An Alternate Recovery Strategy

For the Northern Spotted Owl
in British Columbia, Canada

January 2004

Prepared by

Andrew Miller, MSc.

Member of the British Columbia Spotted Owl Recovery Team

Published by

Western Canada Wilderness Committee

An Alternate Recovery Strategy

For the Northern Spotted Owl in British Columbia, Canada

January 2004

Cover photo: Sharon Toochin
ISBN 1-895123-14-3
Printed in Canada on recycled paper

Acknowledgements

Although this report is published by the Western Canada Wilderness Committee, it was independently written by Mr. Andrew Miller, a former member of the British Columbia government's Spotted Owl Recovery Team. The Wilderness Committee would like to acknowledge Mr. Miller for his courageous efforts towards preventing the extirpation of the Canadian population of Northern Spotted Owls.

By resigning from the British Columbia Spotted Owl Recovery Team in January 2004, and writing this alternate recovery strategy, Mr. Miller has joined the ranks of biologists, government employees and others who have taken a stand against species extinction, often at great risk to their careers.

One can only hope for the day when individuals charged with the task of providing objective, scientific analysis will no longer risk persecution for speaking out when government will not.

Andrew Miller, MSc.

Andrew Miller is a professional wildlife biologist specializing in the study of endangered birds. Mr. Miller has a MSc. from the Forestry Department at the University of Alberta, Canada and was conducting his PhD on the modeling of habitat relationships of songbirds in oldgrowth boreal forests when he took a leave of absence to spend time with his young daughter. Mr. Miller has conducted extensive research, inventory and monitoring of endangered species, in particular the Spotted Owl, with the United States Forest Service and the Oregon Cooperative Wildlife Research Unit on behalf of the US Fish and Wildlife Service.

Mr. Miller was a member of the BC Spotted Owl Recovery Team until January, 2004 when he resigned in protest over government inaction to protect this critically endangered bird.

Western Canada Wilderness Committee

The Western Canada Wilderness Committee is Canada's largest membership-based citizen-funded wilderness preservation organization.

227 Abbott Street, Vancouver, BC V6B 2K7 CANADA
Phone: 1-800-661-WILD (free toll in Canada and US)
(604) 683-8220 (Vancouver area)
www.wildernesscommittee.org

Contents

EXECUTIVE SUMMARY

An Alternate Recovery Strategy

For the Northern Spotted Owl in British Columbia, Canada

The Northern Spotted Owl has been designated "endangered" in Canada since 1986 by the "Committee on the Status of Endangered Wildlife in Canada" (COSEWIC). The owl is on British Columbia's most endangered list, the "red list", with a ranking of "S1" meaning it is critically imperiled. In the United States, the owl has been listed as federally threatened since 1990 (USDI, 1990) and is listed as threatened by the states of Oregon and Washington (Blood, 1998). Federal migratory bird legislation in Canada does not apply to "raptors" and thus management of the Spotted Owl is a provincial jurisdiction, with legislated oversight by the federal government.

The British Columbia (BC) government convened a Spotted Owl Recovery Team (SORT) in 1990 to create a recovery plan for the species. However, the SORT was disbanded and replaced by bureaucrats in 1995 after the scientists failed to support a BC government imposed, socio-economic based, Spotted Owl Management Plan (SOMP) which had only a 60% chance of success.

The owl declined more dramatically than estimated throughout the late 1990s and early 2000s after SOMP was implemented.

Photo: Robert Lankinen/First Light.

Due to public pressure, SORT was re-convened to develop a scientific recovery plan as originally intended. In extensive deliberations consistent with federal protocol, SORT has since deemed that recovery of the owl is biologically and technically feasible, although socio-economic factors challenge recovery.

The owl declined from an estimated historic population of 500 adult pairs to less than 33 pairs in 2002. Only 15 owls were located during the 2003 survey efforts. The Committee On the Status of Endangered Wildlife In Canada (COSEWIC) has determined that a population of 250 adult owls would be necessary for downlisting to "threatened" status. Recovery is an ambiguous term and many uncertainties are inherent in the determination of what constitutes "recovery". The exact number of owls and an appropriate distribution that signifies recovery will likely not be known until it is achieved. Thus, until ideal distribution and population viability numbers are refined and/or achieved, a goal of achieving 250 adult owls will be a focal point of all recovery actions.

Because of the many inherent uncertainties around recovery, this recovery strategy calls for Emergency Interim Measures (EIM) to immediately and permanently protect the owls' remaining unprotected high quality type A habitat (379,251 ha) as a precautionary measure. Further, this strategy calls for a temporary moratorium on logging all the owls' lower quality unprotected type B habitat (106,207 ha) until the ideal distribution, and amount, of additional habitat to be protected and/or managed is determined through recovery action planning processes. SORT had a similar recommendation to protect all type A and B habitat in an earlier draft of their Recovery Strategy, until a complete and exhaustive inventory of owls was conducted. However this recommendation, along with a recommendation that sufficient knowledge exists to define critical habitat, was removed from the final draft, based in part on timber industry concerns.

Although SORT, in it's preparation of a recovery strategy, was guided by Federal directives to "provide scientific advice….and flesh out the structure of recovery actions" (RENEW, 2003), it failed to do so. SORT also failed to live up to spirit of Canada's new endangered species legislation, the *Species At Risk Act* (SARA), which directs that recovery strategies must be purely scientific, with no consideration of socio-economics, and that recommended recovery actions must not be limited by lack of absolute scientific certainty. To this effect SORT failed to identify critical habitat, despite adequate information to do so, and failed to adequately identify and recommend habitat protection measures by using "scientific uncertainty" as a rationale. SORT's recovery strategy limits future protection of type A habitat by emphasizing the creation and management of new habitat from regrowing clearcuts rather than protection of the old growth habitat which already exists. SORT's emergency "interim management guidelines" resulted in a recommendation to protect only 1% of the total amount of Spotted Owl habitat remaining in BC. This additional "protection" was to be achieved by transferring protected area "credits" from one Spotted Owl protection area to another.

SORT's recovery strategy had high scientific rigor in its description of the owls' biology and the ecological crisis affecting Spotted Owls. However, SORT discounted the need to protect additional type A survival habitat, without evidence, by claiming that areas from which owls have recently and inexplicably died are now suddenly available for immediate re-colonization.

SORT's recovery strategy also failed to identify that the current amount of habitat protection may be a limiting factor. SORT's recovery strategy based future habitat protection largely on recruiting new habitat from the managed (logged) landscape even though it will be at least 50 years before low quality habitat from re-growing clearcuts is recruited in appreciable quantities. It must be emphasized that the Spotted Owl does not have a long term unless decisive and bold action is taken immediately. Further, evaluation criteria were not precise nor measurable.

SORT recommended that future spatially explicit habitat and population modeling form the basis of critical habitat and population viability definitions. Although population and habitat modeling are a necessary component of recovery, to delay habitat protection based on the need to clarify perceived uncertainty, is without basis and contrary to federal directive (RENEW 2003). Further, to base future definitions of survival and recovery habitat on extremely imprecise, gross scale conclusions from habitat modeling exercises is scientifically indefensible.

Yet ample scientific evidence exists regarding the Spotted Owl to develop an effective recovery strategy, as

demanded by the owls' current status. In fact, knowledge of the intricacies of Spotted Owl ecology is greater than for any other forest dependant species in North America. In anticipation of the requirements of the SARA and RENEW, this document applies that science to arrive at an alternate recovery strategy with the sole objective of achieving the species' recovery according to federal directives from the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). A primary difference is that this alternate recovery strategy highlights the need for short-term action based on habitat protection and augmentation, because the owl does not have a long-term. Based on current timelines the owl could be extirpated or declared "not recoverable" before SORT's strategies can be implemented.

This Spotted Owl recovery strategy, like SORT's, applies to a geographic area claimed by Coast and Interior Salish speaking people from the Squamish, Stolo, Nlaka'pamux, and Stl'atl'imx First Nations. BC's Spotted Owl range is located in the southwestern coast of British Columbia and extends from the international border 200 km north to Carpenter Lake, 100 km east to Lillooet, and southeast to the international border near Manning Park. All First Nations in this area have outstanding claims for their traditional territory. A memorandum of understanding with First Nations regarding Spotted Owl recovery is still needed. At time of publication, First Nations representation was absent from SORT.

Despite being established by BC government directive, SORT has received only 3% of funds requested from the BC Government to achieve recovery planning. Further, government failed to acknowledge SORT's Interim Management Guidelines submitted early in 2003. As a result of a lack of BC government support, some SORT members openly question the value of their continued participation. Federal representatives on SORT have criticized the process for extreme under-funding and the team for failing to define and recommend action to enable the protection of survival habitat.

In December 2003, the BC government returned the final recovery strategy to SORT for editing. The BC government asked SORT to 1) clarify the feasibility of recovery, despite very clear policy that directs SORT to conclude that the species is recoverable unless proven otherwise; 2) include discussion of a scientifically discredited forest industry sponsored report (the Keystone Report) which effectively claimed that Spotted Owls are not declining; 3) Conduct yet another time consuming and unnecessary scientific review of the data used by SORT, as per timber industry directive, to determine the downward owl population trend.

Background

The Northern Spotted Owl (Strix occidentalis caurina) is critically endangered due to historic and ongoing clearcut logging of its old growth forest habitat. However, recovery of the owl is complicated by other "secondary" factors associated with extreme forest fragmentation, which results in demographic and genetic change and increased predation.

Concerns about the status of the owl first arose in 1969 (Marshall, 1969), and was closely followed by a PhD thesis (Forsman, 1972) that found that owls preferred forests which were aged 220-600 years. Forsman subsequently found that 94% of roosts and 89% of nests were in old growth (Forsman et al 1984).

30 years of intensive international research has resulted in an unprecedented level of knowledge about the owls' habitat requirements and ecology. Indeed, the owl is one of the most well-studied wild animals on earth. The owls' need for very large, inter-connected old growth reserves is well known. In addition, the owl's extensive movement patterns of up to 111 km require habitat protection above and beyond inter-connected old growth reserves. Habitat protection in "matrix areas" outside old growth reserves has been under-valued and is a factor in the owl's decline. Given the owl's extensive movement patterns, protection of all remaining high quality habitat is warranted. Pockets of remaining high quality type A habitat will, if protected, provide heterogeneity in the homogenous landscape that will result from regrowing clearcuts.

Eight percent of the Spotted Owls' range and 1% of its population (less than 33 pairs) currently occurs in British Columbia, almost entirely on public land. The owl has declined 90-97.5% from historic pre-European population estimates. From 1992-2002 the owl declined by 67% at an annual rate of –10.4% (Blackburn and Godwin, 2003). At the current rate of decline, SORT estimates the owl will become extinct in BC within a few (three or more) years (SORT, 2003).

The majority of high quality Spotted Owl habitat has been surveyed repeatedly, but a comprehensive inven-

tory of all low and high quality habitat has never been undertaken. Although inventory is a high priority, it is informally estimated by the Spotted Owl Recovery Team (SORT), based on habitat availability, that a maximum of only ten new owl sites would be discovered.

Since a limited number of owl surveys began in 1985, 66 owl sites have been located in BC. SORT informally estimated in late 2003, that there were less than 25 pairs, and possibly less than 25 individuals remaining, which is a 95% and 97.5% reduction respectively in the owls' estimated historic population in BC.

