance is to conduct further research on the main prey species, the Northern Flying Squirrel, because early efforts by Ransome and Sullivan (2003) suggest a possible decline in flying squirrel numbers in some Vancouver watersheds that appears to coincide with declines in both Spotted and Barred owls (Blackburn et al. 2002).

11. Ecological and Technical Feasibility of Species Recovery

A number of key policies require that the SORT assess the biological and technical feasibility of recovering the Northern Spotted Owl in British Columbia:

- The National Framework for the Conservation of Species at Risk includes the goal to "... prevent any species from becoming extinct as a consequence of human activities."
- The Accord for the Protection of Species at Risk states that a "lack of full scientific certainty must not be used as a reason to delay measures to avoid or minimize threats to a species at risk."

- The RENEW Recovery Handbook specifies use of a precautionary approach, where “... species for which recovery feasibility is unknown would be considered recoverable until proven otherwise.”

Accordingly, the SORT has evaluated the feasibility of recovering the Northern Spotted Owl in British Columbia and has determined that recovery is biologically and technically feasible.

Based on the examination of potential recovery actions, the SORT believes there is sufficient suitable habitat to support the existing small but endangered population of Spotted Owls until the recovery plan can be implemented. Some of these recovery actions (e.g., definition and protection of critical habitat) should be implemented as soon as possible, and should address the factors that contributed to the Spotted Owl’s current population status to reduce the likelihood of extirpation. Over time, additional suitable habitat could be recruited in a spatial distribution that could enhance the population’s chances of reaching the recovery goal. However, early attempts at modeling (Blackburn, pers comm.) suggest that, while feasible, meeting the recovery goal of 250 adult owls may require some level of population augmentation in addition to improved habitat conservation. Moreover, it should be made clear that reaching the recovery goal will be a long-term project, likely measured by decades or even longer, rather than years, and that the recovery goal itself needs to be re-evaluated every five years. Ongoing modeling may refine the timeframe that this might entail.

Although the SORT believes that recovery is biologically feasible, it is recognized that Spotted Owls face several significant logistical, societal and economic challenges to recovery, and that even if all these challenges are met, there is no guarantee that recovery will occur. The likelihood that the Spotted Owl will recover naturally (without human intervention) to numbers sufficient to down-list the species is considered to be extremely low, and therefore, active human intervention is recommended. Population augmentation measures could have a major effect on the rate of recovery. Challenges to recovery include the loss of habitat, the effects of resource competition with Barred Owls, the potential effects of habitat fragmentation on dispersal success, and demographic factors that are especially critical when populations are small (e.g., low reproductive and juvenile survival rates). Most importantly, populations continue to decline on both sides of the Canada-United States border and the current small population size in British Columbia is extremely susceptible to stochastic environmental, demographic, and genetic events (see sections 4 and 5). Recovery actions need to be undertaken in several areas; the time available to stabilize populations is short, and costs could be significant.

While the task at hand seems daunting, there are several examples of species at risk being successfully brought back from the brink of extinction or extirpation. The Whooping Crane and California Condor populations were both reduced to a few dozen individuals. Intensive recovery efforts, including captive breeding and release, have succeeded to reverse these population trends and increase their chances of recovery. The Vancouver Island Marmot is currently on the brink of extinction and major recovery efforts including intensive research, captive breeding, predator control and habitat management are being used. The Peregrine Falcon (subspecies *Falco peregrinus anatum*) was once extirpated from much of its world-wide range due to exposure to organochlorine contaminants. Due to bans on the use of these chemicals and the use of captive-breeding and release techniques, it has now been down-listed or de-listed in most jurisdictions. The Burrowing Owl is declining throughout much of its North American range and is considered

Endangered in Canada. It was extirpated from British Columbia, but has now regained a foothold thanks to an ongoing intensive captive breeding, controlled release and habitat stewardship program. This program has enabled the species to breed in the province while habitat research and management efforts continue to search for ways to accommodate a naturally sustaining population. The North American Waterfowl Management Plan is an excellent example of a successful major habitat conservation initiative that focuses on increasing and improving wetland habitats across North America to return waterfowl populations back to the levels of the 1970s. This involved habitat creation and restoration efforts on a massive scale. All these examples point out that recovery of wildlife populations is feasible as long as the species is extant and suitable habitat exists or can be created, and that success is dependent on having dedicated agencies and individuals collectively address the factors causing the decline.

In the sections that follow, we outline some of the issues that appear to most strongly influence the health of Spotted Owl populations in British Columbia. We briefly describe the issues and discuss some of the management activities that might be used to address them. These descriptions address the general feasibility of the noted activity, but, as noted above, the implementation of the activities, singularly or in combination, does not guarantee success. Importantly, detailed evaluation and analysis will be required to identify and prioritize the most appropriate activities and the most effective means for successful implementation. These assessments and analyses will contribute to, or be identified in, the recovery action plans.

- **Demography:**

Northern Spotted Owls are long-lived birds, but reproductive output is low relative to most other species of birds, juvenile survival to breeding age is low, and in British Columbia populations are very small and birds are becoming increasingly spatially isolated. Because of these, factors it seems possible that a “natural” recovery would take longer and contain more risk than a recovery that included some form of augmentation. For this reason, various forms of augmentation were identified as possible means to reduce this risk and expedite recovery. These augmentation activities included holding juveniles in captivity over the winter to reduce winter mortality, tracking juveniles over winter to check their condition and perhaps supplement their diets, and captive breeding and subsequent release into the wild. These activities are all feasible, but if implemented, would need to be conducted in concert with efforts to address the factors that currently limit the population. Some of these recovery actions would likely be most effective in the near-term, when the population is most vulnerable to extirpation or delayed recovery due to its small size and uneven distribution.

- **Habitat:**

There appears to be a sufficient amount of suitable habitat already protected to support the existing small population of Spotted Owls. However, the current amount and spatial distribution of protected habitat is considered unlikely to be sufficient to recover the population. Protection of some additional owl habitat and recruitment of new habitat to infill between tracts or patches of existing suitable habitat is required to enable recovery, to foster successful dispersal and reduce competitive pressures. Recruitment of habitat would be a long term process because second-growth stands in British Columbia need to be at least 100

years old, and probably 120 years or older, before they become suitable for Northern Spotted Owls (SOMIT 1997a,b).

The recovery goal of 250 adult owls could theoretically be met by creating 125 territories with each occupied by a potential breeding pair. At roughly 3200 ha per territory, this scenario could be realized by managing 400,000 ha for the species. The current Spotted Owl Management Plan includes 363,000 ha of habitat at various levels of protection. Suitable habitat exists outside the plan area that could be incorporated to increase the amount of area managed for the owl. In addition, territory overlap of up to 12% has been recorded for the species, so careful planning of the spatial distribution of habitat could reduce the total amount needed to meet the recovery goal. Therefore, it seems possible to attain the amount of habitat required. Although these are theoretical values, continuing work on habitat models may help identify numbers of pairs and territories needed to facilitate recovery. The most difficult aspect will be to create the spatial distribution of habitat best suited for population recovery. Recruiting and conserving sufficient amounts of suitable habitat for maintenance and recovery will continue to be the most contentious management issue. The SORT is developing a spatially explicit habitat model that should help us address these issues, as well as related issues including habitat function, habitat quality, and the importance of connectivity both within British Columbia's population and between our population and those in the United States.

- **Barred Owls and other threats:**

Barred Owls first entered British Columbia in the 1940s (Campbell et al, 1990). There is concern that wherever the two species' ranges overlap, the Barred Owl is a significant competitor with the Spotted Owl. Excluding Barred Owls from Northern Spotted Owl habitat in the short-term would require direct and repeated removal of Barred Owls. While this is technically feasible, and existing provincial policy enables the removal of wildlife predators in order to facilitate recovery of endangered species, it may not be publicly acceptable except on small scale, site-specific projects. As the relationship of these two species is not clearly understood, we cannot conclude that the Barred Owl will prevent the feasibility of recovery for the Spotted Owl.

Threats posed by global warming may be largely beyond human control. Changes imposed on British Columbia's forests may improve Spotted Owl habitat in some areas and decrease it in others. Overall, although changes in the forest are anticipated, they are not expected to diminish the feasibility of recovery because the Spotted Owl is distributed across a broad geographical and ecological range.

The threat posed by West Nile Virus (WNV) is potentially great but at this time is unknown and cannot likely be effectively mitigated. The effectiveness of vaccines for species like the Spotted Owl has not been demonstrated, and the ability to locate and capture all owls to apply the vaccine on an annual basis would be a daunting task. Currently, it is not possible to estimate the impact of WNV on the feasibility of recovery for the spotted owl.

After considering the factors above, the SORT concludes that the following actions are all biologically and technically feasible, and collectively have the potential to benefit Spotted Owls and thus increase the size of the population:

- recruit new habitat to connect home ranges
- increase or reconfigure the amount of protected habitat in landscapes
- enhance the development of currently unsuitable or less suitable habitat;
- translocate Spotted Owls into more suitable habitat, and to increase local populations;
- provide supplemental prey to juvenile owls over winter to increase survival and recruitment
- possibly overwinter juveniles and establish a captive breeding program; and
- if and where necessary, implement other actions that address threats of predation, competition, and disease.

In summary, Northern Spotted Owls are capable of persisting and recovering in British Columbia given the right circumstances. Concerns about recovery potential are not about the basic biology of the owl, but mainly reflect the small population size, the current effectiveness of dispersal habitat, the time frame to effectively implement habitat improvements, and the difficulty in removing or reducing threats of competition from Barred Owls. Intensive population management may be needed to bridge the gap until these factors are adequately addressed.

In this context, and following the guidance of the policy directives stated at the beginning of this section, the SORT deems it biologically and technically feasible to recover the Spotted Owl. It should be noted, however, that substantial recovery efforts and financial resources are needed immediately. Until action is taken and success demonstrated, options for recovery diminish and there remains a high risk of extirpation.

12. Recommended Approach / Scale for Recovery

The recommended recovery approach will focus on preventing further population declines, conserving sufficient habitat over the short and long term to sustain the population, and increasing population size as soon as possible to more stable, resilient levels. Recovery of the Spotted Owl requires an integrated approach at a number of spatial scales. This is warranted because Spotted Owls use large areas of the landscape while requiring specific habitat attributes at the stand level. The 1997, the Spotted Owl Management Plan (SOMIT 1997a, b) was developed at a subregional scale (1:100 000) to address management across the owl's entire known range at that time. Since then, the known range has expanded to include parts of the Cascades Forest District. At the landscape level (1:20 000), management units under the SOMP are based on territories and clusters of territories to address both the territorial requirements of breeding pairs and the dispersal requirements of their young. Habitat enhancement efforts are focused at the stand level. During the recovery process, all three management spatial scales—subregional, landscape, and stand—need to be considered simultaneously and integrated to ensure that the owls' needs are met.

13. Socio-economic Considerations

The SORT recognizes that the RENEW Recovery Manual (ROMAN 2003) does not require a detailed socio-economic analysis to be incorporated in the recovery strategy, as the assessment of recovery feasibility is to be based entirely on biological, not economical issues. Rather, the socio-economic analyses are to be conducted during, and incorporated into, the recovery action plans after the biological and technical feasibility of recovery has been determined in the recovery strategy. However, due to the significance of the potential costs and impacts of recovery actions, or lack thereof, for this species in British Columbia, it was felt prudent to incorporate a strategic-level description of the scale, scope and location of the impacts. It will be equally important, but likely more difficult, to assess the value of the benefits of recovery, both in economic terms and in terms of not losing a native species. The following sections are an attempt to outline some of the aspects of socio-economic costs and benefits that will apply to recovery of the Spotted Owl in British Columbia. These will be used to guide more detailed socio-economic analysis as the SORT moves on to identifying and assessing potential recovery actions.

A) COSTS

The costs of recovery can be broken into various categories including the costs of increased habitat protection, the costs of establishing and implementing population augmentation activities, the costs for activities targeted at improving survival and recruitment, and the costs associated with conducting needed inventory and research.

Increased Habitat Protection

Habitat protection is a key issue throughout the species' range. The Spotted Owl has no chance of recovery if sufficient suitable habitat is not conserved in the appropriate spatial distribution throughout its range. Some habitat within its range is considered non-recoverable. This is largely limited to urban and rural habitat in the Lower Mainland, much of which is under private or municipal ownership and cannot feasibly be converted to suitable Spotted Owl habitat. One major exception to this is the Capilano, Seymour and Coquitlam watersheds of the Greater Vancouver Regional District. These are large areas of forested habitat north of the City of Vancouver that are managed to protect the Greater Vancouver water supply. They are already included within the existing Spotted Owl Management Plan (SOMP) and do not require additional protection.

As the Spotted Owl requires large areas of old-growth forest habitat for breeding, foraging and dispersal, it is anticipated that the biggest impact of increased habitat protection may be in the forest sector, including the British Columbia Timber Sales Program, through impacts on the timber harvesting land base (THLB) and timber supply. Potential THLB impacts will be limited to the parts of the Squamish, Chilliwack and Cascade Forest Districts (FDs) within the species' range. It is important to note that the impacts to the forest sector, in terms of total additional hectares set aside, may not be as great as anticipated. There are already 363,000 ha managed for Spotted Owls within the Squamish and Chilliwack FDs under the existing SOMP. There is no habitat set aside in the Lillooet area of the Cascades FD, which currently holds several active territories. However, the draft Land and Resource Management Plan (LRMP) for the Lillooet

area does contain an allotment of habitat to be dedicated to Spotted Owl management that is sufficient to incorporate most of these active territories. Theoretically, if the LRMP habitat budget is added to what already exists in SOMP, depending on the amount of overlap that can be incorporated through clustering of adjacent territories, there may not be a need to add much more total area to have enough territory to meet the recovery strategy's goal of 250 adults owls (assuming this is roughly equal to 125 pairs/territories). However, the existing network of conservation areas is quite fragmented, and the final Habitat Action Plan may require the spatial arrangement of these areas be reconfigured, including the establishment of connectivity corridors to allow for better dispersal between them, and to the U.S. populations to the south. Ongoing modeling efforts should help determine how best to arrange the conservation areas on the landscape and how best to accomplish this over time. These modeling efforts could also assist to capture and compare timber impacts of different landscape scenarios. The need for some additional protection is likely in the short term to ensure protection of survival habitat (areas that contain known occupied sites), but other changes could be incorporated/recruited over a longer time frame.