The causes of the owls' impending extinction in BC are multifaceted. Loss of habitat and physical isolation of owls caused by extreme habitat fragmentation have negatively influenced survival, reproduction, recruitment and immigration rates. However, there are other secondary threats that are compounding the problems of habitat loss and reduced habitat connectivity. These threats include competition and hybridization with Barred Owls, predation by other raptors (particularly in logged areas), climate change, loss of genetic diversity, random environmental events, and disease. Although secondary factors may currently be defining components of the owls' decline, SORT's failure to recommend an end to the primary factor of decline, ongoing habitat loss, is not scientifically defensible because it will hasten the owls' decline and limit the owls ability to recover. Six of the remaining unprotected owl sites are being logged and one of the three known offspring from 2003 telemetry study was killed near a logging operation in January, 2004.

Challenges to recovery include:

- A potential lack of political will to implement necessary type A and B habitat protection measures in the face of forest industry pressure to minimize the impact of protections.
- BC Government failure to follow direction from and/or influence the outcomes of SORT.
- BC Government failure to fund inventory, monitoring, and augmentation of the small and isolated population.
- Continued SORT reliance on an ineffective and socio-economic based Spotted Owl Management Plan (SOMP), approved in 1995, which applies only to owls found between 1992 and 1995, and which has since witnessed a decline in Spotted Owls.

The US Forest Service is now considering recommendations from former Chief Executive Officers (Forest Service Chief's) for a complete ban on logging old growth forest within the range of the northern Spotted Owl. Spotted Owl habitat declined on US public land from 17.5 million acres in 1800 to only 7.1 million acres in 1989, a loss of about 60% of the original habitat, and the loss was far greater on private and state land (Thomas et al. 1990). Despite a protection plan somewhat superior to SOMP, the owl continues to decline in the US. Thus, total protection has been recommended for the owl's old growth habitat by the principal author of the original protection plan, among others.

Emergency Recommendations

Based on the extensive scientific knowledge of the Spotted Owl and causes of its endangerment, emergency interim measures (EIM) must be immediately implemented to forestall extirpation. These measures must:

1. Permanently protect all of the owls remaining type A (high quality) habitat. Type A habitat is known and mapped (379,251 ha.).
2. Implement a temporary logging moratorium on all lower quality type B (106,207 ha.) and non-habitat until the spatial distribution of forests that must be protected and/or managed for the owl is refined. Type B and non-habitat are known and mapped.
3. Provide immediate funding for inventory and population augmentation to forestall extinction of the owl in Canada (extirpation).

PART ONE

COSEWIC Listing Information

Physical Description of the Spotted Owl's Canadian Range

The range of the Spotted Owl in BC is characterized geologically by rugged, high elevation coastal mountain ranges separated by narrow strips of lush, old valley bottom forest. Spotted Owls are restricted to lower elevation (generally less than 900m) old growth forests, which occur in these strips of lush forest between mountain ranges. These strips of old growth forest have been largely eliminated or severely fragmented due to clearcut logging (Hodum et al 2002). Thus, the owl no longer occurs over much of its former range but instead is confined to the few concentrations of habitat remaining. 16% of the land-base is protected in parks but only about two-thirds qualifies as habitat (high and low quality), and only one-third is high quality type A owl habitat.

The owl has also been forced to partially abandon much of its former low elevation forest, and in many areas the owl now resides predominantly in marginal higher elevation habitat (up to 1,370m) where reproductive capability is diminished. Franklin et al (2001) found that vigor is a defining attribute in the relationship between forest age (habitat quality) and reproduction. Thus, as the owl is forced to exist in lower quality forests, it is logical to conclude that reproductive fitness is compromised. The owl no longer inhabits many areas where it was presumed to exist prior to logging, and it also no longer inhabits many areas with historic owl records.

Distribution and Range of the Spotted Owl (Global and Canadian)

The Spotted Owl (Strix occidentalis) is a non-migratory bird with three sub-species found only in North America: the Northern Spotted Owl (Strix occidentalis caurina), the California Spotted Owl (Strix occidentalis occidentalis), and the Mexican Spotted Owl (Strix occidentalis lucida). This recovery strategy focuses on the Northern Spotted Owl, which ranges from Northern California to British Columbia (BC). Unless otherwise specified, all subsequent reference to Spotted Owl or "the owl" in this report refers to the Northern subspecies, Strix occidentalis caurina.

The entire Canadian population of Spotted Owls occurs in southwestern BC and, according to BC's principal government expert, historically may have numbered 1000 adult paired individuals (Blackburn and Godwin, 2003), and an unknown, but possibly equal, number of non-adult owls. In BC, the owls' current range extends 200 km north of Vancouver to Carpenter Lake, east 100 km to Lillooet, and southeast to Manning Park at the US border. The owl's current range extends west to the coast only in the extreme south of its range near Vancouver. However, based on historic observations and on the presence of suitable habitat the owls' historic range likely extended west to the mainland coast in the Sunshine Coast Forest District, thus expanding the owls range by 23%. The cause of the apparent abandonment of the western 25% of its' potential historic range is unknown. However, the pattern is consistent with the current observed trend of owls abandoning territories from west to east. This recovery strategy however, addresses only the owls' currently known range since 1985. Based on this current range, 8% of the owls' North American range is located in Canada.

Population Abundance

The global population of Spotted Owls is estimated at about 6,000 potential breeding pairs (Forsman et al. 2003). The population includes 2,300 in California, 2,900 in Oregon, 860 in Washington, and 33 in British Columbia. Most reports use a range of 3,000-6,000 potential breeding pairs.

The northern sub-species is estimated to have a population of about 2,800 pairs (Forsman et al. 2003). BC is estimated to have about 1% to 2% of the global population and 8% of the global range. Recent unpub-

lished data for the northern sub-species as of 2004 suggest that about 2,500 pairs remain in Oregon, 400 pairs remain in Washington and less than 25 pairs remain in BC (Forsman, pers. comm. 2003). Washington and BC have had the most pronounced recent population declines.

Abundance figures include only adult potentially reproductively active birds (>three years old), as younger owls do not directly contribute to recruitment. The number of sub-adults in BC is unknown, but based on very high juvenile mortality rates and low reproductive success of the known pairs in BC, there may be few sub-adult birds alive in BC. No sub-adult owls have been confirmed in BC, and the existing population is of advanced age (avg. nine years). However, young owls are generally not strongly territorial and thus are extremely difficult to locate. Spotted Owls live up to 17 years in the wild and are generally not reproductive after age 12 (G. Miller, pers. comm.).

The high juvenile and sub-adult mortality rate (75%) suggests that the population of non-adult owls required to maintain a healthy population of owls is at least equal in size to the adult population (E. C. Meslow, pers comm.).

Population Trend

Prior to European settlement in Canada within what is now referred to as the Chilliwack and Squamish Forest Districts, which cover the majority of the owls' range, the size of the Spotted Owl population in Canada was estimated at approximately 500 adult pairs (Blackburn et al. 2002). The Canadian population was estimated at fewer than 100 pairs in 1991 based on low response rates during field inventories conducted from 1985 to 1988 (Dunbar 1991, Dunbar and Blackburn 1994). Recent estimates of the size of the Canadian population are less than 33 potential breeding pairs in 2002 (Blackburn and Godwin 2003). The SORT unofficially estimated, in late 2003, that less than 25 pairs and possibly as few as 25 individuals remain, a 95% and 97.5% reduction, respectively, in the estimated historic population. This low estimate was based in part on the fact that in 2003, only 15 owls were located at ten sites in BC during a survey, which visited most of the recently known sites once or twice. If the population is only 15 owls, then the population has been reduced by 99%.

During inventory and monitoring conducted between 1992 and 2001, Spotted Owls were located at 65 sites in British Columbia in the Squamish, Chilliwack, and Cascade Forest Districts. 40 of these sites were monitored for occupancy between 1992 and 2001. The data 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% and -8.9%, Blackburn et al. 2002). The population declined an additional 35% between 2001 and 2002. Between 1992 and 2002 Spotted Owls declined by 67% at an average rate of -10.4% per year (Figure 3, Blackburn and Godwin 2003).

Monitoring of Spotted Owls at 15 different demographic study areas between 1985 and 1998 in the US showed an annual female population reduction of -3.9% (95% C.I. = +/- 3.6%) (Franklin et al. 1999). A 60% decline between 1992 and 2002 was found at the Cle Elum study area in Washington (Forsman et al. 2002b). 2003 survey data from US populations suggest that the owl is declining throughout its range but more rapidly farther north (J Buchanan, E Forsman, pers. comm.).

PART TWO

Biologically Limiting Factors

Biologically limiting factors are life history characteristics that may influence recovery and may make a species susceptible to disturbance, such as clearcut logging in the case of the Spotted Owl.

Recruitment

Spotted Owls have a naturally low reproductive recruitment rate: sexual maturity is delayed, clutch size is small and juvenile mortality is high. High juvenile mortality is somewhat offset by high adult survivorship. However, when a population is crashing, high adult survivorship becomes irrelevant because the few young owls that do reach adulthood are extremely unlikely to be able to locate another adult without population augmentation such as the physical relocation of owls.

Reproduction

Spotted Owl populations have reproductive cycles characterised by high variance in the number of owls breeding in a given year (Franklin et al. 2002). Indeed, several studies have found that the majority of Spotted Owls do not breed every year (Gutierrez et al. 1995). In one study area in Oregon, however, the percentage of breeding females each year averaged 56% (range: 18-82%) over 18 years from 1985 to 2002 (Forsman et al. 2002b). The cause of poor reproductive years is unknown but is related to an aging population with reduced recruitment. Poor reproduction may also be related to environmental events such as climate change, caused at the stand level by extensive logging that alters interior forest micro-climate conditions important to Spotted Owls, and at a larger scale by chemicals in the atmosphere.

Most Spotted Owls do not successfully reproduce until age three, and although a high proportion of younger owls are paired, successful breeding is delayed until adulthood (Forsman et al. 2002a). Average age of successful breeding in Oregon was 3.5 years (Forsman et al. 2002b). Owl reproductive rates generally slow with age and there are few successfully reproductive pairs over age 12 (E. Forsman, pers. comm.). Reproductive rates may be influenced by other factors associated with logging such as prey abundance, increase in predator numbers, and micro-climate conditions.

Clutch sizes range from one to three eggs. Of 2,113 broods examined from 1984 to 1994, 42%, 56%, and 2% contained one, two, and three fledged young, respectively (Gutiérrez et al. 1995).

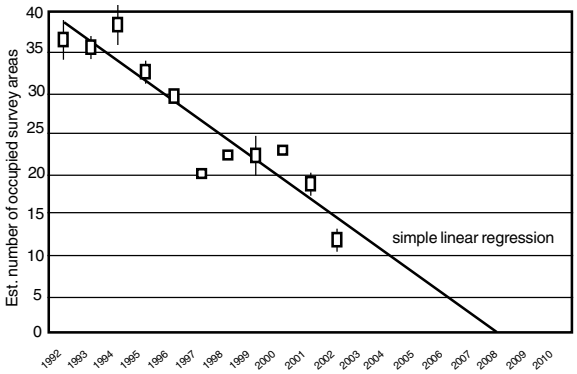


Figure 1 (SORT, 2003). Estimated number of occupied survey areas among the 40 survey areas from 1992 to 2002 (with 90% C.I.). The Linear Multiplicative model suggests the number of occupied survey areas declined by about 67% at an average annual rate of -10.2% (Blackburn and Godwin 2003).

Dispersal

Juvenile Spotted Owls disperse from the nest at the end of the breeding period, usually in September. Spotted Owls often do not find permanent territories until between 2 and 5 years of age. About 6% of single adults disperse annually (Miller et al. 1997, Forsman et al. 2002a).