Other development activities that may be impacted to a lesser extent include mining operations, hydro developments (e.g., powerlines, dams), recreational developments (e.g., ski hill expansions), and urban/rural developments (e.g., roads, housing, agricultural expansion). In addition, much of the range of the Spotted Owl is under some form of First Nations land claim and some Indian Reserves may overlap suitable habitat. It is unknown how resolution of First Nations interests may impact on habitat protection measures

Population Augmentation

Although habitat protection is required to enable recovery, population augmentation could have a significant impact on the level of recovery attained and the rate at which it occurs. Given the extremely low population estimates currently available for British Columbia, some level of population augmentation may be necessary to prevent extirpation in the short term. Augmentation programs could be applied anywhere in the species range, but would be focused most on areas where populations appear to have “winked out”, or where single birds are believed to be persevering alone with little chance of finding a mate.

As stated earlier in this report, three approaches to augmentation are considered feasible. These three approaches each have their own costs. A brief summary of the scope of the items to be considered for socio-economic assessment include:

- Capture/Overwinter/Release: Costs associated with capturing birds, building pens, providing food and care over winter, and release/monitor program in spring.
- Translocation: Costs associated with capturing, translocating and monitoring single birds to attempt to create breeding pairs.
- Captive-breeding: Costs associated with capturing birds and building long-term pens suitable for captive breeding, as well as associated release/monitoring programs for young produced.

In addition, before proceeding with these approaches, strategies that assess available methodologies, past experience, people and materials required, and chances of success should be prepared. People involved in these programs may include SORT members, MoE staff, and contractors. Partnerships would need to be made with private facilities for breeding and housing birds. Some of these actions would require long term commitments to facilities, staff and funding.

Increased Survival

Another approach is to try to ensure survival of existing birds and increase the rate of recovery of the population is to attempt to increase their survival in the wild. The two methods suggested in the recovery strategy include predator/competitor control and winter feeding. These approaches could be applied to existing wild birds wherever they are known to exist, and/or to any areas where owls have been translocated or introduced.

Predator/competitor control may prove controversial, but is technically feasible, and may be justifiable in areas where considerable effort and cost has already been spent on introductions and translocations. It would likely be neither economically feasible, nor socially acceptable, to embark on a long-term control program at all territories throughout the Spotted Owl's range. Costs associated with this activity would be those associated with hiring people capable and willing to locate and destroy predatory and competing species from designated Spotted Owl areas.

Winter feeding of juveniles to help them survive their first winter (known to be the period of highest mortality) would require locating young birds and applying transmitters to them in order to be able to track them through the winter to occasionally provide them with food. Costs would include staff/contractor time, costs of radio-transmitters, helicopter rental, and costs of acquiring suitable food items. If successful, this could prove to be a most cost-effective approach.

Research/Inventory

Research and inventory are needed to ensure that the recovery actions recommended are based on the best science available and have the greatest likelihood of attaining the recovery goal. Modeling is required to help determine the best spatial arrangement of habitat on the landscape and what demographic factors are the highest priorities to work on. Research will help us to better understand the relationships between the owls, their habitat, their prey and their competitors which will result in better management approaches to address these issues. Inventory is needed to find and monitor the owls and their nests sites for habitat protection, population augmentation, and increased survival approaches identified above, as well as to evaluate the success of recovery efforts over time. The greater funding available for research and inventory, the better the science based results will be. Appendix 2 contains a preliminary list of research topics. Research and inventory could occur anywhere throughout the owl's range and would involve SORT members, government and industry scientists, academia and contractors. Partnerships, creation of a Spotted Owl recovery fund, and use of existing funding agencies could help share the costs.

B) BENEFITS

It will likely be much more difficult to assess the economic value and benefits of recovering the Spotted Owl than it will be to assess the costs. This is partly because some of the benefits entail reducing the likelihood that a potential punitive action could be taken, and it is very difficult to determine the value of something not occurring. It is also partly because it is very difficult to put an economic value on an esoteric concept such as preventing extirpation of a species, though some attempts have been made in this regard. Nonetheless, it is entirely possible that the long term benefits of recovery of a species could outweigh the short term costs. Some of the benefits that need to be considered include:

- **Prevention of extirpation:** The public in Canada have expressed strong support for protection of species at risk as well as a willingness to bear some cost such efforts, so there is an inherent value in doing this. In addition, costs of recovery increase the more at-risk a species becomes. While costs for recovery of the Spotted Owl in Canada at its present status are high, they will be much higher if the species becomes extirpated as it will then necessarily have to include captive-breeding, translocation and release programs that will be more expensive than working with an extant species.
- **Provision of ecological services:** Habitat suitable for spotted owls also generates potential benefits in the form of carbon benefits and other ecological services. While putting a dollar value on these values is difficult, the socio-economic analysis at the action planning stage will discuss these potential benefits in more detail.
- **Protection of other species that require similar habitat:** Due to its requirement for large areas of old-growth forests, the Spotted Owl can be considered an umbrella species for other species within its range that have similar requirements. Therefore, habitat protection measures for the Spotted Owl could overlap with the amounts needed for other species. Some examples may include Northern Goshawks, Tailed Frogs (*ascaphus truei*), ungulate winter range, Marbled Murrelets (*brachyramphus marmoratus*), Northern Flying Squirrels and numerous plant communities and invertebrate species.
- **Reduction of long-term recovery costs:** The cost of planning for and implementing recovery of species-at risk programs is expensive. The provincial and federal governments, along with other stakeholders are putting a lot of funds into recovery efforts for the Spotted Owl in British Columbia. Generally speaking, the more at-risk a species becomes, the more expensive its recovery will be. Extirpation of the Spotted Owl from British Columbia would not end the province's responsibility for its recovery. As long as habitat remains or is recoverable, and the species exists somewhere in its range, recovery is still potentially feasible; however, the costs would be significantly higher. The sooner a recovery plan for the Spotted Owl can be implemented and tested, the sooner that real progress towards recovery can be made, and the sooner that the costs for recovering this species may decrease. In addition, due to the relatively large habitat requirements of this species, this can also be seen as a cost avoidance in terms of other recovery programs for overlapping species at risk that will indirectly obtain protection.
- **Assistance with International Markets:** Taking concrete steps towards the recovery of the Spotted Owl would enable the provincial government to internationally market-message this

as an example of best available science being used to provide sound forest and species-at-risk management in British Columbia.

- **Avoidance of Environmental Non-Government Organization (ENGO) lawsuits and other actions:** British Columbia has already entered into, and lost, lawsuits with ENGO's regarding protection of Spotted Owl habitat. It has also suffered from environmental action opposing timber extraction locally and internationally resulting in associated costs to industry and government. Without appropriate protection measures and actions for such a high profile species as the Spotted Owl, this is likely to increase and could become quite costly. Creating and implementing a scientifically sound recovery plan could avoid these costs and the repercussions associated with them.
- **Support for industry certification:** The need for industry certification is a direct result of the success environmental boycotts and actions. Receiving certification is now a major economic benefit to timber companies, which in turn provides an economic benefit to government. Industry certification is based on an ability to show responsible environmental stewardship. In the case of lands within the range of the Spotted Owl, this can be best demonstrated by preparing and implementing a scientifically sound recovery plan. As an additional benefit, having and following such a plan for the Spotted Owl will provide more certainty for timber companies operating in the species' range.
- **Benefits for tourism:** Tourism is a major revenue producer for British Columbia and to a large part this is due to our image as a "supernatural" location. This image could be tarnished internationally if we extirpate the Spotted Owl without making every effort possible to prevent it, and this could have a negative impact on the tourist industry and the benefits the government accrues from it.
- **Support for British Columbia's international reputation/credibility:** Directly related to the item on tourism is the effect that losing such a high profile species could have on the reputation of British Columbia's government within Canada and abroad, and the potential economic ramifications that could come from this. ENGO's have been publicly stating their concerns that the Spotted Owl will soon be extirpated from the province due to the governments lack of action to protect and recover it. Regardless of the final cause, if this occurs, it will give greater credibility to ENGOs and less to the government for all future endangered species management issues, and this could have considerable economic consequences for the government, and for the province's industries. This could be avoided, even if extirpation still occurs, by being able to illustrate that British Columbia has taken all possible appropriate actions necessary to attempt to conserve and recover the species here.
- **Avoidance of federal sanctions:** British Columbia has signed the National Accord regarding the protection of species at risk and as such can be held accountable for their actions regarding recovery and protection of these species. In addition, the federal Species at Risk Act has been released and its regulations will soon follow. Under this legislation, it is possible that the federal government could apply its safety net legislation if it believes that British Columbia is not taking the appropriate action to recover and conserve the species in Canada. This can be avoided entirely by preparing and implementing a recovery plan for the Spotted Owl that is approved by the competent federal minister.

- SECTION II: RECOVERY

14. Recovery Goal

The recovery goal is to down-list the Spotted Owl in British Columbia from its current Endangered status by establishing a stable or increasing, self-sustaining population (more than 250 mature individuals) that is distributed throughout its natural range.

15. Recovery Objectives

Recovery objectives have been established to address the short- and long-term needs of the population. This includes identifying immediate actions (short term) required to address the critically low population size and high risk of extirpation, as well as identifying benchmarks required to down-list the species and remove the threat of extirpation over the long term.

15.1 Immediate Objectives

The immediate objective is to stop the population decline to prevent extirpation in British Columbia.

Between 1992 and 2002, the population is thought to have declined by 67%, and extirpation appears imminent within the next few years. To increase adult recruitment rates equivalent to or to exceed adult mortality rates, the biologically limiting factors (see section 4) that influence Spotted Owl survival, reproduction, and recruitment need to be addressed. To prevent extirpation, factors that threaten the species' survival in British Columbia (see section 5) also need to be addressed. These threats to the population must be reduced or eliminated to allow for more favourable conditions so that the species can reach a stable, self-sustaining population size. Interim recommendations to address these needs were drafted by the SORT in January 2003 (see Appendix 1).

15.2 Population Objectives

The overall population objective is to increase the number of Spotted Owls to maintain a stable, self-sustaining population distributed throughout its natural range in British Columbia.

COSEWIC reconfirmed the Spotted Owl as Endangered in Canada in May 2000 because of the very low numbers and because, as a habitat specialist, it requires old-growth coniferous forests, which are decreasing in extent and becoming highly fragmented (see section 1).

Because the population size in British Columbia is critically low, the Spotted Owl is extremely vulnerable to extirpation from stochastic events. Increasing the population size will lower this vulnerability and provide for a more stable population that is more resilient to fluctuations in population size. As well, maintaining populations distributed as widely as possible across the

overall natural range of environments and habitats occupied by the species would result in a population that is less vulnerable to stochastic events.

To down-list the species to COSEWIC's Threatened status, the long-term recovery objective is to increase the population to a minimum of 250 mature individuals (owls older than 2 years) distributed through the natural range of the Spotted Owl in British Columbia. It is recognized that some portions of the historic range are no longer capable of restoring a natural population (e.g., Lower Fraser River Valley).

15.3 Habitat Objectives

The overall habitat objective is to conserve and restore sufficient habitat throughout the species' natural range to support a self-sustaining population of Spotted Owls in British Columbia.

Habitat provides all of the life requisites needed for the Spotted Owl to survive. The amount, distribution, and quality of habitat influence population size and stability. In portions of the species' range, habitat restoration is needed to increase the likelihood of sustaining the owl population. To down-list to COSEWIC's Threatened status, a sufficient amount, distribution, and quality of habitat must be conserved and restored across the species' natural range to support a self-sustaining population of Spotted Owls in British Columbia.

15.4 Other Supporting Objectives

Other supporting objectives include increasing the communication aspects of recovery, developing appropriate partnerships, and finding sources of funding.

Recovery of the Spotted Owl in British Columbia is too large an undertaking for any one party to accomplish alone. Recovery actions will be costly, will affect numerous stakeholders, and will likely be closely scrutinized by the media, the public, the forest industry and environmental groups. Success of recovery actions will depend on the level of financial support, effective communication of the best available science to stakeholders and interested parties, and the creation of functional multi-stakeholder partnerships. These supporting objectives are important to all three preceding objectives.

16. Strategies to Meet Recovery Objectives

The SORT has identified the following strategies to effect recovery of the Spotted Owl in British Columbia. A summary of these strategies is presented in Table 2. It is recommended that some strategies be implemented immediately. Other recovery strategies require further analysis and consideration before identifying the best approach to achieve recovery objectives. Recovery action plans that provide recommendations on detailed strategies and actions for recovery should be completed within a year of release of the recovery strategy. Where appropriate, components of the recovery action plans should be implemented as soon as possible (before March 2005) to

assist recovery and prevent extirpation. To assist the SORT, Recovery Implementation Groups may be established to refine and implement strategies, objectives, and recovery action plans.

16.1 Immediate Strategies

Strategies to stop the decline and prevent extirpation

Due to the critical nature of the Spotted Owl population in British Columbia, in January 2003, the SORT presented the provincial government with interim management recommendations to be implemented immediately to prevent extirpation and maintain options to recover the species (Appendix 1). New management recommendations to stop the decline and prevent extirpation will be part of recovery action plans that will include the identification of critical habitats and/or management actions to augment the population.

16.1.1 Immediately protect all Spotted Owls.

Due to the small population size, there is critical need to protect all Spotted Owls and their habitat in British Columbia as the highest priority recovery action. Such action is needed immediately to prevent extirpation. All remaining individuals are essential to provide the genetic diversity and act as a “seed” source to increase and recover the population. As well, any disturbance (natural or otherwise) that lowers the reproductive potential of the population will increase the rate of population decline.

16.1.1.1 Find all Spotted Owls.

To implement this strategy, a continuing inventory that locates all remaining individuals is needed in order to apply protection to the owls. This information will also provide essential baseline information on the number, distribution and reproductive status of owls throughout their range in British Columbia on which recovery actions will depend. For example, if more owls are found than expected (i.e., more than 33 potential breeding pairs) then recovery actions thought to be needed may be lessened. Conversely, if fewer pairs of owls exist than expected, then more stringent recovery actions may be warranted. A failure to obtain such information could delay actions that affect recovery as well as lead to poor management decisions and perpetuate economic uncertainty, all of which could increase the likelihood of extirpation.

16.1.2 Immediately identify and conserve survival habitat.

Survival habitat represents the minimum quantity, quality, and distribution of habitat needed to maintain the current population and prevent further population decline. Simply conserving habitats found only within currently occupied territories will not guarantee maintenance of the population. Factors such as the distribution of owls and the ability of individuals to find habitats and mates play significant roles in maintaining the population. As such, survival habitat must include those habitats found within occupied territories, as well as habitats that are needed to facilitate dispersal and new territory establishment. Further loss of survival habitat could result in further declines in the population and jeopardize the likelihood of naturally recovering the species.

16.2 Population Strategies

Strategies to support population growth

Large populations are more resilient to fluctuations in population size than small populations. Simply stabilizing the population at its current small size will result in a population that is still extremely vulnerable to extirpation. Therefore, the population size must be increased to higher and more resilient levels. These levels will then maintain the population's capability to restore itself after natural declines in owl numbers. To increase the population requires the protection of unoccupied suitable habitats that are sufficient to maintain potential breeding pairs and that allow dispersing individuals to establish new territories.

16.2.1 Monitor the population trend.

Monitoring of the population is necessary to determine the success or failure of any management actions taken to effect recovery of the species. Monitoring will provide information to assess the health of the population and allow informed management decisions to be made. Given the apparent imminent threat of extirpation, it is recommended that a comprehensive monitoring program be immediately implemented on an annual basis. This monitoring program should continue until the population becomes stable and the risk of population decline is relatively low.

16.2.2 Determine the minimum population size required to attain a stable, self-sustaining population distributed across the species' natural range.

The minimum population size needed for a stable, self-sustaining population in British Columbia is unknown. To down-list the species to Threatened status, one COSEWIC criterion is to maintain a minimum of 250 mature individuals (owls older than 2 years). However, simply distributing 250 mature owls across the species' natural range could result in an unstable population because distances between these owls may be too great to allow pair formation and to sustain recruitment of owls into the population. In conjunction with habitat supply models, it is recommended that population models be used to determine the minimum number of mature owls needed and time frames required to achieve a stable, self-sustaining population throughout the species' natural range. The models should assess the influence of various biological and limiting factors on population recovery. It is also recommended that these models consider a range of recovery actions (e.g., population augmentations, habitat protection, etc.) to determine the most effective methods of attaining a self-sustaining population over the shortest timeframe. Target date for completion of models is within a year of release of the recovery strategy.

16.2.3 Artificially increase owl recruitment through population augmentation.

The population decline in British Columbia over the last decade indicates that conditions were not favourable during this period to support population growth. Future conditions that will influence population growth are unknown. For the population to naturally increase requires that owls find mates and sufficient suitable habitat to support regular breeding. Because of the small, sparsely distributed population, as well as the low amount and fragmentation of habitats in the landscape, chances of owls naturally finding mates and suitable habitat is thought to be low.

Natural population growth may therefore require many decades to increase to more resilient levels, during which time the population may become extirpated due to stochastic events.

Given the critical nature of the status of the Spotted Owl population in British Columbia, it is recommended that population augmentations be considered (i.e., assessed and evaluated for feasibility) immediately, and implemented—if deemed appropriate—to prevent further declines and extirpation. Population augmentations are very risky and have the potential to cause more harm to the population if management actions are not well planned and closely monitored. Therefore, the Population Augmentation Action Plan should include an assessment of the risks, costs, and benefits associated with the capture and overwintering of juveniles, the translocation of single adult owls to other territories with single owls, importing owls from the United States, and the establishment of a captive breeding/release program. Furthermore, these actions should not be implemented without adequate conservation of habitats needed to support the population. Simply increasing owl numbers will not result in recovery if the habitat and environment cannot support a self-sustainable population.

16.2.3.1 Overwintering juveniles.

Juvenile Spotted Owls have low survival rates than adults. The primary causes of juvenile mortality are starvation and predation during dispersal. If juveniles are not being recruited into the population at a rate that replaces adults, then extirpation is certain. To increase the survival rate of juveniles during dispersal, juvenile owls could be captured before they disperse from their natal territory and held over the winter in an appropriate holding facility. The owls can then be released the next year during favourable conditions into areas with sufficient habitat, and possibly into a territory that contains a single owl of the opposite sex. The intent of this strategy removes the initial challenge facing juveniles of learning to forage efficiently and finding sufficient habitat during harsh winter conditions.

The very low and declining number of breeding pairs that exist, the even lower number that produce fledglings, and the low survival rate of juveniles suggests that overwintering of juveniles may be an effective direct recovery action that could be taken immediately. The capture and overwintering of one juvenile owl in 2002/2003 shows that capture and overwintering of Spotted Owls is feasible (Ian Blackburn pers comm.). The bird readily adapted to captivity, caught and fed on live rodents, and survived the winter in good health. However, the bird only survived one month in the wild after its release in the spring, although care was taken to select a suitable site for its release. Mortality was caused by starvation. The lessons learned from this attempt will be extremely valuable if it is tried again, although, of course, even more caution will need to be taken to obtain a successful outcome.

16.2.3.2 Translocating single owls.

The Spotted Owl population in British Columbia is very small and pockets of occupied territories are becoming more isolated from each other. The likelihood of a single owl dispersing and finding another single owl of the opposite sex is daunting, especially for established individuals that may be reluctant for various reasons to leave their territories. To facilitate pairing, single Spotted Owls could be captured and translocated into the home range of another owl of the opposite sex. Adequate pre-capture and pre-release

monitoring to determine single status, as well as sexing, would be required before this management technique would be viable. This option would create a vacant territory and preclude a natural pairing in that territory if a dispersing juvenile of the correct sex found its way to the territory. However, this method offers the advantage of pairing between two adult birds, which may increase breeding opportunities rather than waiting a year or two for the juvenile owl to mature. This method should be considered only after any juveniles being overwintered have been assigned territories for release. As with other population augmentation activities, great caution must be taken to weigh the positive and negative consequences of non-action versus action. Potential negative consequences could include lack of compatibility of owls, as well as reduced carrying capacity if prey is limiting in the receiving site. Some risks may be reduced by translocating owls from the United States into habitats in British Columbia. However, this may create other risks to the population (e.g., incompatibility to local climates, disease).

16.2.3.3 Captive breeding.

It may be necessary to capture Spotted Owls with the intent of developing a captive breeding program. Candidate owls of opposite sex would be paired within a facility to produce viable offspring. The offspring would then be released into unoccupied habitats or paired with a single owl of the opposite sex within an adequate home range. Maintaining a pedigree program is essential in order to reduce the chances of inbreeding and the potential expression of deleterious traits. Due to the high risk of extirpation, it may be necessary to immediately consider captive breeding to allow any chance of recovery.

The costs and logistical requirements of a captive-breeding program are substantial and consideration must be given to the genetic requirements for a viable breeding program. It is recommended that this approach, if implemented, be tested on a trial basis before proceeding on a large scale. Priority should be given to using any existing non-releasable captive owls (e.g., from wildlife rehabilitation facilities) where possible.

16.2.4 Artificially increase owl survivorship and fecundity

16.2.4.1 Augment the abundance of prey at active owl territories.

The availability of prey during the breeding period may limit the number of owls attempting to breed, and may result in low fecundity if nesting attempts fail or do not occur during years with low prey abundances. Artificially increasing the abundance of prey at nesting areas may increase nesting attempts and fecundity, as well as potentially increasing adult survivorship as prey resources are sufficient to sustain all individuals. Concerns for such actions include habituating owls to a supplemental food program, increasing the presence of other competitors/predators that also feed on the same prey items, as well as the feasibility and associated cost and magnitude of such a program.

16.2.4.2 Track and feed juvenile owls through the winter.

Survival and recruitment of juvenile Spotted Owls is low. Attaching transmitters to juvenile owls before they fledge would enable tracking and feeding them throughout the critical winter period. If successful, increasing survivorship of first year birds may prove

to be a comparatively cost-effective method of population augmentation. Direct hand feeding of the young owls would negate concern of increasing the presence of other competitors/predators that could result from actions suggested in 16.2.4.1, however, concerns for habituating the birds to supplemental food and to humans need to be considered and mitigated. A trial project was initiated in 2003.

16.2.4.3 Remove competitors and predators from active owl territories.

To artificially increase prey abundance within owl territories, the removal of major competitors and predators (e.g., Barred Owls and Great Horned Owls) from these areas may reduce competitive pressures on prey and prevent possible displacement/predation of Spotted Owls. This may be most applicable around nest sites during the breeding period to ensure an abundance of prey items to support the owl family.

Before applying such techniques, the effect of competition on limiting prey abundance for Spotted Owls during breeding must be assessed to confirm that such action seems reasonable. In addition, the effectiveness of removing competitors may be jeopardized by other individuals simply moving in to replace the removed birds. This might require increased fieldwork and funding for ongoing monitoring and removals that could affect the program's feasibility. If implemented, it is recommended that these measures be tested on a trial basis first before expanding this program. Lastly, removal of competitors may incite displeasure from some organizations and some members of the general public opposed to that type of wildlife management.

16.3 Habitat Strategies

Strategies to address habitat conservation

It is still uncertain how much of what types of habitat needs to be conserved in what spatial distribution in British Columbia to allow survival and recovery of the Spotted Owl. The existing management plan (SOMIT 1997a) tried to address these issues. However, the plan does not include the entire range of the owl as it is known today and also does not protect new sites found within the plan area after 1995. As well, although the plan anticipated an immediate decline before a long-term increase/stabilization, the short-term decline rate is higher than anticipated, and the owl is now considered to be in imminent danger of extirpation from British Columbia. How much of the decline is due to habitat factors versus other factors is unknown, but the habitat needs for recovery to meet RENEW criteria need to be assessed to enable future habitat management for the species.

16.3.1 Identify and conserve critical habitat.

Critical habitat is composed of survival and recovery habitats throughout the species' natural range. These habitat types will be determined in the Habitat Action Plan. Until critical habitats are defined and formalized through appropriate government land-use decisions and federal registry, it is recommended to use existing surrogate definitions of habitat used in the Spotted Owl Management Plan (see section 6.2), and apply the recommendations in section 16.1 to protect habitat for the Spotted Owl.

The Habitat Action Plan will identify the quantitative and qualitative aspects of suitable habitat needed for nesting, roosting, foraging, and dispersal of Spotted Owls, and whether landscape-level conditions influence this suitability. It will review and assess the accuracy of the currently defined minimum age of suitable habitat as being more than 100 years old, as well as the landscape requirement to maintain at least 67% suitable habitat within active owl territories or Long-Term Activity Centres. When combined with temporal and spatial modeling, this should enable the more accurate definitions of survival and recovery habitat that are necessary to define the species' critical habitat.

16.3.1.1 Determine the minimum amount and distribution of critical habitat needed to maintain a stable, self-sustaining population distributed throughout the species' natural range.

In conjunction with population modeling, it is recommended that habitat supply models be used to assess the adequacy of the current distribution of habitat to recover the species. Such models can also predict future habitat supply and the timeframes required to create the habitat conditions (positive or negative) necessary for the owl's survival. The model should assess various habitat conservation scenarios to determine the timeframe and likelihood of achieving a stable, self-sustaining population throughout the species' natural range. This assessment should also evaluate the effectiveness of the current Spotted Owl Management Plan. Target date for model completion is within a year of release of the recovery strategy.

16.3.1.2 Develop management guidelines to conserve critical habitats.

Once survival and recovery habitats are established, guidelines are needed to identify management actions to conserve habitat within each jurisdiction (e.g., protected areas, federal lands, etc.). The guidelines should include management actions to create, enhance, and maintain habitat, as well as actions to reduce threats from natural disturbances such as fire and insects. The guidelines should consider and evaluate existing management strategies for these types of activities that are identified in the existing Spotted Owl Management Plan. Until new guidelines for conserving areas identified as critical habitat are in place, it is recommended that the Spotted Owl Management Plan's strategies be used to conserve habitat within existing owl management areas.

16.4 Other Supporting Strategies

Government policy alone may not necessarily guarantee recovery. To best effect recovery, it is recommended that partnerships with stakeholders be established to promote the conservation of the Spotted Owl. Aside from conserving the owl, other apparent benefits may include shared resources, focused activities (e.g., research), ecocertification support, goal orientated resource management (e.g., habitat enhancement), and increased public awareness.