Juveniles disperse in random directions, an average of 14 km for males and 24 km for females, and up to 110 km, in search of new territories. Due to extreme fragmentation and rugged landscapes, dispersal distances in BC may be greater. Dispersal is technically concluded when an owl resides at a new location for more than a few days, although the bird may disperse again if habitat conditions are not suitable. Some owls search unsuccessfully for a permanent residence for years (Forsman et al. 2002a).

Dispersal may be influenced by barriers such as mountains and large areas of unsuitable habitat such as clearcuts (Thomas et al. 1990, Miller et al. 1997, Forsman et al. 2002). Miller et al. (1997) found that clearcuts represent a barrier to dispersal. The quality of dispersal habitat is a critical factor affecting both the distance traveled in search of a territory and the threats posed by predators during dispersal. Spotted Owls' historic dependence on old growth forests suggests that they are not accustomed to predators outside this system. Thus, as the proportion of clearcuts increases, the relative threat to Spotted Owls from predation also increases because most predation of Spotted Owls occurs by habitat generalists, which prefer younger forests.

Survival

Survival of juveniles is low and is considered a major limiting factor in population recruitment (Gutiérrez et al. 1995). On average about 75% of Spotted Owls die before they reach adulthood. However, anecdotal information in BC suggests this number may be closer to 100% (SORT, 2003). In one study only 15-28% of juveniles survived their first year. On average about 50% of fledglings die before or during dispersal (Forsman et al. 2002a). Adult owls, however, are long-lived averaging 84% annual survival (Gutiérrez et al. 1995, Franklin et al. 1999). Some banded individuals are known to survive to at least 16-17 years (Gutiérrez et al. 1995). Survival is largely predicated on the level of fragmentation young owls experience while searching for a territory.

It is unknown whether such high mortality rates are normal as Spotted Owls have never been, and can not be, studied in a natural condition. Regardless, it is logical to assume that mortality rates of juveniles and adults would be significantly less if fragmentation was decreased.

Mortality

Adult Spotted Owls have high survivorship. However, when adult Spotted Owls die prematurely it is most commonly of starvation, especially in fragmented landscapes and in younger forests lacking important structural attributes where prey populations are limited and predators more abundant. Owls in drier northeastern extremes of the species' range prey on a wider range of species and thus are less subject to limited availability of flying squirrel. The greater diversity of prey selected in the northern and eastern extreme of the owl's BC range may be an explanation for the fact that the majority of owls in 2002 and 2003 were located in this drier region.

Sub-adults die most commonly from predation (68%), primarily during dispersal when they are forced to exist in marginal habitat or have to fly across large clearcut areas to access patches of suitable habitat. Avian predators that prefer fragmented landscapes include great horned owl, red-tailed hawk, raven, and barred owl (Forsman et al 2002a). Goshawk is a natural predator with which the Spotted Owl has co-evolved and thus has some defense against. However, goshawk generally prefer smaller avian prey.

Predation in BC may play a proportionally larger role in limiting the Spotted Owl population due to the small and more fragile nature of the population and the more fragmented landscape. In BC, forests managed for timber are characterised by much larger clearcuts and higher levels of fragmentation than is allowed in US public forests, where most owls now reside. In BC, the extreme level of fragmentation and limited dispersal and movement corridors resulting from the more mountainous geography may also be a compounding factor negatively affecting owl mortality.

Disease and Parasites probably play a significant role in owl mortality, especially given the small and physiologically stressed population (Forsman et al. 2002a). However, disease and parasites are natural sources of decreased fitness and mortality common to all predatory birds (Gutierrez et al, 1995).

PART THREE

Habitat Requirements

Spotted Owls rely on old growth forests for nesting, roosting, safety, and hunting, movement and dispersal requirements. Many variables affect the relationship between reproductive success and forest age class, however, there is a strong relationship between forest age, and Spotted Owl survival and reproduction. Franklin, (2001) found that vigor is a defining attribute in the relationship between age class and reproduction with vigor increasing in older stands. The complexity and multiple inter-relationships of ecological variables regarding the owls association with old growth forests are such as to defy simple management solutions based on modeling (models are based on maximum simplification and/or isolation of only some of the important variables which affect habitat suitability, population attributes and viability). Modern management solutions necessarily under-represent the complexity of, and the multiple inter-relationships among, ecological variables. Thus, a complex habitat specialist, like the Spotted Owl, with a small rapidly decreasing population, is not suited for some modern forest management solutions based on theoretical minimum protection levels and computer modeling program-based simplification. Models are best used to evaluate habitat protection, after the fact, when a large sample is present and where ecological variables are simple, not complex. Thus, given the unknowns, the only solution consistent with the precautionary principle is to protect all owl habitat until proven otherwise.

Spotted Owls need very large expanses of structurally complex old forest. Stands of old forest must also be interconnected to accommodate the owls' extremely wide ranging and random movement patterns. Within old forests, Spotted Owls select stands with the largest trees, the most diverse species assemblage of trees restructural diversity, the most complex canopy structure, the greatest diversity of dead, standing and fallen, woody debris and snags spanning al decay and size classes, and the most cool and humid forest available (Thomas et al 1990, USDI, 1992). Old forests not affected by high levels of fragmentation generally have a cool micro-climate which is highly favoured by Spotted Owls (Gutiérrez et al. 1995). In most of the owls range these habitat characteristics are maximized in large stands older than 140 years, but frequently these forest structure attributes are not fully developed until stands are older than 250 years.

Spotted Owl habitat in BC is also characterized by being more heterogeneous at the landscape level than in the US. In BC, extremely rugged terrain is characterized by climatic extremes. Temperatures range from -40 to +40 centigrade and precipitation ranges from 20-150 inches. Further, BC has more continuos precipitation patterns in most areas whereas in the US, 90% of precipitation occurs from October through May. As a result, BC has more redcedar component in Spotted Owl habitat, and longer stand replacing disturbance cycles.

Home Range Requirements

Home range size depends on habitat quality, fragmentation, heterogeneity of the landscape, food availability, competition, and predators (USDI, 1992). As logging induced fragmentation increases, home range size increases (Carey et al 1992). Logging in BC, due to geological necessity, has been extremely concentrated in valley bottoms, and thus has created a greater amount of fragmentation than in most other public land jurisdictions in the US. Logging in southwestern BC has been concentrated in the very ecosystem sub-units (BEC subzones) upon which Spotted Owls are most highly dependent, and this has forced Spotted Owls to colonize areas of less suitable, higher elevation habitat (Blackburn and Godwin, 2003). Where fragmentation is less regulated on US state and private land, Spotted Owls have

been almost completely eliminated or are confined to very small habitat patches where their vigor is compromised and home range cannot be assessed with validity. Occasionally, Spotted Owls occupying state and private land are located in extremely productive floodplain forest fragments which may be smaller in size than is typical. However, these exceptional situations, like owls in redwood forests, should not be generalized upon because they are unique to a tiny fraction of the landscape.

Spotted Owl home ranges are very large and are generally larger in the north and west, and in highly fragmented areas (Gutiérrez et al. 1995, Forsman et al. 1984, Thomas et al. 1990, Carey et al. 1990). There is generally a strong relationship between high levels of fragmentation and low survivorship of Spotted Owls (Bart 1995, Riple et al 1997, Myer et al 1998, Bart 1995 and Forsman et al 2002a). Home range size is determined by many factors including age of forest, level of fragmentation and prey availability (Carey et al. 1992).

Home-range allotments for Spotted Owls in BC are likely too small (Blackburn and Godwin, 2003) and may be a direct contributor to the owls present endangerment. Home-range figures used for management of the Spotted Owl in BC were adapted from a more homogeneous environment in the US Cascades. In the US Cascades the owls likely have smaller home-range requirements than in BC's heterogeneous forests which characterize the overwhelming majority of owl habitat in BC. Regardless, home-range size is very large throughout the owls range and is principally linked to low prey (flying squirrel) density, limited high quality hunting habitat, and low nest site availability (Carey et al. 1992).

Studies in Washington found home ranges from 1,302 - 11,047 ha (Hansen et al. 1993) and 2,100 - 4,000 ha. (Gutierrez et al. 1995). Blackburn and Godwin (2003) found home ranges in BC ranging from 1,732 - 4,644 ha. based on a sample size of three which were not recorded to protocol because of limited tracking duration. Median annual home ranges of Spotted Owl pairs were larger in the central Washington forests (3321 ha, 67% suitable habitat) than the drier eastern forests (2675 ha, 71% suitable habitat, Hanson et al. 1993). Home ranges in the Olympic range, which is the most ecologically similar to the owls preferred CWH habitat in BC, were larger (5,500 - 11,000 ha) and had similar, extreme levels of fragmentation (over 50%) as is characteristic in BC. The net home range size of owls in the Olympic range were larger than the home range allowances allocated to owls in BC.

For management purposes, the median home-range size used in BC is 3,200 ha. (67% suitable). This figure may be too low for the majority of Spotted Owl habitat in BC (SORT, 2003). Given the widely accepted theory that Spotted Owls in the western and northern extreme of the range have larger home range requirements, and that fragmentation levels in BC are higher than other public land jurisdictions, maximum rather than median home range sizes should be used until data suggests otherwise.

Nesting and Roosting Requirements

Spotted Owls have high nest site fidelity, frequently using the same nest or alternating between two nesting trees for many years (Gutiérrez et al. 1995). Nest site availability is a limiting factor affecting territory establishment and limiting population density. Spotted Owls predominantly use existing cavities in large diameter old growth trees for nesting. In drier eastern habitats primarily east of the Cascades and in similar very dry atypical habitats were large nesting cavities are less available, owls use mistletoe platforms and abandoned hawk nests when suitable large diameter cavities are unavailable (Buchanan et al. 1993, Forsman et al. 1984; Dawson et al. 1986, Forsman and Giese, 1997). In 2002, two nests in drier northeastern areas of British Columbia were located in abandoned hawk nests (Hobbs 2002). In BC, sites where owls would be expected to regularly use non cavity nesting structures are likely limited to a small portion of the owls range in the Lillooet Forest District, which encompasses about 13% of the owls overall present habitat.

Many tree species are used for nesting, provided large cavities are present (Forsman and Giese 1997). Although limited nest site data exists in BC, most commonly owls use cavities or broken tops in large diameter western hemlock, redcedar, silver (amabilis) fir and Douglas fir.

Spotted Owls' thermoregulatory connection to old growth habitat is well known (Barrows, 1981 Gutierrez et al, 1995). From a thermoregulatory perspective old growth forest is perhaps most important for roosting, which typically occupies the majority (60%) of the owls daily activity budget (G. Miller, pers. comm.). Carey et

al. (1988) and Forsman et al (1984) found that 88% and 94% respectively of roosting habitat was in old growth forest. Spotted Owls easily succumb to heat stress and thus roosts are typified by cool, dark, and moist locations which generally occur low in the canopy, on lower, often north facing, slopes, in areas with high diversity of structural attributes and often near water or moist ground (Blakesley et al. 1992, Barrows 1981, Carey et al. 1992). Spotted Owls regulate their body temperature on extremely hot days through gular fluttering which requires a high energy expenditure and results in sleep deprivation. Thermoregulatory factors are probably associated with the absence of Spotted Owls from south facing slopes and areas east of the Fraser River in the northeast part of their range.

Foraging, Prey, and Predator Protection Requirements

Spotted Owls are a perch and pounce (sit and wait) predator. North of the Columbia River separating Oregon and Washington, owls primarily feed on flying squirrels while further south, and east of the Cascades they feed on a mix of flying squirrels and other rodents (Gutiérrez et al. 1995, Buchanan, J. 1996).