16.4.1 Promote habitat stewardship

Portions of the Spotted Owl's natural range currently contain unfavourable habitat conditions for supporting owls. Restoration of habitat may accelerate the recruitment of these habitats and

increase chances of recovery of the species. It is recommended that goal-oriented resource stewardship plans be established by stakeholders to address key habitat supply issues (e.g., dispersal habitat). For example, areas of unsuitable habitat within areas conserved for Spotted Owls should be prioritized for habitat enhancement. Furthermore, these plans may result in financial support to implement these actions (e.g., Federal Habitat Stewardship Fund, Provincial Forest Investment Account, and Spotted Owl Recovery Fund, if established; see section 16.4.3).

16.4.2 Promote owl population stewardship

Because of the small population size, close monitoring of the owl population is needed to implement recovery actions. Implementation of some population augmentation measures will require facilities for breeding and overwintering, as well as staff time to monitor the effectiveness of these actions. These types of actions will require substantial resources to fund and maintain. It is recommended that partnerships among stakeholders be established to share resources and assist in these recovery actions to stabilize and increase the owl population.

16.4.3 Promote financial support to assist recovery actions

To effect recovery will require substantial resources. A potential limiting factor that may prevent recovery and cause extirpation is a lack of sufficient funding to develop and implement recovery actions. The provincial government is the lead jurisdiction responsible for the protection and recovery of the Spotted Owl. As such, it is recommended that the provincial government establish and financially support a Spotted Owl Recovery Fund. It is also recommended that the government seek partnerships with other stakeholders (including the federal government), as well as seek other funding avenues and public donations to sustain the recovery fund over the long term until the species has recovered. These funds will be used to support recovery actions that could include research and inventory, habitat recovery, population recovery, and effectiveness monitoring. Use of these funds should follow the priorities of the SORT. A conceptual framework for this fund is presented in Appendix 3.

16.4.4 Promote adaptive management / research to address information gaps and improve the effectiveness of recovery actions

Although the Spotted Owl is one of the best studied birds in North America, some pertinent information that would improve recovery efforts in British Columbia is lacking (see section 10). In addition, as recovery actions are implemented, monitoring their effectiveness on the province's Spotted Owl population is necessary to ensure that such actions are warranted and do not cause further harm to the species. Adaptive management is a process that can improve management actions incrementally by implementing actions in ways that maximize opportunities to learn from experience. It is recommended that research and monitoring activities be coordinated so that these activities are focused on high-priority projects needed to accomplish and monitor recovery actions. A preliminary list of priority projects is provided in Appendix 2.

16.4.5 Promote public awareness

An integral part of recovery is public awareness of the plight of, and actions taken to conserve, the species. Recovery of the Spotted Owl depends on public support. Unfortunately, most media

attention focuses on the conflict of “Spotted Owls versus Forestry Jobs,” rather than focusing on the challenges and solutions to maintain both. The conservation of the Spotted Owl is not achieved just at the local level, but is also influenced at the provincial, national, and international levels. To effect recovery, it is recommended that a communication strategy be implemented to provide information on recovery efforts and plight of the owl that is accessible at the local, provincial, national, and international levels. Consideration should be given to establishing a Web site for the Spotted Owl.

16.4.6 Promote innovative solutions to address social and economic consequences

The recovery of the Spotted Owl has social and economic consequences that extend beyond just the forest industry and the jobs it provides. Our society includes those that want to harvest resources, those that want to save endangered species, and those that want both. To balance both will require innovative solutions to optimize recovery efforts while minimizing negative consequences. A comprehensive social and economic analysis, including an ecological economic component, should be completed for recovery options identified within recovery action plans. It is also recommended that innovative solutions be considered in these evaluations. A strategic overview of the scope of socio-economic issues is presented in section 13 of this report

Table 2. Summary of strategies needed to meet recovery objectives.*

Section	Priority	Objective	Broad Strategy	Specific Steps	Anticipated Effect
16.1.1	Urgent	15.1	Protect population	Protect all occupied and managed territories	Prevent extirpation
16.1.1.1	Urgent	15.1, 15.2, 15.3	Inventory	Conduct comprehensive inventory	Improved management of habitat and augmentation
16.1.2	Urgent	15.1, 15.3	Protect habitat	Identify and conserve Survival Habitat	Prevent extirpation
16.2.1	Urgent	15.1, 15.2, 15.3	Monitor population status	Assess viability of current population	If population declines, then urgency for actions increases
16.2.2	Urgent	15.2, 15.3	Minimum viable population size	Develop population model to help determine minimum numbers of breeding owls needed for self-sustaining population	Establish population benchmark for recovery
16.2.3.1	Necessary	15.1, 15.2, 15.3	Augment population	Decision on capture and over wintering juvenile owls within a year of release of the recovery strategy	Potentially increases recruitment of juveniles
16.2.3.2	Necessary	15.1, 15.2, 15.3	Augment population	Decision on translocating single adult owls within a year of release of the recovery strategy	Potentially increases number of breeding individuals
16.2.3.3	Necessary	15.1, 15.2, 15.3	Augment population	Decision on captive breeding by within a year of release of the recovery strategy	Potentially increases recruitment
16.2.4.1	Beneficial	15.1, 15.2	Augment prey abundance	Supplemental feeding program at nesting area	Increases fecundity and owl survivorship
16.2.4.2	Beneficial	15.1, 15.2	Augment prey abundance	Radio-track and supplemental feed juveniles through winter	Increases juvenile owl survivorship/recruitment
16.2.4.3	Beneficial	15.1, 15.2	Augment prey abundance	Remove prey competitors and owl predators from owl territory	Increases fecundity and owl survivorship
16.3.1	Urgent	15.1, 15.2, 15.3	Protect habitat	Define critical habitat including survival and recovery habitat	Identify habitat requirements needed to effect recovery
16.3.1.1	Urgent	15.1, 15.2, 15.3	Habitat protection	Develop habitat supply model to help determine minimum habitat needs to maintain self-sustaining population	Establish habitat benchmark for recovery
16.3.1.2	Beneficial	15.1, 15.2, 15.3	Habitat enhancements	Develop silvicultural guidelines to create, enhance, maintain habitat	Increases recruitment rate of suitable habitat
16.4.1	Beneficial	15.1, 15.3, 15.4	Habitat stewardship	Promote habitat stewardship with forest companies	Improved forest management plans that benefit Spotted Owls and forest company
16.4.2	Beneficial	15.1, 15.2, 15.4	Population stewardship	Promote owl population stewardship with stakeholders	Improved population management and augmentation success
16.4.3	Urgent	15.1, 15.2, 15.3, 15.4	Financial support	Promote a funding strategy to sustain resources	Long-term funding resources available to effect recovery
16.4.4	Necessary	15.1, 15.2, 15.3, 15.4	Adaptive management and research	Promote research and adaptive management to address information gaps	Improved effectiveness of recovery actions
16.4.5	Beneficial	15.1, 15.2, 15.3, 15.4	Public awareness	Promote public awareness for greater support for recovery actions	Improved public support and understanding of challenges and actions
16.4.6	Necessary	15.2, 15.3, 15.4	Socioeconomic considerations	Promote innovative solutions to socioeconomic consequences	Reduced socioeconomic impacts of recovery

* Note: Because of the level of endangerment of this species, the SORT feels that all these strategies are necessary and of high importance, but have ranked them here in accordance with their relative important to each other.

17. Potential Impacts of the Recovery Strategy on Other Species and Ecological Processes

Conservation of habitat for Spotted Owls will benefit a multitude of vertebrate, invertebrate, and plant species that use mature and old and late successional coniferous forests. One obvious example is deer that use such forests for winter range.

Harper and Milliken (1994) concluded there were approximately 71 species of vertebrates closely associated with late-successional and old forests within the range of the Spotted Owl in Canada (4 amphibians, 34 birds, 17 mammals, and 16 fish). Of these vertebrates, 18 are considered at-risk, either provincially or nationally, in 2003 by the British Columbia Conservation Data Centre (Leah Ramsay, pers. comm.). In addition, the CDC has identified seven plant species in this habitat in this area to be at-risk (Jenifer Penny, pers. comm.). Furthermore, on a broader scale, Harper and Milliken (1994) list a total of 76 bird species and 138 invertebrates that are known to use older forests within the Spotted Owl's range for some part of their life requisites.

The large landscapes required to manage and conserve populations of Spotted Owls lend themselves to application of ecosystem-based approaches to forest management. The restoration and conservation of habitat for Spotted Owls will help maintain functioning late-successional forest ecosystems, and help regulate water and nutrient cycles. Strategies to conserve Spotted Owls will need to address the natural ecological processes of different ecosystems and insure that these processes are not artificially changed to unstable conditions that threaten their ecosystem function.

18. Actions Already Completed Or Underway

18.1 Summary of Actions

The Spotted Owl has been the focus of intensive management efforts, inventory, and research throughout its range in North America. In British Columbia, most effort has been concentrated on inventory and habitat management in the Squamish and Chilliwack Forest Districts. This section lists actions already completed or underway in British Columbia, presented in approximate chronological order starting with the establishment of the first SORT in 1990.

18.1.1 Canadian Spotted Owl Recovery Team

A Spotted Owl Recovery Team (SORT) was first established in 1990 to develop a national recovery plan. However, concerns about potential socioeconomic impacts led instead to the development of management options that ranged from maximum to minimum habitat protection for the owl and, consequently, maximum to minimum socioeconomic impacts. A report entitled *Management Options for the Northern Spotted Owl in British Columbia* (Dunbar and Blackburn 1994) outlined six main options to manage the Spotted Owl. In 1995, after a provincial cabinet level decision, the premier's office announced a plan to manage Spotted Owls through existing

and new protected areas and enhanced forest conservation measures through the British Columbia Forest Practices Code. This plan was released as the Spotted Owl Management Plan (SOMP) in 1997 (see section 18.1.3).

The original SORT did not endorse the option selected because it predicted only a 60% probability of improving the status of the owl in British Columbia, and the team felt that 70% was the minimum they could accept (Dunbar and Blackburn, 1994). The SORT disbanded shortly after the release of SOMP and was replaced by the Spotted Owl Management Interagency Team (SOMIT). SOMIT consisted of representatives from the ministries of Environment and Forests who were charged with developing and implementing SOMP.

18.1.2 Interim Conservation Strategy

In 1993, pending development of a management plan and a future cabinet decision on the long-term management of the species, the provincial government implemented an Interim Conservation Strategy for Spotted Owls. This resulted in some level of habitat conservation at all known Spotted Owl locations in the province and a mechanism to protect more owls if they were found in the future. Each Spotted Owl location was managed to maintain 67% suitable habitat (forest older than 120 years) within a 3200-ha activity centre. This strategy was replaced by the SOMP in 1997.

18.1.3 Spotted Owl Management Plan

A joint Ministry of Forests and Ministry of Environment, Lands and Parks team was established in 1995 to develop a Spotted Owl Management Plan (SOMP) focusing on one of the options presented by the SORT. Their goal was to “provide a reasonable probability that owl populations will stabilize, and possibly improve, over the long-term, without significant impacts on timber supply and forestry employment.” The provincial government released the SOMP in 1997 (SOMIT 1997a,b). SOMP established 21 Special Resource Management Zones (SRMZs) that included 159 000 ha of protected areas and 204 000 ha of Crown forest land to be legally established as Resource Management Zones under the *Forest Practices Code of British Columbia Act* (Figure 6). SOMP is still in effect today (2003) and the following paragraphs detail its provisions.

SRMZs are spaced a maximum 20 km apart, edge to edge, to provide a reasonable chance that owls may disperse from one SRMZ to another. SRMZs vary in size, encompassing between 2 and 13 Long-Term Activity Centres (LTACs, each about 3200 ha). Each LTAC is capable of sustaining a potential breeding pair of Spotted Owls, either immediately or in the future after habitat recruitment/restoration. According to the plan, the long-term stabilization—and possible improvement—of the Spotted Owl population depends on maintaining, or restoring, a minimum 67% of the gross forested area as suitable habitat (i.e., forests older than 100 years, taller than 19.4 m, and below 1370 m elevation) in each LTAC. Of the 101 LTACs identified within SRMZs, only 55 LTACs currently meet the minimum 67% habitat target. Recruitment of habitat up to this minimum target in the other 45 LTACs may require up to 60 years to achieve (Blackburn and Godwin 2003).

The SOMP provides temporary protection for an additional eight Spotted Owl locations, termed Matrix Activity Centres (MACs), found entirely or partially outside of SRMZs. These MACs are to be phased out by allowing, over a 50 year period, limited clearcutting of suitable habitat at a rate similar to the recruitment of suitable habitat into SRMZs. However, some MACs will be phased out sooner to achieve forest company timber needs to offset the impacts associated with the creation of the Mehatl Creek Protected Area (SOMIT 1997a).

As per Cabinet direction, the SOMP does not provide protection—beyond the existing provisions of the *Forest Practices Act* (1995) and *Forest and Range Practices Act* (2003)—to Spotted Owl locations discovered after June 1995 that are found outside of SRMZs, MACs, and protected areas. Since June 1995, 19 new Spotted Owl locations have been discovered and remain unprotected. Fourteen of these occur further north beyond the managed range of SOMP, eight of which occur in the Cascades Forest District (Blackburn and Godwin 2003). The remaining 5 of the 19 unprotected new locations occur within SOMP's current boundary, but outside of existing SRMZs and MACs.

It was intended to establish SOMP as a Higher Level Plan under the *Forest Practices Code of British Columbia Act*, but this did not take place. Nonetheless, SOMP is largely being implemented by forest companies (Blackburn and Godwin 2003).