Habitat suitability and home range size for Spotted Owls is strongly associated with prey availability and predator avoidance. Avoidance of predators and successful hunting is most likely in very old intact forests. Two of the most significant challenges facing Spotted Owls is finding sufficient food and avoiding predators (Weathers et al 1991). The interplay between successful hunting and predator avoidance is a crucial ingredient in Spotted Owl's selection of hunting habitat. The density of prey is only one of many factors that influence successful hunting.

Many authors have observed that prey selected by Spotted Owls, particularly their dominant prey source northern Flying Squirrel, are more abundant in older forests with high structural diversity and high, dead-and-down woody material content (Carey et al 1992, Hilton and Hilton, 2001). Flying squirrels do select younger forest if advanced structural criteria are met, although there is a preference for old growth forests (Ransome and Sullivan 2003, Forsman et al. 1994, Carey et al. 2002, Hamer et al. 1998). Flying squirrels are found in younger forests that were subject to non-stand replacing disturbance events such as low and moderate intensity fire and single tree or small group selection logging.

However, it is not only abundance of prey which drives Spotted Owls to select old growth for hunting. Other factors accentuate the importance of old growth to owls for hunting such as protection from predators, thermoregulatory and possibly other physiological functions, and specific aspects of stand structure to facilitate hunting. Younger forests aged 60-140 years may contain flying squirrels but they do not necessarily meet other hunting associated habitat requirements. To assume that forests at the younger end of this range in particular are suitable for hunting, without ground-truthing, as is presently the case, is not scientifically justifiable.

Although owls use a more wide variety of habitat for hunting than for nesting, foraging habitat is nonetheless characterized by old trees, high canopy closure and complex forest structures (Gutiérrez et al. 1995, Thomas et al. 1990). Radio telemetry data indicates that old forests offer higher quality foraging and roosting habitat, and are used disproportionate to their availability (Thomas et al. 1990, Forsman et al. 1984; Carey et al. 1990; Carey et al. 1992). Thus, if owls had more old growth to hunt in, then they would select old growth preferentially over other habitat.

Dispersal Requirements

Broad corridors of unfragmented 100 year old plus habitat must be recruited to link clusters of Spotted Owls and their habitat and to facilitate dispersal and movement. Generally, the width of such corridors must be adequate to maintain micro-climate conditions typical of intact, unfragmented forest. Although the exact width may vary depending on local conditions, a 1 km width was recommended for Spotted Owls in BC (Blackburn and Godwin, 2003). Others have recommended that 50% of dispersal habitat be maintained for Spotted Owls with trees greater than 30 cm diameter (USDI, 1992). In BC 30cm diameter trees equate to those about 80 years old. Blake and Carr (1984) also recommended wide dispersal, movement and migration corridors for interior and area sensitive birds. Each owl activity centre, regardless of current occupancy, should be linked to other LTACS within SRMZ's, and also between SRMZ's with minimum 100 year old forest corridors.

The widely adhered to practice of forcing Spotted

Owls to disperse through young formerly clearcut forest presents an unacceptable risk and is a situation for which owls are not adapted, and it therefore jeopardizes their safety. Although many studies document that dispersing juvenile Spotted Owls use fragmented and/or young habitat (Forsman et al. 2002a), to assume that this dispersal situation adequately maintains biological fitness is unfounded. Although numerous studies document the highly elevated risk of predation during dispersal, nothing has been done to address this issue in BC, and only minimal changes have been made to the management of dispersal habitat in the US. This is yet another example of socio-economic considerations driving endangered species recovery actions.

Historically, dispersal habitat was primarily unfragmented old growth and mature forest. Dispersal success in a natural system is unknown but it is logical to assume that success was much higher due to large expanses of unfragmented old growth and mature forest. Indeed, most predation is inflicted by species which prefer fragmented habitats and such predation occurs primarily in or directly adjacent to formerly clearcut areas through which owls are forced to pass when dispersing or travelling between blocks of suitable habitat.

Although owls can disperse through any forested habitat, and even through clearcuts if they do not become food for a predator, the success of dispersal obviously declines in such situations. Dispersal success is probably much lower now that at any time in history. Severe fragmentation of dispersal habitat is perhaps equally important to the lack of old growth nesting habitat in the decline of the species. Indeed, decreasing dispersal success has tremendous negative implications for the future reproductive success of the species.

Dispersal habitat represents the single largest amount of habitat used by owls. However, it's importance has been undermined by the simple fact that most of this habitat type remains in the productive timber land-base and is managed without consideration for Spotted Owls. With upwards of 90% of habitat clearcut in some ecosystems, the reality that owls must disperse through clearcut areas and associated young forest has become a given. Thus, because owls have no option but to disperse through young forests, managers have concluded that young forest is acceptable for dispersal despite the fact that rarely are structural attributes present to enable owls to hunt while they are dispersing. Dramatically extended rotation ages and advanced silvicultural treatments are the solution.

The ideal proportion of mature and old forest to best facilitate dispersal is unknown. However, the simple fact that the majority of the Spotted Owls' range, especially in BC, was historically in a mature and old growth condition, suggests that the quantity, distribution and age of this habitat is a crucial element affecting juvenile mortality, and ultimately the very survival of the species. In the immediate short term the logical solution is to maintain 1 km wide, completely intact corridors of 100 plus year old forest between all historic owl locations and all areas where at least 50% of habitat remains within a 3.2 km radius of a given habitat patch.

PART FOUR

Threats

Primary Threat: *Habitat lost to logging*

Secondary Threats: *Physical isolation caused by logging induced fragmentation that results in demographic and genetic change and increased predation.*

Habitat Loss

The precipitous decline (up to 97.5%) in the BC Spotted Owl population was caused primarily by post 1900 clearcut logging of the owls habitat and has resulted in a small, fragmented population that is vulnerable to extirpation. Modern logging practices, characterized by clearcut logging with minimal retention of trees (avg. 4%), are inconsistent on all fronts with the ecological needs of the Spotted Owl. Retention levels averaging 15-20% in the 1/8 of the landscape managed for Old Growth will have no appreciable value to Spotted Owls for at least 50 years. No economically viable method of industrial logging has been demonstrated that maintains structural attributes necessary for Spotted Owls. However, with juvenile and sub-adult mortality likely approaching 100% in BC, there is a danger that only stopping logging in old growth habitat will still result in extinction without population augmentation and without significant changes to forest management (SORT, 2003).

Logging of old forests and resulting fragmentation are the primary factors that caused the population decline, but secondary factors (such as narrowing of the gene pool and physical isolation of the owls) are now compounding the primary factor of clearcut logging (Blackburn and Godwin 2003, USDI 1992, Dunbar and Blackburn 1994, Gutiérrez et al. 1995). Both ongoing primary and secondary causes of population decline must be addressed. Protecting the owls habitat alone will not solve the problem, but is the logical first step closely followed by population augmentation to assist juveniles with captive over-wintering and subsequent location of habitat, as well as to assist adults in locating suitable habitat and mates.

Recruitment of young owls into the population is likely negligent because of fragmentation induced barriers to dispersal and movement. No banded juveniles have been relocated in BC. Modern rotational logging practices, which are nearly 100% clearcut and modified clearcut (variable retention), with minimal (avg 4% as currently practiced) retention of standing trees, represent a permanent loss of type A habitat to Spotted Owls. Spotted Owls use managed forests for juvenile dispersal, adult movement corridors, and when adequate structural diversity is present, hunting. Atypical usage of other stand types is discussed in "Atypical habitat" section. But managed forests, regardless of current methods of silvicultural treatment, will generally not attain structural attributes necessary for owl reproduction and roosting prior to being logged again under rotation logging plans which average 100 years.

Clearcut logging continues to be the primary threat to Spotted Owls: six currently known owl sites are being logged and one juvenile owl was killed near a logging operation in January, 2004. Few new owl sites are likely to be found as the majority of large patches of high quality habitat have already been surveyed (I. Blackburn, pers. comm. 1998). The SORT estimates that fewer than 10 new owl sites remain to be found. Expectations to find new owls in dry interior forests must be tempered by the fact that owls are found almost exclusively in a rare type of Douglas fir (IDFww) which is extremely limited in distribution. Hopes to find new owls in parks must also be tempered by the fact that only about one-third of parks are high quality type A habitat, much of which has been previously surveyed. Although a few owl pairs may be located in parks, far more likely is that a few single sub-adult and adult owls are subsisting at minimal levels in parks, waiting for larger patches of higher quality habitat at lower elevations to become available.

With the exception of the Fraser Valley, urbanization has played a small role in habitat loss. However, even if urban areas had been left in the productive timber landbase, short rotation cycles of about 100 years would have virtually precluded utility for roosting, hunting, and nesting.

Large scale natural disturbance generally plays a small role in regulating the amount of Spotted Owl habitat. Stand replacing natural disturbance intervals average about 500 years in the majority of owl's preferred

old growth CWH habitat (range 270-700 years) in BC. Disturbance events that do occur in CWH are generally small to medium size in scale and intensity, and have the effect of creating more stand level structural diversity suitable to Spotted Owls, not less.

Clearcut logging practices have increased the threat of large scale disturbance in Spotted Owl habitat. Short interval rotational clearcut logging has eliminated structural complexity, and as these managed, homogenous forests grow older, disturbance regimes may be significantly altered in many areas formerly inhabited by Spotted Owls. Thus, modern logging practices have resulted in a permanent vegetative disclimax which will have a devastating impact on Spotted Owls' ability to recover.

Short rotation logging, urbanization, agriculture, roads, pipelines, reservoirs, hydro-electric dams and associated lakes, recreational developments, and utility corridors generally lead to a permanent loss of high quality habitat for Spotted Owls.

As a result of permanent vegetative disclimax caused by rotational logging and/or subsequent development, the connectivity between the Canadian and US populations is primarily restricted to the Skagit River Valley near Manning Park. Most other areas of former connectivity with the US population have been severed and now represent barriers to dispersal (Forsman et al. 2002a). Although it is likely that some exchange of genetic material occurs with the larger US population, some scientists now speculate that the Canadian population is distinct.

Although all logging is considered to have a negative impact on Spotted Owls, there has been little experimentation due to the critically endangered condition of the population (Hansen et al, 1993). Conducting such experimentation on a critically endangered species is scientifically baseless and raises many ethical questions. It is well known that many of the habitat attributes that are known to contribute to high quality Spotted Owl habitat are removed by commercial logging of any form. However, in the far eastern extreme of the owls' range, the owls do occur in stands that have been subject to historical single tree selection and small group removal selection logging (Blackburn et al, 2001, Weber, 2002). Although these activities may be consistent with some of the owls ecological needs, there is no evidence to suggest that such logging has not compromised the owls' fitness or vigor. Thus, logging of any type, should not be permitted until such time as the owl has recovered and effective experimental trials can be conducted.

The recent BC Supreme Court decision to permit long narrow strip shaped clearcuts and pocket clearcuts in a currently active Spotted Owl site with a historic nest site may lack scientific credibility, but is a legal testament to the near complete lack of legal recourse in BC to regulate the "experimental" logging of critically endangered species habitat.

Range Expansion of Barred Owls

The fragmentation induced expansion of the range of the Barred Owl from the north and east into Spotted Owl habitat, which began in southwestern BC in the 1960s, has become a major limiting factor affecting the Spotted Owl (Campbell et al. 1990, Dunbar et al. 1991, Hamer 1988, Gutierrez et al. 1995). Barred Owls are aggressive habitat generalists which colonize fragmented habitat, whether occupied by Spotted Owls, or not. Competition with Barred Owls is a threat to Spotted Owls through increased competition for habitat and prey, as a result of hybridization and predation, and as a result of competitive exclusion (Wilcove 1987, Carey et al. 1992, SOMIT 1997a). Hybridization occurs between the two species but is uncommon and offspring are infertile (Gutiérrez et al. 1995, Kelly 2002, Hamer et al. 1994).