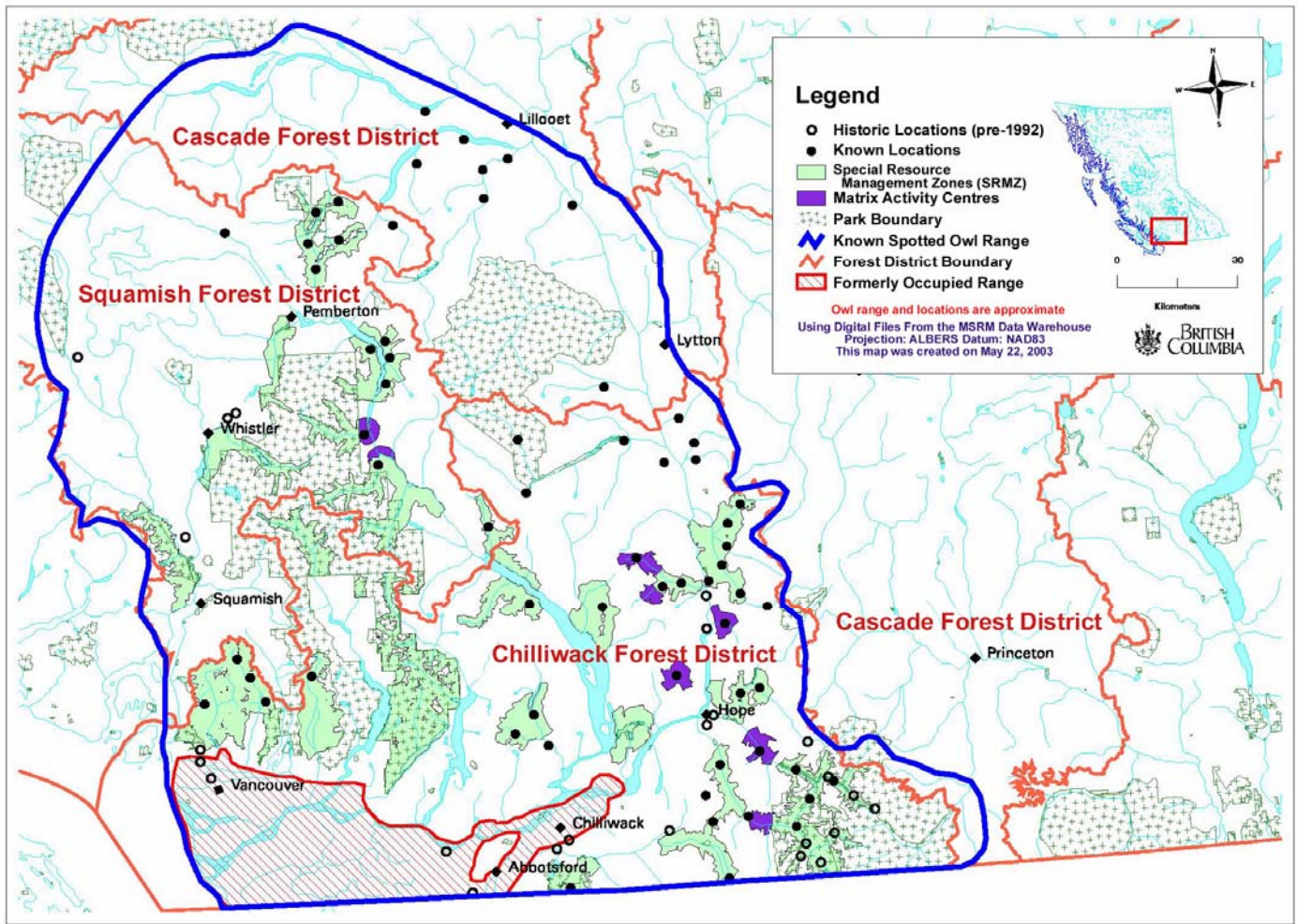


Figure 6. Extent of the Spotted Owl Management Plan.

18.1.4 Analysis of the Spotted Owl Management Plan

Early reviews of SOMP were mixed. One review suggested the species would become extirpated in British Columbia (Hodum and Harrison 1997); another suggested the population would stabilize without a SOMP (Demarchi 1998). The SORT did not endorse the 1997 management plan as a national recovery plan because they deemed the predicted probability of improving the conservation status of the species to be too low.

The SOMP predicts a 60% chance of the population stabilizing and possibly improving its status over the longer term, but recognizes that the Spotted Owl population would continue to decline for the 20 to 30 years after its implementation. However, the sharpness of the decline in Spotted Owl numbers over the past decade and the possibility of imminent extirpation without additional recovery efforts (Blackburn et al. 2002) support the need for a re-evaluation of the existing management plan and consideration of new approaches to manage the owls and their habitats. Accordingly, the SORT has begun to re-evaluate SOMP and will continue to do so through the recovery process.

18.1.5 Inventory and monitoring

Through the 1990s and early 2000s, inventories were conducted (as much as resources allowed) to determine the range, distribution, and abundance of Spotted Owls in British Columbia, as well as to assist in resource management decisions. When feasible, breeding assessments and nest site searches were performed. In 1998, provincial government biologists began to attach leg-bands to Spotted Owls to identify individuals and monitor their movements and habitat occupancy. Between 1998 and 1999, transmitters were affixed to several breeding pairs to monitor, opportunistically, habitat use and home range sizes. Recent summaries of the overall status of the Spotted Owl (SOMIT 1999; Blackburn and Godwin 2003) and population trends and future outlook (Blackburn et al. 2002) have been prepared. Lastly, in September 2003, three fledged juveniles were affixed with transmitters to ascertain their dispersal movements and overwinter survival.

18.1.6 Mapping and modeling

GIS habitat models have been developed by the Ministry of Water, Land and Air Protection biologists to better identify suitable habitat, connectivity problems, new areas to survey, and to aid higher level planning for Spotted Owl habitat. Habitat maps have been produced, but are still works-in-progress. A demographic and habitat supply model is also being developed by the SORT.

18.1.7 Forest Practices Code

The Forest Practices Code, enabled by the *Forest Practices Code of British Columbia Act*, contains provisions for maintaining certain percentages of old-growth forest (Province of British Columbia 1995a) and conserving riparian habitat (Province of British Columbia 1995b) across the landscape. The *Forest Practices Code Act* is currently being replaced by the new *Forest and*

Range Practices Act, which contains provisions for legally designated protected areas such as Ungulate Winter Ranges. These areas, although not large enough to protect an owl's territory, could provide some protection for some important habitat or habitat features and therefore assist in the overall management of the species. The Forest Practices Code also contains the Identified Wildlife Management Strategy accounts which are directed at conserving habitat for wildlife species at risk from forest and range activities.

18.1.8 Identified Wildlife Management Strategy

Under the Forest Practices Code, an Identified Wildlife Management Strategy (IWMS) has been established to address those species that require additional habitat protection above other provisions (e.g., Old-growth Management Areas) of the Forest Practices Code. A draft IWMS account has been developed for Spotted Owls for version 2 of the IWMS documents. Under IWMS, a limited number of Wildlife Habitat Areas may be established on provincial Crown forest and/or range land, including such areas not covered by the SOMP (Province of British Columbia 2003). Wildlife Habitat Areas of sufficient size and quality have the potential to protect owl territories.

18.1.9 Cascade Land and Resource Management Plan (LRMP)

Work has been ongoing to develop a LRMP for the Cascades Forest District. Recent surveys have discovered active Spotted Owl sites here that are not protected by the existing management plan. Accordingly, the Spotted Owl and its habitat requirements are now included in the wildlife issues that this LRMP addresses. Once approved by government, this LRMP will provide a mechanism for government to act on issues regarding Spotted Owl habitat.

18.1.10 Spotted Owl Status Reports

The Spotted Owl was first designated as Endangered in Canada by COSEWIC in 1986 (Campbell and Campbell 1986). This was reconfirmed in 1999 based on an updated COSEWIC Status Report (Kirk 1999). Because of requirements to accommodate the federal *Species At Risk Act*, all COSEWIC rankings were reassessed in 2000. For the Spotted Owl, this was again based on the 1999 COSEWIC Status Report, and the Endangered status was reconfirmed. Although there is no doubt about the status of this species, there has been much recent important work done on the species in British Columbia and in the United States, and the COSEWIC report needed further updating to include this. Accordingly, the province is currently completing an updated provincial Status Report for publication in 2003 (Blackburn and Godwin 2003). It is intended to forward this to COSEWIC for review and consideration as a COSEWIC Status Report after completion.

18.1.11 Re-establishment of SORT

In October 2002, after news of the owl's worsening decline, a new SORT was initiated to review the existing SOMP and develop a recovery plan to meet the requirements of the federal *Species at Risk Act*. This recovery strategy is the first step in that process. It is being developed to enable recovery action plans to be prepared and implemented, which may include plans for inventory, research, population augmentation, habitat enhancement, and habitat protection. The actions

plans will then be combined with the recovery strategy into a final recovery plan for the Spotted Owl in Canada.

18.1.12 SORT's 2003 Interim Management Recommendations

Shortly after the re-establishment of SORT in October 2002, the provincial government requested that SORT prepare interim management recommendations based on the best science available at the time. The new SORT provided interim management recommendations to government in January 2003 (Appendix 1). These recommendations cover immediate needs for inventory, research, captive management, habitat enhancement, and habitat protection.

The government has taken these under advisement and are considering the establishment of interim measures for Spotted Owls, although as of November 2003 no decision has been made.

18.1.13 Recent industry action

Two forest companies (International Forest Products Limited in October 2002 and Canadian Forest Products in January 2003) holding Crown forest tenures within the range of the Spotted Owl have voluntarily deferred logging in SRMZs in response to concerns for the owl. They are awaiting action/direction from government before deciding on how long to maintain the deferrals.

18.1.14 Capture and overwintering of juvenile owls

A trial capture and overwintering of one juvenile Spotted Owl was performed during the winter of 2002/2003. This owl was successfully maintained over the winter and released back into the wild wearing a radiotransmitter on April 16, 2003. Before release, the owl was vaccinated against West Nile virus as a precautionary measure. The owl was tracked regularly and recaptured on May 15 to assess her condition. Unfortunately, it was found that she had lost over 30% of her weight and was in very poor condition. She was taken back into captivity in an attempt to rehabilitate her, but she died the next day of apparent malnutrition. Much useful information was learned by this experiment that will be used to improve on any such attempts in the future.

18.2 Statement of When Action Plans will be Completed

This recovery strategy outlines many options for recovery actions. The SORT plans to use the information in this recovery strategy to guide the development of recovery action plans. The recovery action plans, when combined with the recovery strategy, will make up the complete recovery plan for the Spotted Owl. The target date for the following recovery action plans and the draft recovery plan is within a year of release of the recovery strategy; however, all efforts will be made to complete them, or parts of them, earlier to enable the needed recovery actions. Canadian recovery action plans will need to complete socioeconomic analyses where applicable (e.g., habitat/population action plans).

1. Habitat Action Plan: to define survival and recovery habitat, review and evaluate effectiveness of SOMP, and provide recommendations of additional habitat recovery actions (within a year of release of the recovery strategy).

2. Population Inventory Action Plan: to outline the population inventory requirements needed to support recovery needs, including inventory and monitoring of occupancy, population trends, and surveys for possible new territories (within a year of release of the recovery strategy)

3. Population Augmentation Action Plan: to provide rationale, protocols, and recommended actions for captive-breeding, overwintering and translocations (within a year of release of the recovery strategy). Decisions on whether to proceed on some augmentation activities will need to be made sooner to accommodate any immediately necessary capture activity. It may prove feasible to combine the inventory and augmentation plans into a single Population Action Plan.

4. Research Action Plan: to provide details and further recommendations for potential research projects (within a year of release of the recovery strategy). A draft list has already been created (Appendix 2), which will be amended as needed and used to rank and guide research activities until the Research Action Plan is complete.

5. Funding Action Plan: to deliver resources needed for recommended inventory, habitat, research, and population augmentation actions. Target date for completion is March 2005, although actions on this should be active and ongoing. A proposal to establish a non-profit society to garner funds for recovery purposes was tabled by I. Blackburn, February 2003, and is under review (Appendix 3).

6. Other recovery action plans: the SORT recognizes that after this recovery strategy is released and work on the above-mentioned plans is underway, a need for combining these plans or adding other recovery action plans may become apparent. If so, they will be incorporated into the recovery plan with the same completion target date of within a year of release of the recovery strategy.

18.3 Evaluation

Several performance measures with schedules to be developed in the recovery action plans will be useful for evaluating the success of the recovery strategy, including:

1. Prevention of extirpation of the Spotted Owl from British Columbia.
2. Prevention of further decline in the range of the Northern Spotted Owl.
3. Sufficient habitat conserved to maintain a viable population. An assessment of how much habitat is required to maintain the target number of owls (250 adults) will need to be made to evaluate the success of this objective.
4. The number of additional unprotected occupied territories protected.
5. Preparation of recovery action plans for habitat conservation, inventory, research, population augmentation, and funding by the dates proposed.

6. The use of silvicultural techniques to speed up recruitment of habitat. An assessment of actual silvicultural treatments conducted will be required, which includes both audit and effectiveness evaluation components.
7. An evaluation of any population augmentation techniques used, including an assessment of changes to the number of juveniles recruited into the population and the number of owls in the wild.
8. Initiation of research on vital topics identified in the Research Action Plan.