Territorial interactions between Barred Owls and Spotted Owls are common. Barred Owls are abundant, utilize Spotted Owl nest sites, and have displaced Spotted Owls from their territories (Hamer et al. 2001, Kelly et al. 2003, Dunbar and Blackburn 1994).

Barred Owls are more often associated with fragmented mixedwood forests as opposed to primarily coniferous forests, and thus tend to occupy disturbed sites in river valley bottoms and floodplains near water and/or near formerly logged sites. Spotted Owls occur more commonly at mid-elevations because most low elevation habitat has been clearcut, excessively fragmented, and/or occupied by Barred Owls (Blackburn and Harestad 2002).

There is speculation that some Spotted Owls in BC seem tolerant of Barred Owls. It is possible that 40 years of Barred Owl interactions in BC may have, through multiple generations of Spotted Owls, selected for owls with the ability to withstand these aggressive competitors. Spotted Owls that seem to have developed tolerance

should be the first to have their offspring selected for augmentation.

Human Disturbance

The only human activities found to have a negative impact on Spotted Owls are associated with logging. Logging has been demonstrated to kill Spotted Owls outright, and have indirectly through the long-term loss of habitat. Stress effects of sustained logging are unknown, but the Mexican sub-species was observed to flush at distances of less than 105 meters from sounds associated with logging (Delaney et al. 1999)

Outcomes of global warming on Spotted Owls could include declining abundance and availability of prey, unusual weather events, vegetation change, increased fire, less or more rain, and more insect outbreaks.

Habitat Change

Forest ecosystems are classified into Natural Disturbance Types (NDT's) based on fire return intervals (fire frequency). Stand destroying fires, for example, generally do not occur, or occur very infrequently in Spotted Owl habitat; otherwise Spotted Owls would not occur in BC. Logging creates stand destroying-like events and is thus inconsistent with the most basic aspects of Spotted Owl habitat ecology.

Forest ecosystems are further classified by vegetation types where presence of a few dominant plant species are used to identify an ecosystem. This system is referred to as the bio-geo-climatic zone system as per Krajina (1965) and Pojar et al (1987).

The majority of the Spotted Owl's range was, prior to clearcut logging, dominated by one of the most stable ecosystems on earth. However, in the majority of the owls habitat west of the Cascades, in hemlock forest classification types, at least 80% of stands were of advanced structural complexity and therefor likely suitable to Spotted Owls (MacKinnon and Eng, 1996). Environmental events such as stand replacing fire and disease generally do not have a significant impact on Spotted Owls in Canada, although in some mesic hemlock zones and in the far northeast extreme of its range in BC low intensity, stand maintaining fires are common. But even in the more dry hemlock zones, structural complexity was likely enhanced by most fire events resulting in the overwhelming majority of CWH stands being suitable habitat for Spotted Owls.

Disturbance events in more wet hemlock zones are characterized by "gap" dynamics, where individual trees or small groups of trees are felled by lighting, wind or disease. This small scale stand level disturbance pattern results in structurally complex stands and also has the effect of limiting large scale disturbance. Heterogenous, structurally complex forests generally do not succumb to major disturbance events.

Modern logging practices, and in some areas, fire suppression, have created a situation where wildfire, wind, insect outbreaks, tree diseases, and floods could have a devastating effect on the ever decreasing Spotted Owl population.

Fire suppression has generally had little effect on the wet, maritime and mesic hemlock forests in BC because of the low frequency of stand replacing disturbance. Fire of intensity sufficient to destroy structural attributes important to Spotted Owls is generally rare in mesic hemlock forests. Some mesic hemlock forests in the north and south of the Lillooet River system were historically subject to 30 - 50 year stand-maintaining fires, but now could face stand-replacing fire due to fire suppression. Clearcut logging has also elevated the potential frequency of fire regimes due to the creation of even age stands that are more subject to fire and disease and due to the practice of leaving the majority of logged material as potentially combustible waste in clearcuts.

Fire return intervals in the northeast extreme of the owls range, in interior Douglas fir forests, are more frequent but are of lower intensity and are generally not stand replacing (Weber, 2002). These light ground fires leave the majority of larger and older trees intact. However, non Douglas fir forests used by Spotted Owls in the far northeast do burn more catastrophically. Thus, owls reside primarily in certain types of Douglas fir that are more fire resistant.

Many forests where owls occur in the northeast are fire refugia forests, where, due to various geologic, geographic, and climatic variables, fire rarely occurs. These sites are characterized by seasonal, coastal moist air masses, high residual ground moisture levels, and stands of advanced age and structural complexity. The result is the creation of small pockets of forest, generally less than 1000 ha in size, which are more like coastal rainforests than dry interior forests.

Thus although fairly large amounts of what would superficially appear to be suitable habitat exists in the northeast, the overwhelming majority lacks the specific ecological conditions required by Spotted Owls. With rare exception, owl sites in the northeast are located predominantly in fire refugia stands or in very specific and rare ecotypes of Douglas fir (IDF ww,dk). Although most currently active Spotted Owl sites exist in this northeast region (because the owls are more tolerant), to assume that more than a few additional Spotted Owls sites are yet to be discovered here is naive, as sufficient quantities of the high quality habitat are uncommon.

Genetic variability in Spotted Owls has probably been reduced dramatically as a result of habitat change and this could have significant impacts on Spotted Owls viability (Caughley and Gunn 1995). Small populations are extremely vulnerable to habitat change and resultant loss in genetic diversity (Caughley and Gunn 1995).

Former spotted owl habitat near D'arcy, British Columbia. Photo: Joe Foy.

PART FIVE

Habitat Identification

The reduced availability of very old forests is the primary cause of the Spotted Owls' decline. The owls are well known for their dependence on very old forests, and frequently inhabit stands with trees over 500 — and occasionally 1000 — years of age.

The overwhelming majority of Spotted Owls daily activity budget on established territories, is spent in either the oldest or the most structurally complex forest available, although the owls do use a wide range of habitat throughout the course of their daily activity budget. The structural attributes of forests needed by Spotted Owls can be found in stands as young as 140 years of age, but these attributes are not often fully developed until stands reach 250 years or more. Indeed 140 years is the minimum age at which high quality structural attributes appear. However, the majority of very old forests preferred by Spotted Owls have been clearcut and permanently lost as owl habitat because they will not be allowed to grow for more than about 100 years before being logged again.

Coastal western hemlock (CWH) forests are the typical habitat in the overwhelming majority of the Spotted Owls' range in British Columbia. Weber (2002) found that only about 80,000 ha or 13% of Spotted Owl habitat is located in the dry interior. Thus 87% of Spotted Owl habitat is CWH. Within this core CWH range, it is estimated that 70% of the highest quality low elevation (less than 500m) valley bottom old growth forests, aged 140 years plus, have been clearcut (K. Klinka, pers comm.; J. Pojar, pers comm.; MELP, 1998). As a result of this extensive low elevation logging, Spotted Owls have been forced to utilize more fragmented landscapes, lower quality higher elevation forests, and younger forests (Blackburn and Godwin, 2003), which has compromised the owls reproductive fitness, exacerbating the population crash. If it is assumed that only 67% of forests were historically suitable to Spotted Owls, then 50% of forests aged 100 years and older in the range of the Spotted Owl in BC have been clearcut (Blackburn I, and S. Godwin, 2003). However, if higher figures of 80-90% are used, then the proportion of Spotted Owl habitat in the landscape was far greater, and far more has been logged. This figure used has tremendous importance as it is a benchmark for the amount of Spotted Owl habitat that should be managed for. No records of the extent of logging have been compiled by government or industry.

Unfortunately, the disproportionate value of very old low elevation forests to Spotted Owls is not reflected in current management plans nor in SORT's Spotted Owl Recovery Strategy. SORT has devalued the loss of low elevation, high quality habitat as evidenced by a lack of attention to the disproportionate value of remaining valley bottom habitat. Habitat definitions and habitat identification procedures used by SORT overstate the value of young forests and fail to adequately address the disproportionate value of low elevation old growth, despite conclusive scientific evidence to the contrary (USDI, 1992).

A fundamental weakness of habitat definitions used by SORT and others is that minimum values are used to identify habitat. Forests which have minimum utility to Spotted Owl reproduction, roosting, and hunting are considered of high value because these forests meet minimum age thresholds. However, 100 year old and even 140 year old, second growth forests are of limited utility, especially for owl reproduction and roosting, when compared to the very old forests which once characterized southwestern BC and upon which owls are dependent. No Spotted Owls in BC, occupying typical habitat, have been observed in stands with overstory dominant trees less than 120 years old. Nests are generally in very large and old trees, and roost sites are typically located in very old stands.

Specific Habitat Identification

Spotted Owls are found predominantly in the Coastal Western Hemlock (CWH) biogeoclimatic ecozone but also the Interior Douglas-fir (IDF), the lower extent of the Mountain Hemlock (MH) and occasionally the Engelmann Spruce - Subalpine Fir (ESSF) biogeoclimatic ecozones (SOMIT 1997a; Meidinger and Pojar 1991). However, when owls use MH and ESSF they do so seasonally. Within this range, Spotted Owl habitats shift from wet and moderately wet CWH ecosystems in the majority of their range to a drier interior ecosystem in the extreme north and east (SOMIT 1997a). The elevation limit of suitable Spotted Owl habitat is usually below 1,370 m. However, higher elevation habitats above 900 m are generally of less value to Spotted Owls, and there is some question as to whether sites above 900 m should be referred to as type A habitat as is currently the norm. 900 m is the average elevational limit of CWH.

Spotted Owls utilize structurally complex forest for nesting, roosting and hunting throughout their range (USDI 1992). In core activity areas, owls typically select forests with the largest trees, highest diversity of tree species and tree size classes, and trees with structural deformities and cavities (Forsman et al. 1984, Thomas et al. 1990, USDI 1992). Spotted Owls also select forests with the most complex canopy structure and greatest canopy cover, the greatest diversity of dead, standing and fallen, woody material and snags spanning all ranges of decay classes, and the most cool and humid forests. Spotted owls also select older forest types for protective cover from predators and protection from weather events (Forsman et al. 1984, Barrows and Barrows 1978, Carey et al. 1992, Hanson et al. 1993, Forsman and Giese 1997).

In BC, Spotted Owl habitat has been compartmentalized into two primary types, type A and B, which reflect higher and lower quality habitat. The value of 100 year old type B habitat in most of the Spotted Owls BC range is limited to movement between areas of higher quality habitat and for hunting purposes when adequate structural attributes are present. The distinction between higher and lower quality owl habitat is somewhat artificial because historically type B habitat (according to current age definitions) was rare and/or locally abundant in the majority of the owls BC range.

Based on preliminary analysis of interim forest cover series data, data published by the Ministry of Forests staff, as well as anecdotal information collected from ministry vegetation classification experts, it appears likely that 80 - 90% of hemlock forests were historically in a condition of advanced structural complexity at any given time and thus likely suitable to Spotted Owls. The stand maintaining fires that were likely typical of the drier CWH zones, based on topographic and aspect considerations, would have resulted in advanced structural characteristics with very old trees more typical of type A than type B habitat. Indeed the habitat suitability map shows that even after decades of logging type A habitat, it is still far and away more abundant than all other age classes combined.