LITERATURE CITED

- Barrows, C.W. 1981. Roost selection by Spotted Owls: An adaptation to heat stress. *Condor* 83:302–309.
- Barrows, C., and K. Barrows. 1978. Roost characteristics and behavioural thermoregulation in the Spotted Owl. *Western Birds* 9:1–8.
- Bart, J. 1995. Amount of suitable habitat and viability of Northern Spotted Owls. *Conservation Biology* 9:943–946.
- Blackburn, I.R., and S. Godwin. 2003. Status of the Northern Spotted Owl in British Columbia. BC Minist. Water, Land and Air Protection, Surrey, BC.
- Blackburn, I.R., and A.S. Harestad. 2002. Supplement to the population assessment of the Northern Spotted Owl in British Columbia 1992–2001. BC Minist. Water, Land and Air Protection, Surrey, BC. 44pp.
- Blackburn, I.R., A.S. Harestad, J.N.M. Smith, S. Godwin, R. Hentze, and C.B. Lenihan. 2002. Population assessment of the Northern Spotted Owl in British Columbia 1992–2001. BC Minist. Water, Land and Air Protection, Surrey, BC. 22pp.
- Blakesley, J.A., A.B. Franklin, and R.J. Gutiérrez. 1992. Spotted Owl roost and nest site selection in northwestern California. *J. Wildlife Management* 56:388–392.
- Buchanan, J.B., L.L. Irwin, and E.L. McCutchen. 1993. Characteristics of Spotted Owl nest trees in the Wenatchee National Forest. *J. Raptor Research* 27:1–7.
- Buchanan, J.B., L.L. Irwin, and E.L. McCutchen. 1995. Within-stand nest site selection by Spotted Owls in the eastern Washington Cascades. *J. Wildlife Management* 59:301–310.
- Buchanan, J.B., J.C. Lewis, and D.J. Pierce. 1999. Characteristics of young forests used by Spotted Owls on the Western Olympic Peninsula, Washington. *Northwest Science* 73(4):255–263.
- Campbell, E.C., and R.W. Campbell. 1986. Status report on the Spotted Owl, *Strix occidentalis*, in Canada. COSEWIC, Ottawa, ON.
- Campbell, R.W., N.K. Dawe, I. McTaggart-Cowan, J.M. Cooper, G.W. Kaiser, and M.C.E. McNall. 1990. The Birds of British Columbia, Vol. 2, Nonpasserines: Diurnal birds of prey through woodpeckers. Royal British Columbia Museum and Canadian Wildlife Service. Mitchell Press, Vancouver, BC. 636pp.
- Canadian Cooperative Wildlife Health Centre. 2003. West Nile virus. Western College of Veterinary Medicine, Saskatoon, SK. Web site: <http://wildlife.usask.ca/english/frameWestNile.htm>

- Carey, A., W. Colgan, III; J.M. Trappe, and R. Molina. 2002. Effects of Forest Management on Truffle Abundance and Squirrel Diets. *Northwest Sci.* 76:148-157.
- Carey, A., S. Horton, and B. Biswell. 1992. Northern Spotted Owls: Influence of prey base and landscape character. *Ecological Monographs* 62:223–250.
- Carey, A., J. Reid, and S. Horton. 1990. Spotted Owl home range and habitat use in southern Oregon coast ranges. *J. Wildlife Management* 54:11–17.
- Caughley, G., and A. Gunn. 1995. *Conservation Biology in Theory and Practice*. Blackwell Science, Cambridge, MA. 459pp.
- Centers for Disease Control and Prevention. 2003. West Nile virus vertebrate ecology. Division of Vector-Borne Infectious Diseases, National Center for Infectious Diseases, Centers for Disease Control and Prevention (CDC), Atlanta, GA. Web site: <http://www.cdc.gov/ncidod/dvbid/westnile/birds&mammals.htm>
- Dale, V.H., L.A. Joyce, S. McNulty, R.P. Neilson, M.P. Ayres, M.D. Flannigan, P.J. Hanson, L.C. Irland, A.E. Lugo, C.J. Peterson, D. Simberloff, F.J. Swanson, B.J. Stocks, and B.M. Wotton. 2001. Climate change and forest disturbance. *BioScience* 51:723–734.
- Dawson, W., J. Ligon, J. Murphy, J. Myers, D. Simberloff, and J. Verner. 1986. Report of the scientific advisory panel on the Spotted Owl. *Condor* 89:205–229.
- Delaney, D.K., T.G. Grubb, P. Beier, L.L. Pater, and M.H. Reiser. 1999. Effects of helicopter noise on Mexican Spotted Owls. *J. Wildlife Management* 63:60–76.
- Demarchi, D.A. 1998. A spatial simulation model for evaluating the response of rare and endangered species to conservation strategies and forest practices: A case study of the Northern Spotted Owl. M.Sc. thesis, Univ. British Columbia, Vancouver, BC.
- Dunbar, D., and I. Blackburn. 1994. Management options for the Northern Spotted Owl in British Columbia. Report of the Canadian Spotted Owl Recovery Team. BC Minist. Environ. Lands and Parks, Surrey, BC. 180pp.
- Dunbar, D., Booth, B., Forsman, E., Hetherington, A., and D. Wilson. 1991. Status of the Spotted Owl (*Strix occidentalis*) and Barred Owl (*Strix varia*) in southwestern British Columbia. *Canadian Field-Naturalist* 105:464–468.
- Forsman, E.D. 2003. Northern Spotted Owl. Available online at <http://biology.usgs.gov/s+t/SNT/noframe/pn172.htm>
- Forsman, E.D., R.G. Anthony, J.A. Reid, P.J. Loschl, S.G. Sovern, M. Taylor, B.L. Biswell, A. Ellingson, E.C. Meslow, G.S. Miller, K.A. Swindle, J.A. Thrailkill, F.F. Wagner, and D.E. Seaman. 2002a. Natal and breeding dispersal of Northern Spotted Owls. *Wildlife Monographs* 149:1–35.
- Forsman, E.D., and A.R. Giese. 1997. Nests of the Northern Spotted Owl on the Olympic Peninsula, Washington. *Wilson Bulletin* 109:28–41.

- Forsman, E.D., E.C. Meslow, and H.M. Wight. 1984. Distribution and biology of the Spotted Owl in Oregon. *Wildlife Monographs* 87:1–64.
- Forsman, E.D., I.A. Otto, S.G. Govern, M. Taylor, D.W. Hays, H. Allen, S.L. Roberts, and D.E. Seaman. 2001. Spatial and temporal variation in diets of Spotted Owls in Washington. *J. Raptor Research* 35:141–150.
- Forsman, E.D., J.A. Reid, S. Graham, J.S. Mowdy, and A.L. Price. 2002b. Demographic characteristics of Northern Spotted Owls (*Strix occidentalis*) on the Tyee Study Area, Roseburg, Oregon, 1985–2002. Unpub. report for wildlife habitat relationships in Washington and Oregon, USDA Forest Service.
- Forsman, E.D., S. Govern, and M. Taylor. 2002c. Demography of Spotted owls on the east slope of the Cascade Range, Washington, 1989–2002. Unpub. report for wildlife habitat relationships in Washington and Oregon, USDA Forest Service.
- Franklin, A.B., K.P. Burnham, G.C. White, R.G. Anthony, E.D. Forsman, C. Schwarz, J.D. Nichols, and J. Hines. 1999. Range-wide status and trend in Northern Spotted Owl populations. Unpub. report. Colorado State University and Oregon State University, Fort Collins, CO.
- Franklin, A.B., R.J. Gutiérrez, P.C. Carlson, D. Pavlacky, J. Rockwiett, W. King, A. Walston, and S. Unger. 2002. Population ecology of the Northern Spotted Owl (*Strix occidentalis caurina*) in northwestern California: Annual results, 2001. Annual Progress Report for Region 5, USDA Forest Service. 18pp.
- Gutiérrez, R.J., A.B. Franklin, and W.S. La Haye. 1995. Spotted Owl (*Strix occidentalis*). In A. Poole and F. Gill, eds. *The Birds of North America* No. 179. Acad. Nat. Sci., Philadelphia, PA, and Am. Ornithol. Union, Washington, DC. 28pp.
- Hamer, T.E. 1988. Home range size of the Northern Barred Owl and Northern Spotted Owl in western Washington. M.S. thesis, Western Washington University, Bellingham, WA.
- Hamer, T.E., E.D. Forsman, D. Fuchs, and M. Walters. 1994. Hybridization between Barred and Spotted Owls. *Auk* 111:487–492.
- Hamer, T.E., D.L. Hays, C.M. Senger, and E.D. Forsman. 2001. Diets of Northern Barred Owls and Northern Spotted Owls in an area of sympatry. *J. Raptor Research* 35:221–227.
- Hamer, T.E., S.G. Seim, and K.R. Dixon. 1989. Northern Spotted Owl and Northern Barred Owl habitat use and home range size in Washington. Preliminary Report, Washington Department of Wildlife. 65pp.
- Hanson, E., D. Hays, L. Hicks, L. Young, and J. Buchanan. 1993. Spotted Owl habitat in Washington. Washington Forest Practices Board, Washington. 116pp.
- Harper, W.L., and R. Milliken. 1994. Other species associated with late successional forests. Appendix C. in D. Dunbar and I. Blackburn, Management options for the Northern

- Spotted Owl in British Columbia. Report of the Canadian Spotted Owl Recovery Team. BC Minist. Environ. Lands and Parks, Surrey, BC. 180pp.
- Herter, D.R., and L.L. Hicks. 1995. Northern Spotted Owl surveys and demography in the Plum Creek Cascade Habitat Conservation Plan area. Tech. Rep. 1, Plum Creek Timber Company, L.P., Seattle, WA. 79pp.
- Hilton, A., and S. Hilton. 2002. Inventory of Northern Spotted Owls: Lillooet Forest District. Unpub. rep. for Minist. Water, Land and Air Protection, Kamloops, BC. 58pp.
- Hobbs, J. 2002. Spotted Owl nest searches in the Lillooet Forest District, 2002: Summary of results. Unpub. rep. for Minist. Water, Land and Air Protection, Victoria, BC.
- Hodum, P., and S. Harrison. 1997. Ecological assessment of the British Columbia Spotted Owl management plan. Unpub. rep., University of California, Davis, CA.
- Horoupian, N., C.B. Lenihan, A.S. Harestad, and I.R. Blackburn. In prep. Diet of Northern Spotted Owls in British Columbia.
- Kelly, E.G. 2002. The range expansion of the Northern Barred Owl: An evaluation of the impact on Northern Spotted Owls. M.S. thesis, Oregon State University, Corvallis, OR.
- Kelly, E.G., E.D. Forsman, and R.G. Anthony. 2003. Are Barred Owls displacing Spotted Owls? *Condor* 105:45–53.
- Keystone Wildlife Research Ltd. 2003. Spotted Owl data review and management plan for the Fraser TSA. Unpub. draft rep. prepared for Fraser TSA Co-operative Assoc. 53 pp.
- Kirk, D.A. 1999. COSEWIC status report on the Northern Spotted Owl, *Strix occidentalis caurina*. Committee on the Status of Wildlife in Canada. 24pp.
- Kurz, W.A., and J.A. Greenough. 1996. Spotted Owl adaptive management program and research needs: Workshop report. Prepared by ESSA Technologies Ltd., Vancouver, BC for the BC Minist. Forests and BC Minist. Environment, Lands and Parks, Victoria, BC. 39pp.
- Lamberson, R.H., B.R. Noon, C. Voss, and R. McKelvey. 1994. Reserve design for terrestrial species: The effects of patch size and spacing on the viability of the Northern Spotted Owl. *Conservation Biology* 8:185–195.
- Loye, J.E., and S.P. Carroll. 1998. Ectoparasite behavior and its effects on avian nest site selection. *Annals of the Entomological Society of America* 91:159–163.
- Meidinger, D., and J. Pojar. 1991. Ecosystems of British Columbia. BC Minist. Forests, Victoria, BC. 330pp.
- [MELP] B.C. Ministry of Environment, Lands and Parks. 1998. Environmental trends in British Columbia. Minist. Environment, Lands and Parks, Victoria, BC.

- Meyer, J.S., L.L. Irwin, and M.S. Boyce. 1998. Influence of habitat abundance and fragmentation on Northern Spotted Owls in western Oregon. *Wildlife Monographs* 139:1–51.
- Miller, A. 2004. Northern Spotted Owl Recovery Strategy for British Columbia, Canada. Unpub. draft rep. 65pp.
- Miller, G., S. Small, and E.C. Meslow. 1997. Habitat selection by Spotted Owls during natal dispersal in western Oregon. *J. Wildlife Management* 61:140–150.
- Moller, A.P. 1993. Ectoparasites increase the cost of reproduction in their hosts. *J. Animal Ecology* 62:309–322.
- [MWLAP] B.C. Ministry of Water, Land and Air Protection. 2003. Spotted Owl database. Surrey, BC.
- Province of British Columbia. 1995a. Biodiversity guidebook. B.C. Minist. Forests and B.C. Minist. Environment, Lands and Parks, Victoria, BC.
- Province of British Columbia. 1995b. Riparian management area guidebook. B.C. Minist. Forests and B.C. Minist. Environment, Lands and Parks, Victoria, BC.
- Province of British Columbia. 2003. Identified Wildlife Management Strategy, Vol. 2. B.C. Minist. Forests and B.C. Minist. Environment, Lands and Parks, Victoria, BC.
- Ransome, D.B., and T.P. Sullivan. 2003. Population dynamics of *Glaucomys sabrinus* and *Tamiasciurus douglasii* in old-growth and second-growth stands of coastal coniferous forest. *Canadian J. Forest Research* 33:587–596.
- [ROMAN] RENEW Operations Manual. 2003. Working draft, 30 January 2003. RENEW Secretariat, Canadian Wildlife Service, Environment Canada, Ottawa.
- [SARA] Species at Risk Act. 2003. Chapter 29 of Canada Gazette Part III, Statutes of Canada, 2002. Queens Printer for Canada, Ottawa. 97 pp.
- [SOMIT] Spotted Owl Management Inter-Agency Team. 1997a. Spotted Owl management plan: Strategic component. B.C. Minist. Environment, Lands and Parks and B.C. Minist. Forests, Victoria, BC. 81pp.
- [SOMIT] Spotted Owl Management Inter-Agency Team . 1997b. Managing Spotted Owl Habitat: Operational Guidelines Component of the Spotted Owl Management Plan. B.C. Minist. Environment, Lands and Parks and B.C. Minist. Forests, Victoria, BC. 39pp.
- [SOMIT] Spotted Owl Management Inter-Agency Team. 1999. Spotted Owl Management Plan: Resource Management Plans. B.C. Minist. Environment Lands and Parks and B.C. Minist. Forests, Victoria, BC.
- Swarthout, E.C.H., and R.J. Steidl. 2003. Experimental effects of hiking on breeding Mexican Spotted Owls. *Conservation Biology* 17:307–315.