Dry CWH zones that would likely have had less structure would have been in the far south and far north, at opposite ends of the Lillooet River system, where south and west facing slopes of homogenous topography are more common, thus allowing for more frequent fires of intense severity. Younger forests less than 100 years are not common anywhere else in the CWH zones and much of the younger forest that does exist regenerated from clearcuts, not fire.

Based on the rarity of type B habitat in CWH forests, it is the opinion of this author that type B habitat definitions were developed primarily based on socio-economic, not biological considerations. Short rotation logging cycles will, in the near future, result in recruitment of large amounts of low quality type B Spotted Owl habitat which will qualify as suitable habitat under current definitions.

Thus, as clearcuts mature a vast sea of low quality type B habitat will dominate the landscape. Unfortunately, most newly recruited low quality habitat will be logged again before reaching type A habitat definitions. Thus, within 50 years, as clearcuts mature and reach the 100 year old age threshold, they will, often incorrectly, be referred to as Spotted Owl habitat. Meanwhile, Type A habitat is being rapidly clearcut. The recruitment of type B and continued elimination of Type A habitat will have the effect of increasing, not decreasing, the owls endangerment. What is needed is to preserve type A habitat that currently exists and adjust rotation ages so that new type A habitat can be recruited.

Type A (high quality) habitat is most simplistically characterized as those forests aged 140 to over 1000 years in age with fully developed structural complexity. Type

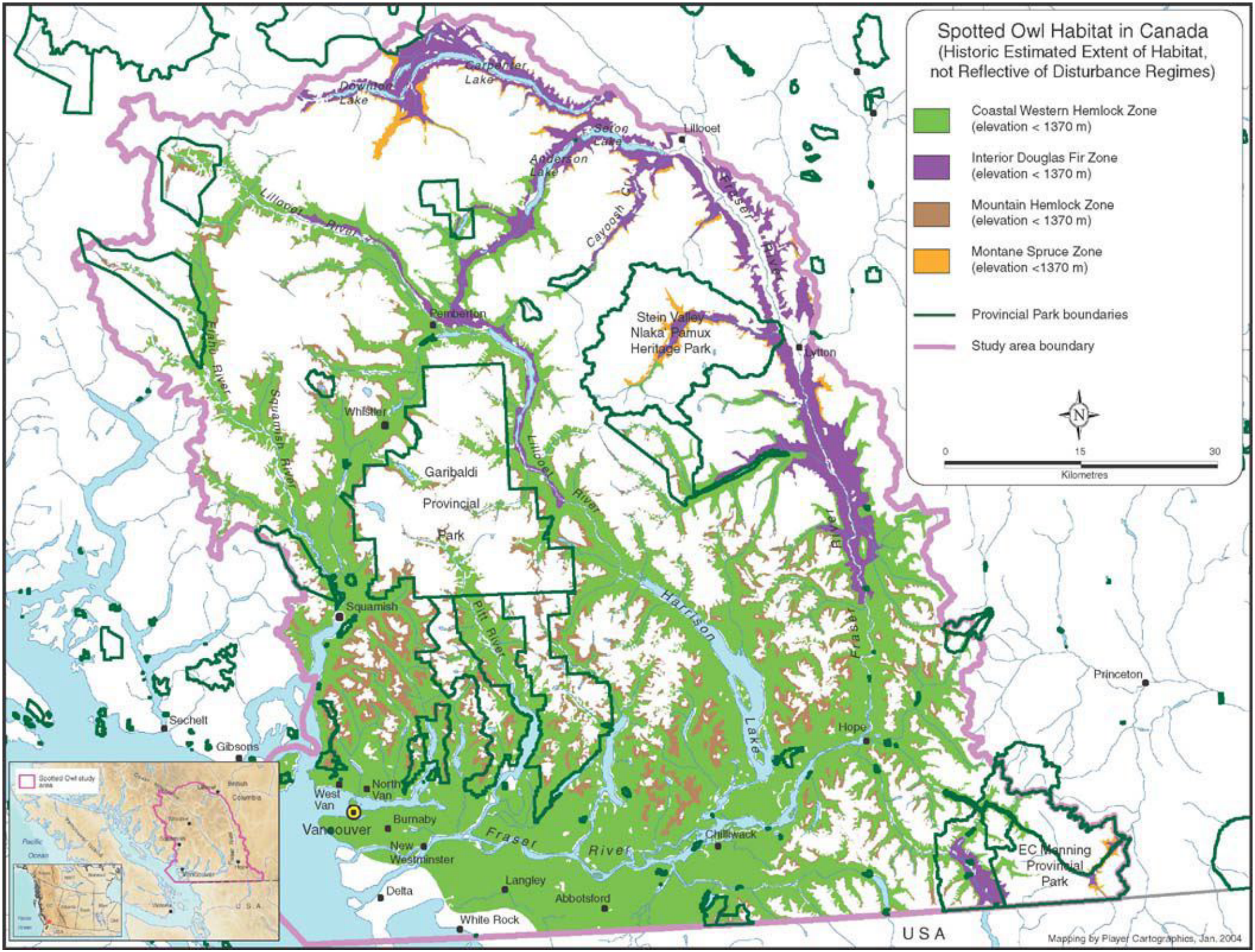
A habitat generally occurs at elevations below 900 meters. 80-90% of all hemlock forests within the range of the Spotted Owl could be in an old growth condition based on (MacKinnon, Eng, 1996). Type A habitat also occurs at higher elevation in the mountain hemlock zone, but these forests often have low utility to owls due to severe winter weather.

At the time type B habitat definitions were developed, no Spotted Owls had been detected in forests with dominant trees less than 120 years (SOMIT, 1997), and the overwhelming majority of observations were in type A habitat over 140 years old. At that time (prior to 1995) all forests aged greater than 120 years were considered high quality. 120 years was thus a critical age threshold below which the quality of Spotted Owl habitat (based on lack of Spotted Owl occupancy) diminished. Inclusion of 100 year old forests in the characterization of Spotted Owl habitat is dubious because of a near complete lack of evidence that Spotted Owls use this forest type other than in exceptional circumstances and in atypical habitat. Type B habitat often lacks the structural attributes required by Spotted Owls. Because so little research has been conducted on the viability of 100 year old forests to Spotted Owls, structural attributes are not even factored into the equation. Rather, age is the predominant, if not the sole, criteria used to evaluate habitat. Thus, type B habitat will be recruited to represent suitable owl habitat, despite the fact that these forests will, in most areas, be of extremely limited utility.

Some refer to forests aged 60-100 years as type C Spotted Owl habitat, but owls generally do not reside in this habitat but rather just pass through it for dispersal or general movement purposes. Thus, with rare exception, in areas subject to specific fire regimes and/or single tree or small group removal selection logging, it should not be referred to as Spotted Owl habitat as owls use this habitat principally for movement.

Younger forests of 100 - 140 years in the drier, extreme north-eastern portion of the owls range, often retain advanced structural components in IDF ww and dk subzones, and thus are often suitable to Spotted Owls for nesting and roosting. However 100-140 year old forests in the owls preferred IDF dk,ww habitat are rare - most are over 140 years old. The suitability of these stands is a function of frequent low intensity fire regimes and/or historic single tree, and small group removal, selection logging, which historically typified this region. Now however, pockets of dry, eastern Douglas fir forest with advanced structure are targeted for clearcutting, and as a result, few remain.

This spotted owl habitat near Chiiliwack was damaged by logging several months after this photo was taken. Photo: Joe Foy.


Spotted Owl Habitat in Canada
(Historic Estimated Extent of Habitat, not Reflective of Disturbance Regimes)
Coastal Western Hemlock Zone (elevation < 1370 m)
Interior Douglas Fir Zone (elevation < 1370 m)
Mountain Hemlock Zone (elevation < 1370 m)
Montane Spruce Zone (elevation <1370 m)
Provincial Park boundaries
Study area boundary
N
0
15
30
Kilometres
Carpenter Lake
Downton Lake
Seton Lake
Anderson Lake
Lillooet
Cayoosh Cr.
Fraser River
Lillooet River
Pemberton
Stein Valley Nlaka' Pamux Heritage Park
Lytton
Whistler
Garibaldi Provincial Park
Lillooet River
Squamish River
Elaho River
Squamish
Pitt River
Harrison Lakes
Fraser River
Princeton
Hope
Sechelt
Gibsons
West Van
North Van
Vancouver
Burnaby
New Westminster
Fraser River
Chilliwack
EC Manning Provincial Park
Delta
Langley
Abbotsford
White Rock
USA
Mapping by Player Cartographics, Jan. 2004

PART SIX

Critical Habitat

Critical habitat for Spotted Owls has been loosely defined by Spotted Owl specialists from the Ministry of Water Land and Air Protection, but not by SORT, despite ample evidence to do so. In fact, a previous draft of SORT's recovery strategy stated that "ample data exists to define critical habitat". The statement was later removed for reasons unknown. Instead, the identification of critical habitat was postponed by SORT, and will be identified in a subsequent, recovery action planning process, through computer modeling exercises that include oversimplification of complex habitat relationships and socio-economic considerations. Thus, critical habitat, as per the non-socio-economic needs of the Spotted Owl, may never be adequately defined and protected.

The basic structural components of Spotted Owl habitat are known, but the specific multi-scale habitat relationships will likely never be known with any degree of certainty. This is not uncommon in biology. In fact the Spotted Owl, given all the data short-comes, is among the best known of habitat specialists. The problems with using models to define the habitat needs of a crashing Spotted Owl population are manifest. There is a presumption when modeling that the issue being modeled is understood. However, there is little data to indicate that the relationship between Spotted Owls and their structurally complex habitat are understood. Therefor, modeling is inappropriate to answer the questions desired by SORT because the sources of error will be too great.

Nonetheless, SORT plans to use computer-based spatial and temporal habitat modeling and analysis based on gross simplifications of complex habitat relationships, and associated high sources of error, to artificially simplify the Spotted Owls' complex habitat relationships. This effort is likely to result in an elegant, but scientifically inadequate identification of critical habitat and population viability that will likely be conservative and dramatically under-represent the true needs of the Spotted Owl, and thus further endangering the owl.

SORT has stated that "the purpose of modeling is to determine whether recovery is possible" and seeks to "model habitat to identify, map and conserve habitat suitable for owl dispersal, movement, hunting, nesting and roosting." Ideally, before modeling, certain scientific questions must be answered first about dispersal behavior, habitat requirements, minimum viable population size, immigration rates, competition, adult survival, fecundity (number of eggs, hatched and fledged), nesting frequency, range of movement, homerange size, and mortality. The problem is that models only work if you have the data, which we do not, and if it was collected from a large population, which it can't be.

Regardless of data, complex habitat specialists like the Spotted Owl are notoriously difficult to model because relationships between the multitude of interdependent habitat relationship variables are very difficult to identify with any certainty, especially on a species with such a small, dispersed population. Nonetheless, the level of knowledge of Spotted Owls is already greater than that for most other species, and actions to protect endangered species habitat are regularly taken on species about which far less is known. The only reason more data is desired for the Spotted Owl is because of socio-economic considerations. The simple fact of the matter is that we will likely never have adequate data to successfully model the Spotted Owls' population nor its habitat with any degree of certainty. There is a basic assumption in modeling that the system being modeled is understood; unfortunately this is not the case.

Thus SORT is in a "catch 22" having committed to conducting modeling but not having the data it needs to do so. Further, random effects are likely a factor in the population dynamics of the species given the small popu-

lation size. Random effects are impossible to model. Models will not give answers to the types of questions SORT is seeking answers to. Models are most effective as evaluative, not predictive tools. In fact, there are no easy answers toward clarifying definitions of the complex habitat needs of the Spotted Owl. Because the owl is crashing and key data sets are missing and/or are very difficult to gather with any degree of statistical certainty, key factors affecting the owls' persistence will not be modeled correctly. Thus reliability of any modeling exercise will likely be so low as to preclude utility.

Because previous attempts at habitat protection have not been as successful as desired, both in the US and Canada, it is logical to be somewhat pessimistic, rather then optimistic about the effect of disturbance (logging) on the integrity of the ecosystem upon which Spotted Owls depend.

Interim Emergency Critical Habitat Designation

Thus, one solution is to go above and beyond the US and Canadian model of habitat protection by protecting all of the owls remaining type A habitat as these stands will in the near future serve as islands of high quality habitat in a sea of low quality regenerating clearcuts. Also attempts should be made to maximize situations where greater than 50% habitat exists within 3.2 km of a given habitat patch, and to manage the surrounding "matrix" through adaptive management techniques that maintain 50% of the working forest landscape in contiguous blocks of 140 year old plus forest greater than 500 ha. in size, and to create 1 km wide corridors of 100 - 140 year old plus habitat between all areas where greater than 50% habitat exists within 3.2 km of a given habitat patch. Then this type of management solution can be tested through time with modeling, if so desired, but the source of error will be so high as to virtually preclude definitive assessment. Thus, the simplistic but logical solution is to facilitate the management plan with aggressive augmentation and then monitor the owl closely to determine when owl mortality equals owl recruitment.

Spotted Owls evolved in BC primarily in type A habitat. While SORT is refining Critical Habitat definitions, attention should be paid to the possibility that historically, 80 - 90% of hemlock forests were type A but only 10 - 20% were type B and C combined. Spotted Owls also likely selected areas with the greatest proportion of high quality habitat (Blackburn and Godwin, 2003). Although low elevation type A habitat in the owls preferred coastal western hemlock forests has been dramatically reduced in extent, this fact should not dilute the importance of maintaining all remaining type A habitat and recruiting type A habitat as quickly as possible. Unfortunately, the currently inadequate spatial and temporal distribution of high quality owl habitat will necessitate that younger habitat be referred to as critical habitat in the short term to bridge the gap in time until clearcuts mature. However, a long term vision of recreating a semblance of what was, should be, at the very least, a guideline in critical habitat mapping exercises.

The inherent difficulty and high level of scientific error involved in accurately mapping the very complicated habitat needs of the Spotted Owl suggest that SORT should err on the side of the conservative, use definitions of the precautionary principle as per federal government directives, and be mindful that, regardless of "political realities based on timber supply", the Spotted Owl evolved in an ecosystem that has been largely eliminated by logging. Thus, every effort must be made to maintain what remains of this lost ecosystem by recommending the protection and recruitment of very old, low elevation forest. There is a real danger that if critical nesting, roosting, and hunting habitat is left, in whole or in part, in the "managed" or "productive" timber landbase, as planned, the result will be a situation where critical habitat is properly defined in spatial and temporal dimensions, but that the structural properties of these forests will be inadequate for reproductive success. Indeed, extending logging rotation cycles in areas managed for the Spotted Owl, as planned, will not lead to the creation of high quality Spotted Owl habitat unless rotation ages are at minimum doubled. It simply makes no sense to maintain shorter rotation cycles because at the very moment forests become of suitable structural complexity to qualify as Type A habitat, they will be logged again and thus will be of only temporary and limited value to Spotted Owls beyond purposes of movement and, depending of structural properties, hunting.

SORT has already started accepting trade-offs, even before the lengthy critical habitat mapping exercises have begun. SORT has recommended that no additional survival habitat of unconfirmed occupancy, nor owl sites

last confirmed prior to 1997, be considered for protection and that only eight very recently discovered owl sites be protected. SORT has no evidence to support their claim that no additional habitat protection is needed. In fact, existing policy directs SORT to recommend extensive habitat protection, as per the precautionary principle, and when scientific uncertainty is a factor with critically endangered species like the Spotted Owl.

Limited interim protection amounting to about 1% of the total amount of owl habitat remaining was initially recommended by SORT for some habitat around eight of 17 recently located owls that are outside of protected area boundaries. However, SORT has changed its tune and is now considering re-allocating currently protected habitat instead of recommending outright habitat protection for some of the above mentioned eight owl sites. SORT changed its recommendation from seeking outright protection of more habitat to re-allocating currently protected habitat, because SORT's initial recommendations were disregarded by the BC government. As a result, SORT has responded by accepting more politically achievable recommendations. SORT has also now recommended that critical habitat be temporarily characterized as per the failed, socio-economic based, surrogate definition of suitable habitat from SOMP (status quo), a management plan that was in place during the recent owl population collapse. SOMP has about a 5% negative impact on timber supply (Blackburn and Godwin, 2003).

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". Currently a critical habitat definition, which is based on a failing owl management plan (SOMP) and which includes socio-economic considerations (SOMP has a 5% impact on timber supply) is used to identify nesting, roosting and foraging habitat. Critical habitat is thus defined as coniferous forest stands older than 100 years with dominant trees taller than 19 m and below 1,370 m - 1,500 m in elevation (SOMP 1997). This definition was developed despite the fact that at the time, no Spotted Owl had been detected in forests with dominant trees less than 120 years old and most Spotted Owls were in fact located in forests with much older trees and at lower elevations. The majority of Spotted Owl habitat, as per the above definition, is located at high elevations where harsher weather result in lower habitat suitability.

In the interim, SORT has endorsed the continuation of the SOMP until such time as critical habitat is re-defined.

Atypical Habitat

In about 25% of the Spotted Owl's range, encompassing about 13% (80,000 ha) of the owls' total habitat, in the far northeastern periphery of the Lillooet Forest District, it has somewhat different ecological tolerances and may be a separate population (Weber, 2002, Hobbs pers. comm.). Forests in the northeastern extreme of the owls' range in BC, and also in areas east of the Cascade Mountains in the US, are drier, are of different vegetative species composition, and have unique ecological conditions which can occasionally be suitable to Spotted Owls. Owls that reside in these extreme habitats have "boom and bust" reproductive cycles. Additionally these owls tend to be shorter lived and produce more offspring, which have higher rates of mortality. Thus, when all factors are considered, recruitment rates are similar to those in more wet, western habitats (D. Herter, pers. comm.)

Although dry site Spotted Owl habitat is often "old growth like" in structural complexity, disturbance from fire, in particular, plays a much larger role regarding its affect on stand structural composition than in the other 75% of the owls range in BC. Owls in these dry site regions are sometimes found in "younger" forests that still have old growth trees and adequate structural complexity, but have been subjected to more regular small scale or low intensity, stand maintaining fire and/or selection logging (single tree or small group removal) (Dunbar and Blackburn, 1994, Buchanan et al. 1995, Weber, 2002). Also, prime owl habitat in this region is not distributed evenly, but generally occurs in small, isolated pockets (fire refugia) that have been protected from fire due to geologic and climatic factors, or is located in certain IDF zones which have maintained exceptional structural diversity. The interior, northeastern owls are not equally distributed across the suitable habitat landscape but are found almost exclusively in very specific habitat types that are exceedingly rare (IDF ww, dk) and/or pockets of fire refugia, which possess unique ecological conditions. Fire refugia are in fact remarkably similar to coastal rainforest and often have a preponderance of cedar (and incidentally a long and complex archeological history).

A few other owl sites in this region are found in habitat which is transitional between wet hemlock zones and dry Douglas fir zones where IDF dw,ww and fxh merge with CWH ms and ds.

The majority of northeastern dry site habitat which is referred to as "suitable" habitat by government is in fact montane spruce and IDF, which because of unfavourable structural attributes has limited value to Spotted Owls. The plausible explanation for the fact that owls are not regularly located east of the Fraser River, north of Boston Bar, along Carpenter Lake, the Stein and the Hurley area is the preponderance of montane spruce, lack of fire refugia habitat, and perhaps compounded by extreme climatic conditions. No owls are likely to be found on the north side of Carpenter Lake, even though it has a high proportion of Douglas fir, because of climatic extremes and lack of fire refugia habitat. Thus, although 80,000 ha of owl habitat has been identified by government in this northeastern dry region, the owls reside almost exclusively in stands dominated by IDF dk, of which only 35,000 ha remain. Further, because IDF dk are the stands of most economic value to the timber industry because of their large Douglas firs, they are being targeted for clearcutting disproportionately to all other stand types. Therefore the likelihood of locating more than a few additional owl sites in this region is slim. Further, extrapolation of data from this minority of habitat to owl habitat as a whole, as some have recommended, is scientifically unjustifiable. Indeed, some speculate that Spotted Owls existing in these unique environmental conditions may be a separate population (Weber, 2002, Hobbs, J, pers. comm.).

The patchy distribution of isolated pockets of high quality interior habitat indicates that owl density was historically likely quite low. Thus, generalizations about the value of interior forests should be moderated by the fact that large patches of suitable habitat capable of sustaining owls are infrequent.

Ironically, the majority of currently known owls in BC are located in these pockets of inland refugia habitat. Some evidence exists that dry site Spotted Owls are more capable of withstanding environmental change and habitat fragmentation (Buchanan et al 1996). If indeed Spotted Owls in maritime forests have been virtually eliminated, which appears to be the case, then special consideration must be given to providing for the needs of owl habitat in these areas to enable recovery. SORT, however, has done exactly the opposite by failing to recommend protection of habitat of unknown occupancy.

PART SEVEN

Habitat Protection

The Spotted Owl Management Plan (SOMP), formalized in 1995, protected known Spotted Owl locations detected between 1992-1995. 37 of 66 known owl sites were protected (56%). The negative impact of SOMP on the logging industry was limited to less than 5%. Within the range of the Spotted Owl in British Columbia, 639,000 ha of 100 year old plus Spotted Owl habitat exist. 11% (approx. 70,000 ha out of 639,000) of this forest was explicitly protected as current "old growth reserves" for Spotted Owls as a result of SOMP, on Crown lands within Provincial Forests. An additional 24,000 ha was intended for protection under SOMP, by way of two additional management zones, but protection never occurred. Another 90,000 ha of 100 year old plus Spotted Owl habitat was already protected in parks.

Including pre-existing parks and clearcuts, The Spotted Owl Management Plan applied to 363,000 ha of forest, of which about 50% was historically clearcut, leaving about 182,000 ha of "protected" areas. But this 182,000 ha is not actually protected because logging is still allowed in areas protected for the Spotted Owl. Logging only stops when 33% of the land "protected" for owls has been clearcut. Once all Spotted Owl protection areas are logged down to the 33% threshold, then protection of the other 67% is granted. Unfortunately, about half of the old growth reserves protected for the owl had already been logged beyond the 33% threshold (the average is about 50%) and these areas will take centuries to regrow to become the highest quality Spotted Owl habitat again.

As discussed, a slight majority of habitat "protected" for owls, as a result of SOMP, has been clearcut and will never be recruited to serve as type A habitat because of short rotation cycles. About 182,000 ha of the 363,000 ha of forest "protected" for owls are actually clearcuts, many of which will be re-harvested when they are about 100 years old. Rotation ages would have to be extended two-fold and clearcutting and variable retention logging (as per current applications) banned if clearcut areas were to be made useful to Spotted Owls.