- Thomas, J.W., E.D. Forsman, J.B. Lint, E.C. Meslow, B.R. Noon, and J. Verner. 1990. A Conservation Strategy for the Northern Spotted Owl. Rep. of Interagency Scientific Committee to Address the Conservation of the Northern Spotted Owl (Portland, OR) 427pp + maps.
- Thomas, N.J., J. Bunikis, A.G. Barbour, and M.J. Wolcott. 2002. Fatal spirochetosis due to a relapsing fever-like *Borrelia* sp. in a Northern Spotted Owl. *J. Wildlife Diseases* 38:187–193.
- [USDI] U.S. Department of the Interior. 1992. Recovery plan for the Northern Spotted Owl: Draft. U.S. Fish and Wildlife Service, Washington, DC. 662pp + maps.
- [WFPB] Washington Forest Practices Board. 1996. Final environmental impact statement on forest practices rules for Northern Spotted Owl, Marbled Murrelet, Western Gray Squirrel. Washington Forest Practices Board, Olympia, WA.
- Wilcove, D. 1987. Public lands management and fate of the Spotted Owl. *American Birds* 41:361–367.

APPENDIX 1: INTERIM MANAGEMENT RECOMMENDATIONS

Spotted Owl Recovery Team Interim Management Recommendations January, 2003

- The following items are interim management recommendations endorsed by all SORT members until the Recovery Plan is completed and implemented, unless otherwise stated below.
- These recommendations may be revisited/updated as information becomes available.
- As SORT has not yet been able to assess the biological “recoverability” of the Spotted Owl in British Columbia, these recommendations reflect the guidance given in the Nov. 2001 RENEW Recovery Operation Manual’s feasibility section that states: “Species that cannot be recovered should as a minimum be managed to maintain current numbers and distributions”.
- SORT recognizes that some of these items involve an increase in habitat protection measures from those contained in the existing Spotted Owl Management Plan.

Overall Purpose

Work towards creating a revised management plan that is approved by government and protects sufficient Spotted Owl habitat throughout its known range to allow recovery to occur as determined by SORT Recovery Strategy and Action Plans.

A. Demographics: Research/Inventory/Captive Management

1. Complete range-wide intensive inventory 2003 field season to establish population estimate and define the species’ range. This is essential for science-based assessment. Effectiveness of all other actions are dependent on sufficient funding for this item (estimate for 2003: \$0.5 to 1 million).
2. Continue investigating capture/release program with consideration of captive breeding. Ensure funding for post-release monitoring.
3. Implement research priorities as determined by the Spotted Owl Recovery Team.

B. Enhancement

1. Where appropriate, encourage silviculture systems to modify forest stands to improve their suitability for Spotted Owl sooner, especially in Long-Term Activity Centres and in connectivity corridors. Avoid occupied owl sites (sites with owls known to be present).

C. Habitat Protection

1. Protect all known Spotted Owl occupied sites within the range of the Spotted Owl, including the Spotted Owl Management Plan, Matrix and unprotected areas (e.g., Lillooet).
2. Within SRMZs, temporarily cease commercial logging in suitable habitat (>100 years) until results of inventory are completed and the situation is re-evaluated; logging can continue for enhancement as per B1.
3. NB. Full consensus was not reached on this item. Seven of nine team votes were in favour of the above position on SRMZs. The Industry representative and alternate did not agree to a complete ban—they preferred considering increasing the harvest threshold above 67% but below 100% dependent on risk assessment on a site by site biological basis. They also prefer any such restrictions not to apply to existing approved cutting permits. The Academia representative felt there was room for some flexibility between the two positions.
4. Matrix areas—manage as per current Matrix phase-out strategy under SOMP, except where they hold active owls as per C1.
5. Identify, and protect/manage critical connectivity habitat, e.g., connection of Lillooet to Fraser TSAs.

Definitions:

- “Protect” means to cease all removal/alteration of suitable habitat within the area identified, except where such activities were done for enhancement purposes.
- “Occupied” means a site that was known to have been occupied by an owl or pair of owls during one or more surveys conducted from 1997 to the present.

D. Additional Management Tools

1. Include SPOW as Endangered under the *Wildlife Act* (enables CWMAs).
2. Include SPOW in IWMS to enable WHAs.

APPENDIX 2: PRELIMINARY LIST OF RESEARCH TOPICS

Broad Topics	Information Gaps for Decision Process	Specific Research Topics ^a	Type of Study ^b
POPULATION			
Demography / trends			
	Range	Distribution relative to known range as index of health	Inventory (appropriately designed)
		Pattern of distribution in the landscape at different spatial scales, e.g., international and regional (metapopulations, U.S. comparison; subpopulations for local)	Assess existing information / literature, and database gathering
	Abundance	Index of number of animals (animals or habitat [ha] over time)	Inventory and research
	Quality of population	Proportion of breeders and non-breeders, and age-specific issues	
	Population parameters	Survivorship, natality, immigration/emigration Dispersal distances	
Genetic profiling			
	Measure of variability	Relative to southern populations Relative to ecosystem types	
	Identification of individuals	Population tool to track lineage Population tool to estimate population size	
Population modeling / trends			
	Population viability	Minimum number of breeders and distribution to sustain population over time Minimum spatial distribution of breeders Population projections for management decisions	
HABITAT			
Features of habitat (topography, vegetation, forest structure)			
	Nesting habitat	Describe nest trees Describe nest patches (immediate proximity to nest) Describe nest stands (area of similar habitat type immediately surrounding the nest patch) What is the availability of type A and B suitable habitats, and within-stand variation of these habitats?	
	Home range (nesting / foraging)	Describe area used/selected during breeding period (area most used by adults [male] while young in nest) Describe post-fledging area used (i.e., before juvenile dispersal) Describe overwintering area used (i.e., after young disperse) What area of habitat must be suitable in a home range (e.g., 67%) and how should it be distributed?	
Dispersal habitat			
	Habitat-specific survivorship	Do SPOW juveniles have higher survivorship in some habitat types?	
	Selection of habitat	What habitats are selected by juveniles for dispersal?	
	Barriers	Are young forests, roads, lakes, ridges, etc., barriers to	

	juvenile dispersal?
Modeling habitat	
Suitability / capability	Amount and availability over time at different population levels Change in habitat availability over time with natural disturbance (fire) Connectivity of habitat Fragmentation (patch size, distribution, and connectivity)

PREY

Population

Abundance and distribution	Availability of prey relative to different spatial criteria (e.g., broad ecosystem, stand/forest type, geographic region, and SPOW habitat) Is prey availability limiting SPOW survival? Does the importance of flying squirrels and bushy-tailed wood rats in diet differ by ecosystem?
Population trends	Relative to weather, food availability
Ecology of prey	Prey habitat Prey breeding requirements Prey foraging requirements

PREDATORS / COMPETITORS (niche overlap)

Barred Owl (BDOW)

Population	Trends in BDOW population How does adult and juvenile survivorship and dispersal for BDOW differ from SPOW? Do BDOW breed with SPOW? Under what conditions?
Habitat	Do BDOW select wetter ecosystems (thus distribute differently in the landscape) than SPOW? What are features in nesting and home range habitat of BDOW? How do they compare to SPOW? Do BDOW move seasonally and does this change how they might overlap SPOW habitat What is home range size of BDOW What habitats do BDOW select for foraging in the landscape? Does they differ by ecosystem, or overlap with SPOW habitat requirements? Does the BDOW population now saturate available habitat?
Prey	What are prey of BDOW? How do relative proportions in the diet compare to those reported for SPOW?
Behaviour	Does BDOW behaviour change when overlapping home ranges of SPOW?

Great Horned Owl (GHOW)

Population	What is the density of GHOW in coastal ecosystems?
Habitat	How are GHOW distributed in the landscape compared to SPOW? Where do GHOW forage and does this present high risk to SPOW?
Prey	What is diet of GHOW?

Other predators

Type	What are other potential predators of SPOW?
Habitat	What habitats do these predators generally forage within?

HABITAT ENHANCEMENT

Forest structure

Stand conversion	Can unsuitable habitats for breeding and/or foraging be converted to suitable within home ranges?
Recruitment of younger stands	Can stand development be accelerated so suitable stands are grown in less than average years? Can stand structure (e.g., snags, vertical and horizontal complexity, large branches) be created? If so, how long does this take?
Landscape connectivity	Can stands be enhanced to provide connectivity for dispersal?

Prey

Abundance	Can abundance or density of prey be increased using alternative systems to enhance prey forage or nesting/denning habitat?
-----------	--

HABITAT MAINTENANCE

Forest structure

Stand-level operations	Can alternative silvicultural systems be applied that do not reduce habitat quality short term/long term?
Landscape patterns	Can landscapes be altered while maintaining dispersal habitat?

Prey

Abundance	Will retention of legacy stands help maintain prey abundance when silvicultural systems are applied to adjacent stands?
-----------	---

^aStudy questions.

^bFor example, inventory, monitoring, research, or adaptive management.

APPENDIX 3: CONCEPTUAL PROPOSAL: SPOTTED OWL RECOVERY FUND

Background

The Spotted Owl is threatened with imminent extirpation throughout its entire range in British Columbia. The species has been designated as Endangered by COSEWIC and is red-listed in British Columbia as a candidate for legal protection under the provincial *Wildlife Act*. In 2001, the Spotted Owl was assigned the highest priority species requiring recovery efforts in Canada.

In 1997, the provincial government implemented a Spotted Owl Management Plan (SOMP), anticipating that the population would stabilize and recover over the next 100 years. A population decline of 70% between 1992 and 2002 suggests that SOMP may be inadequate to stabilize the population over the short term, and extirpation is possible within the next 5 years. It is estimated that fewer than 30 breeding pairs of owls exist in British Columbia.

A Spotted Owl Recovery Team (SORT) was re-established in 2002 to address recent scientific information and develop a revised Recovery Plan for the species by 2005. The team includes members from the ministries of Water, Land and Air Protection, Sustainable Resource Management, and Forests, the Canadian Wildlife Service, Simon Fraser University, BC Environmental Network, the forest industry, and the Greater Vancouver Regional District. A Recovery Action Group has been established to develop a Recovery Fund of financial resources to sustain full implementation of the long-term recovery efforts needed to prevent extirpation.

Proposal

The provincial government will establish a Committee, either as a Recovery Action Group or independent from SORT, and empower the committee to oversee fundraising, allocations, and other expenditures of the Spotted Owl Recovery Fund. The Committee will liaise with SORT and ensure that allocations and expenditures are consistent with SORT recommendations. Committee membership will be voluntary and selection will be based on funding resource commitments of the various parties, and/or as deemed appropriate by SORT and/or government. The chair of SORT will sit as a Committee member.

The Committee will establish a public trust fund, as a non-profit organization, for the sole purpose of supporting Spotted Owl recovery efforts identified by SORT. A not-for-profit organization will be contracted by the Committee for the purpose of trust fund management and will not be permitted to use the funds without Committee approval.

SORT will be responsible for identifying funding priorities, reviewing proposals, and providing recommendations to the Committee for funding allocations and expenditures.

Through partnerships with corporate, federal, and provincial government agencies, as well as other funding sources and public donations, the goal of the trust fund is to provide a long-term sustained funding source for recovery efforts. This goal includes securing up to \$20 million as a seed source to provide long-term benefits from interest and investments that provide a sustained funding source (e.g., annual operating budget of \$1 million). Achieving this seed source, in

consideration of immediate allocation needs for recovery efforts, may require many years to attain.

It is proposed that the provincial government, in partnership with other agencies and other funding sources and public donations, support this initiative and provide annual contributions to the fund until the seed source goal has been achieved.

Purpose

A single collaborative trust fund with a sustained funding source is essential to ensure that priority recovery efforts identified by SORT are implemented in a timely manner to prevent the extirpation of the Spotted Owl. These recovery efforts are expected to be required for at least 25 years.

A single source of funding for Spotted Owl Recovery will prevent duplicate proposals sent to multiple funding sources, eliminate under-funded proposals caused by a dependence on multiple funding sources, and provide a mechanism to ensure that the proposals funded meet SORT priorities. A single source also reduces the need by various funding agencies to annually request, review, and prioritize Spotted Owls proposals.

Potential Partners

BC provincial government
Federal government
Greater Vancouver Regional District
Forest industries
Grouse Mountain Refuge for Endangered Wildlife
Habitat Conservation Trust Fund
World Wildlife Fund
Vancouver Foundation
BC Conservation Foundation (e.g., not-for-profit organization and fund manager)
VanCity Credit Union (e.g., trust fund holder)
Ethical funds (e.g., trust fund investment manager)

Other Potential Funding Sources

Public donations
Non-compliance forestry fines
Service fees

Eligible Activities

The Spotted Owl Trust Fund will be divided into four funding categories, with donations distributed among all four categories as determined by the Committee, or as specified by the donor. The four categories are research and inventory, habitat recovery, population recovery, and effectiveness monitoring.

Research and Inventory

- Monitoring population trends—including mortality, reproduction, etc.

- Habitat requirements—including home range, amounts and quality of habitat.
- Habitat and population modeling—assess habitat and population over time.
- Inventories—to determine range, distribution, and abundance.
- Predator/competitor/prey associations—including studies on Northern Flying Squirrels, Barred Owls, and Great Horned Owls.

Habitat Recovery

- Developing guidelines for the creation and enhancement of suitable habitat.
- Support forest companies in the creation and enhancement of suitable habitat.
- Workshops and training on forest practices that benefit Spotted Owls and their prey.

Population Recovery

- Operational support for captive breeding facility.
- Capture and translocation of owls.
- Annual status reports.

Effectiveness Monitoring

- Review, assessment, and revisions to management/recovery plans.
- Compliance and enforcement.
- Review and monitor the effectiveness of recovery efforts.
- Adaptive management.

APPENDIX 4: COSEWIC CRITERIA FOR ENDANGERED AND THREATENED SPECIES

COSEWIC Organization and Procedures Manual

Table 2: COSEWIC Criteria for Endangered and Threatened Species

These are essentially IUCN Red List criteria (IUCN 1994) that were reviewed and evaluated by COSEWIC (COSEWIC 1999). See IUCN Red List Categories (IUCN 1994) for definitions and interpretation guidelines.

	Endangered	Threatened
A. Declining Total Population		
Population decline rate of at least:	50% in 10 years or 3 generations	20% in 10 years or 3 generations
using <i>either</i>		
(1) population reduction observed, estimated, inferred, or suspected in the past		
<i>or</i>		
(2) population decline projected or suspected in the future.		
based on		
a) direct observation		
b) an index of abundance appropriate for the taxon		
c) a decline in area of occupancy, extent of occurrence and/or quality of habitat		
d) actual or potential levels of exploitation		
e) the effects of introduced taxa, hybridisation, pathogens, pollutants, competitors or parasites		
B. Small Distribution and Decline or Fluctuation		
<i>Either</i> extent of occurrence	<5,000 km ²	<20,000 km ²
<i>or</i> area of occupancy	<500 km ²	<2,000 km ²
<i>and</i> any 2 of the following 3:		
(1) <i>either</i> severely fragmented:	(isolated populations with a reduced probability of recolonization, once extinct)	
<i>or</i> known to exist at # locations	≤5	≤10
(2) continuing decline	any rate	any rate
in any of the following:		
a) extent of occurrence		
b) area of occupancy		
c) area, extent and/or quality of habitat		
d) number of locations or populations		
e) number of mature individuals		
(3) fluctuating	>1 order/mag	>1 order/mag
in any of the following:		
a) extent of occurrence		
b) area of occupancy		
c) number of locations or populations		
d) number of mature individuals		
C. Small Total Population Size and Decline		
Number of mature individuals	<2,500	<10,000

and 1 of the following 2:

(1) rapid decline rate of at least	20% in 5 years or 2 generations	10% in 10 years or 3 generations
(2) continuing decline <i>and</i> either (a) fragmentation or (b) all individuals in a single population	any rate all populations <250	any rate all populations <1,000

D. Very Small or Restricted

Either

(1) # of mature individuals	<250	<1,000
or		
(2) population is susceptible	(not applicable)	area of occupancy <100 km ² or # of locations ≤5

E. Quantitative Analysis

Indicating the probability of extinction in the wild to be at least:	20% in 20 years or 5 generations	10% in 100 years
---	-------------------------------------	------------------

Special Concern:

Species which are particularly sensitive to human activities or natural events but are not endangered or threatened species.

Examples of reasons why a species may qualify for “Special Concern”:

- A species that is particularly susceptible to a catastrophic event (e.g., a large seabird population near oil tanker route)
- A conservation-dependent species that would likely become at risk if not for active protection and management (e.g., a fish or mammal species protected from over-harvest)
- A recovering species, no longer qualifying for risk categories but not yet clearly secure, or subject to resumption of threat in future

Examples of reasons why a species may not qualify for “Special Concern”:

- Rarity alone in the absence of recognized threat
- Threat with little possibility of serious harm (e.g., large, fecund population subject to harvest)

APPENDIX 5: SUITABLE SPOTTED OWL HABITAT DEFINITIONS FOR BRITISH COLUMBIA (from SOMIT 1997)

Habitat Type	Superior Habitat (nest, roost, forage, and dispersal)	Moderate Habitat (roost, forage, and dispersal)
Wetter ecosystems: Maritime Coastal Western Hemlock and Mountain Hemlock Biogeoclimatic Zones		
Natural Disturbances: Rare to infrequent stand-initiating events.		
Suitable habitat characteristics	<ul style="list-style-type: none"> • Three or more canopy layers, multi-species canopy dominated by large (>75 cm dbh) overstorey trees (typically 37–185 stems/ha) • Moderate to high (60–80%) canopy closure. • Five or more large (>50 cm dbh) trees/ha with various deformities (e.g., large cavities, broken tops, dwarf mistletoe infections). • Five or more large (>75 cm dbh) snags/ha. • Accumulations ($\geq 268 \text{ m}^3/\text{ha}$) of fallen trees and other coarse woody debris on the ground. 	<ul style="list-style-type: none"> • Two or more canopy layers, multi-species canopy dominated by large (>50 cm dbh) overstorey trees (typically 247–457 stems/ha, although densities as low as 86 stems/ha are possible where large diameter trees are present). • Moderate to high (60–80%) canopy closure. • Five or more large trees/ha (>50 cm dbh) with various deformities (e.g., large cavities, broken tops, dwarf mistletoe infections). • Five or more large (>50 cm dbh) snags/ha. • Accumulations ($\geq 100 \text{ m}^3/\text{ha}$) of fallen trees and other coarse woody debris on the ground.
Dryer ecosystems: Sub-maritime Coastal Western Hemlock and Mountain Hemlock, and Interior Douglas-fir and Engelmann Spruce–Sub–Alpine Fir Biogeoclimatic Zone		
Natural Disturbances: Infrequent stand-initiating events to frequent stand-maintaining fires; however, fire suppression has increased the frequency of stand-initiating events.		
Suitable habitat characteristics	<ul style="list-style-type: none"> • Three or more canopy layers, multi-species canopy dominated by large (>50 cm dbh) overstorey trees (typically 173–247 stems/ha, although densities as low as 86 stems/ha are possible where large diameter trees are present). • Moderate to high (60–85%) canopy closure. • Five or more large trees/ha (>30 cm dbh) with various deformities (e.g., large cavities, broken tops, dwarf mistletoe infections). • Seven or more large (>50 cm dbh) snags/ha. • Accumulations ($\geq 268 \text{ m}^3/\text{ha}$) of fallen trees and other coarse woody debris on the ground. 	<ul style="list-style-type: none"> • Two or more canopy layers, multi-species canopy dominated by large (>30 cm dbh) overstorey trees (typically >247 stems/ha). • Stands must contain 20% Fd and/or Hw in the overstorey. • Greater than 50% canopy closure. • Five or more large trees/ha (>30 cm dbh) with various deformities (e.g., large cavities, broken tops, dwarf mistletoe infections). • Five or more large (>30 cm dbh) snags/ha. • Accumulations ($\geq 100 \text{ m}^3/\text{ha}$) of fallen trees and other coarse woody debris on the ground.

APPENDIX 6: ACRONYMS USED IN SPOTTED OWL RECOVERY STRATEGY

BDOW	Barred Owl
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CWMA	Critical Wildlife Management Area
dbh	Diameter at breast height
ESSF	Engelmann Spruce-Subalpine Fir (biogeoclimatic zone)
Fd	Douglas-fir (tree species)
GHOW	Great Horned Owl
GIS	Geographic Information System
GVRD	Greater Vancouver Regional District
Hw	Western hemlock (tree species)
IWMS	Identified Wildlife Management Strategy
IUCN	World Conservation Union
LRMP	Land and Resource Management Plan
LTAC	Long-term Activity Centre
MAC	Matrix Activity Centre
MELP	Ministry of Environment, Lands and Parks
MH	Mountain Hemlock (biogeoclimatic zone)
MoE	Ministry of Environment
MoF	Ministry of Forests
MSRM	Ministry of Sustainable Resource Management
MWLAP	Ministry of Water, Land and Air Protection
RENEW	Recovery of National Endangered Wildlife
RIG	Recovery Implementation Group
ROMAN	RENEW Operations Manual (April 30, 2003)
SOMIT	Spotted Owl Management Inter-Agency Team
SOMP	Spotted Owl Management Plan
SORT	Spotted Owl Recovery Team
SPOW	Spotted Owl
SRMZ	Special Resource Management zones
TSA	Timber Supply Area

WHA Wildlife Habitat Area
WNV West Nile Virus

ADDENDUM 1

Schedule of Studies to Identify Critical Habitat

Prepared by the Canadian Spotted Owl Recovery Team

24 April 2006

Schedule of inventory and research activities for identification of critical habitat for Spotted Owls in Canada.

Description of Activity	Rationale	Timeline	Activity or Report Completed
Develop survey standards for Spotted Owls.	Standards are needed to ensure sufficient effort is expended in an area to detect a spotted owl if it is present or reliably conclude owls are not present. Such standards are required to provide credible survey results.	2004	Hobbs, J., I. Blackburn, and A. Harestad. 2004. Survey protocol standards for the Northern Spotted Owl (<i>Strix occidentalis caurina</i>) in British Columbia. Resources Inventory Standards Committee, BC Ministry of Sustainable Resource Management, Victoria, BC. 34 pp.
Monitor populations of Spotted Owl to gather data on spatial and temporal variability in abundance and distribution within the species range.	Sites occupied by Spotted Owl need to be identified and monitored to determine population trend and locate occupied sites.	2004, 2005	Surveys completed by BC Ministry of Water, Land and Air Protection.
Seek and inventory undocumented populations and characterize their habitats.	Identify additional occupied sites and critical habitat. Considerable effort was spent conducting surveys in areas that contained suitable habitat for Spotted Owl but had not been included in previous surveys.	2005	Surveys and report completed by BC Ministry of Environment, including information on some additional sites surveyed by Keystone Wildlife Research Ltd., and Eco-Vision and Seepanee Ecological Consulting.
Characterize the habitats and microhabitats of Spotted Owl nest sites in British Columbia.	Quantify habitat variables for habitat mapping and habitat modeling. Further refine critical habitat.	2004	Manley, I., A. Harestad, and L. Waterhouse. 2004. Nesting habitat of the Northern Spotted Owl in British Columbia. Final Report submitted to Canadian Forest Products Ltd. and Canadian Spotted Owl Recovery Team. 46 pp.
Characterize broad climatic features of habitats for Spotted Owl populations in the United States.	Helps to identify constraints on suitable habitats in British Columbia.	2004	Main, B. and A. Harestad. 2004. Climatic indices and population parameters of Northern Spotted Owls: implications to management in British Columbia. Final Report submitted to Canadian Forest Products Ltd. and Canadian Spotted Owl Recovery Team. 35 pp.
Identify characteristics of Spotted Owl habitat in British Columbia	Helps refine suitable habitat and thus ensure surveys, monitoring and identification of critical habitat are more efficient and accurate.	2004	Harestad, A., L. Waterhouse, and S. McCullam. 2004. Refining characteristics of Spotted Owl habitat to improve habitat inventories in British Columbia. Final Report submitted to Canadian Forest Products Ltd. and Canadian Spotted Owl Recovery Team. 27 pp.

Schedule of inventory and research activities for identification of critical habitat for Spotted Owls in Canada.

Description of Activity	Rationale	Timeline	Activity or Report Completed
Develop and apply habitat mapping and modeling to assess relations of protected areas, natural disturbances, and land management activities to Spotted Owls and their habitats.	Identified large-scale areas which likely contain critical habitat for Spotted Owls to meet recovery goals in 50 years; examined population trends, examined preliminary policy options reviewed by the CSORT; presented methods to identify options for critical habitat selection.	2004-2006	Sutherland, G.DA. Fall, D. O'Brien, F.L. Waterhouse, and A.S. Harestad (editors). A framework for landscape analysis of habitat supply and effects on populations of the Northern Spotted Owl in BC. Submitted to BC MoFR, Res. Br., Vic., BC. Spec. Rep. (in review).
Develop seamless database of forest inventory.	Forest type and age class are needed for habitat modelling of suitable Spotted Owl habitat	2004-2005	Ministry of Water, Land, and Air Protection and Ministry of Forests.
Complete draft Recovery Action Plan for Spotted Owl	Using all information gathered from the above actions and sources, draft a Recovery Action Plan that includes a habitat section that gives sufficient recommendations and guidance to the provincial government to enable them to identify Critical Habitat	2004-2006	CSORT final draft Action Plan for Spotted Owl in BC submitted to provincial government for approval.
Identify Critical Habitat for survival, recovery and potential reintroductions, including existing suitable habitat and capable habitat that can be recruited over time.	Consider guidance from Action Plan recommendations, habitat mapping, modeling and other relevant information sources to identify Critical Habitat and develop a habitat management plan for Spotted Owl recovery that is coordinated with existing protected areas and land use/management activities	2006-2007	Ministry of Environment to provide identification of Critical Habitat and a revised Habitat Management Plan for the recovery of the Spotted Owl in BC.