SOMP also provided temporary protection for some forest in areas referred to as Matrix Activity Centers (MAC's). An additional 1.3% (8,500 ha out of 363,000) was temporarily protected in Matrix Activity Centres (MACs) and will be logged as older forest is recruited from clearcuts in Special Resource Management Zones (SRMZs). These areas will be harvested to offset predicted timber supply and forestry employment impacts. There is a danger that older forest in MACs, when cut, will be replaced in SRMZs by younger 100 year old ma-

Known Owl Locations	Squamish Forest District	Chilliwack Forest District	Cascade Forest District	Total
SRMZs	10	27	0	37
MACs	2	6	0	8
Outside SOMP	2	9	8	19
Total	14	42	8	64

Table 1. Known Spotted Owl Locations within British Columbia (1992 - 2002) [Blackburn and Godwin 2003]

turing forests resulting in a net loss of habitat.

Most logging in areas "protected" for Spotted Owls has occurred within the past 25 years and virtually all since 1940. Thus, it will be at least 50 years before low-end 100 year old habitat is recruited in appreciable amounts for Spotted Owls. However, the moment many of these young regenerating forests "protected" for owls reach the 100 year old threshold, they will be cut again under rotational logging plans. Therefore, 33% of the habitat "protected" for owls is not actually protected, and in fact, in most cases, has been permanently lost to owls for nesting, roosting and hunting.

100 year old forests would be of more use to owls if they were subject to alternative logging methods, advanced silviculture treatments, or affected by fire, but the majority will likely only be used by owls for movement corridors until such time as they are harvested again. This is problematic because the most limiting habitat is not and never will be 100 year old forest, but rather very old forest used for nesting, roosting and hunting. SORT's near complete lack of recognition of the short and long-term value of very old forests is scientifically baseless.

The overwhelming majority of older forests protected for owls in the 1995 SOMP are very old class 8 and 9 forests aged 140 years plus. SOMP recommends that 17% of these forests protected for owls can be lower quality type B habitat despite the fact that historically this figure was closer to 5% in most of the owls range. Thus, as logged forest matures and reaches the 100 year threshold, it is likely that these 100 year old forests will be traded for older forest up to the 17% threshold, and subsequently logged. This is problematic because it will result in high value old forest being traded for lower value 100 year old forest. Class 6 and 7 forests are more common in drier Douglas-fir areas in the eastern and northern 1/4 of the owls range in areas outside the jurisdiction of SOMP. Thus, even under the current SOMP, low end type B habitat will in the future be substituted, so that preferred type A habitat can be logged.

SOMP is restricted to the Chilliwack and Squamish Forest Districts although owls are found outside of these areas. Parks and protected areas in SOMP include Provincial Parks (E.C. Manning, Cascade Provincial Recreation Area, Golden Ears, Garibaldi, Cypress, Skagit Valley, Mehatl and Birkenhead Lake), the Greater Vancouver Water District, and Ecological Reserves (Chilliwack River and Skagit River Cottonwoods).

19 new Spotted Owl territories that were either discovered within the existing management plan's boundaries after 1995, or outside the plan area within the Cascades Forest District, are not offered any protection under SOMP. Eight of these sites, in the Cascade Forest District, will be offered some protection by trading currently protected habitat.

SORT removed recommendations from the penultimate draft of their Recovery Strategy that, in the absence of comprehensive owl inventory (which has not occurred), called for interim protection of all suitable habitat over 100 years. Specifically, SORT recommended that all type A and B habitat be considered critical habitat and be afforded interim protection until inventory is complete. However, when government funding for inventory was not provided, SORT completely eliminated all references regarding protecting habitat of unconfirmed occupancy. SORT then changed its recommendation again such that now, currently protected habitat will be traded off to gain protection for the remaining unprotected owls discovered in the past five years.

I recommend that SORT reinstate and reaffirm its recommendation to temporarily protect all type A and B habitat. Further, all type A habitat must be considered critical habitat and afforded immediate permanent protection because through time these forests will greatly contribute to increasing landscape level diversity of forests and regardless of fragmentation and isolation effects, even small patches of Type A habitat will provide habitat for this wide ranging species. Further, I recommend that until such time as habitat modeling is complete and habitat protection needs clarified, that all type B habitat be protected, because there is no evidence that these habitats will not be of some utility to Spotted Owls in the short term.

Habitat Trends

This trend analysis discussion makes a distinction between low and high elevation Spotted Owl habitat and it separates maritime (very wet) forests, sub-maritime (less wet) forests, and dry site habitats in the far east and northern extremes of the owls range. Also, the differences in ecological value of type A and B habitat are discussed. Coastal western hemlock forests constitute the bulk (88%) of the Spotted Owls habitat and prob-

ably contained the overwhelming majority of the owls' historic population. Old growth habitat is more limited in extent in dry eastern and northern forests. Indeed, old growth type A habitat is an anomaly in the drier, northeastern extreme of the owls' range.

Although approximately 181,000 ha of the mostly highly fragmented suitable habitat is protected in BC (Blackburn et al. 2002), the owl continues to decline because of factors associated with extreme fragmentation and ongoing logging of type A habitat. Both protected areas and managed forests suffer from extreme fragmentation, but the problem is worse in the managed forest landscape. Therefore it is likely that the high levels of fragmentation and insufficient spatial distribution of habitat, the physically isolated remaining owls, as well as other biological limitations and threats are all simultaneously contributing to the declining population of Spotted Owls.

A precautionary approach to managing the problem of declining owl numbers would involve the immediate protection of all remaining high quality type A habitat, temporary protection for all type B habitat, an agressive plan of relocating isolated owls, as well as other recommended recovery actions. This precautionary approach to habitat protection would be maintained until such time as a different course of action is warranted, such as clarification of protection needs from modeling exercises. However, the amount of old growth needed to recover the owl is a hotly debated topic and likely will be for many years.

Although it would seem a basic level of research, mandatory for conducting forest management activities like logging, the inventory and statistical analysis of forest age class distribution has never been conducted at more than a gross level. As a result, considerable debate exists as to the actual historic proportion of the land-base that was believed suitable Spotted Owl habitat at any given time. The debate is centered on the frequency and intensity of disturbance events that regulate the proportion of old forest to young forest. Government estimates used by SOMP suggest that only 67% was greater than 100 years, whereas published data from forest ministry employees suggest that within the coastal and mountain hemlock zone on the BC coast, of which the majority of Spotted Owl habitat is a subset, this figure is about 90%. This figure, whether 67%, 90% or somewhere in between, has tremendous importance because the amount of old growth which needs to be protected or restored for the Spotted Owl should be based on the historical proportion of owl habitat in the landscape.

Another primary trend is the virtual elimination, by clearcut logging of prime, high quality type A habitat from low elevations. Logging in southwest BC was historically disproportionately focussed on this type A, highly productive and economically valuable Spotted Owl habitat, which occurred in narrow ribbons at the bottoms of valleys and between mountains. Although considerable amounts of lower quality, higher elevation habitat still exists, this habitat does not meet all the life history requirements of Spotted Owls, although it is referred to as type A.

Maritime Habitat

Data compiled by Ministry of Forests personnel (MacKinnon and Eng, 1995) found that based on interpreted satellite imagery about 90% of hemlock forests on the coast of BC, of which the majority of Spotted Owl habitat is a subset, was greater than 100 years old. The authors state that "because stand-destroying disturbances are so uncommon in coastal British Columbia, it can be assumed that the vast majority of younger forests result from logging." Mountain Hemlock zones are currently about 90% older forest aged 100 years plus. 21% of these forests are currently class 8 and 62.5% are class 9. Thus 83.5% of these forests were class 8 and 9 (type A Spotted Owl habitat) as of 1990. Coastal western hemlock forests have similar disturbance patterns.

Despite this data, the BC government has steadfastly adhered to its claim that disturbance patterns in coastal BC are similar to disturbance patterns in an entirely different inland ecosystem in the United States — the Cascade range — which consists of different plant species and is affected by different climatic patterns than the majority of owl habitat in BC. Only 25% of the owls' BC range is technically defined as the Cascade region and only about 13% (80,000) of the owls' habitat is located in this region.

Conservative and possible inaccurate information used by SORT estimate that of the 1,320,000 ha of forested landscape within the south coastal range of the Spotted Owl that only 67% or 881,000 ha were historically greater than 100 years old, and that 639,000 ha remains. However, if Mackinnon's and Eng's data is used

and thus it is assumed that about 90% of forest was historically greater than 100 years, then 1,188,000 ha was greater than 100 years old at any given time. The implication is that depending on which figures are used, then far more forest has been logged and far more needs to be protected (assuming that a modern habitat protection plan should be based on the historical abundance of old growth forests) for the Spotted Owl.

What is known is that 639,000 ha of the original 1,320,000 ha of > 100 year old forest within the maritime range of the Spotted Owl remains. Depending on which figure (67% or 90%) is used, a dramatically different picture is painted about the amount of habitat lost to clearcut logging. SORT's data suggests that only 28% (242,000 ha) has been lost to clearcutting. But the 90% figure indicates that 47% (549,000 ha) has been lost. However, when only high quality, low elevation habitat is considered, it is estimated that 70% has been lost to logging. It now becomes clear that Spotted Owls have indeed been forced to occupy lower quality higher elevation habitat because their preferred low elevation habitat has been so heavily fragmented. This is not to say that extremely fragmented low elevation forest is unworthy of protection, but that a complete moratorium on logging must be implemented in these areas to allow younger forests to mature and thus reduce the effects of fragmentation and allow owls to re-colonize.

Further compounding the habitat availability debate is that the figure of 1.32 million ha includes seldom used, higher elevation habitat, despite the fact that owls prefer lower elevation habitat. If an elevation limit was imposed which accurately reflects the habitat preferred by Spotted Owls, or a coefficient used which reflected the lower value of higher elevation habitat, then the figure representing the amount of prime Spotted Owl habitat lost to logging would soar because most clearcutting has also been at lower elevations.

What is most disturbing about the SORT habitat estimates is not that inaccurate data was possibly used to calculate the amount of clearcut logging, but that SORT claims that as clearcut areas grow back and reach the 100 year old age threshold, and therefore offset the overall impact of habitat loss. This is a fallacious argument which assumes that the value of 100 year old low-end type B habitat equates with high quality type A habitat, which averages many hundred of years in age. The value of type A habitat is thus likely far greater than type B habitat. Recruitment of 100 year old forest, regardless of silvicultural treatment, does not compensate for the past and ongoing loss of very old maritime owl habitat.

Sub-Maritime Habitat

Eastern and northern extremes of the owls' range in BC, where owls likely historically existed at lower population densities due to the preponderance of younger forests, are subject to more frequent stand replacing and smaller scale disturbance events than is typical for maritime forests. Ironically, the maritime like pockets of structurally complex interior forest where owls exist are generally not subject to typical dry site disturbance regimes because of elevated, but extremely localized, moisture regimes as per botanical indicators or are geographically protected from typical fire patterns. Thus, the pockets of maritime like forests are not subject to typical dry site forest disturbance patterns. Thus no generalizations should be made, as SORT has done, about the overall value of interior forests to Spotted Owls.

With the exception of the relatively small pockets of known class 8 and 9 forests in the sub-maritime regions, drier interior forests need to be more extensively studied prior to mapping critical habitat. Many younger forests that may qualify as owl habitat, but have been subject to "single tree or small group" selection logging and/or fire, need to be assessed for suitability.

Recruitment of Low-end Type B Habitat Aged 100-140 Years

Young type B habitat will, over the next 50 years, begin to represent a disproportionate amount of "suitable" habitat throughout the range of the owl. Because there is little low elevation, old forest left to cut, it is expected that in the future the decreasing rate of logging of old forest and increasing recruitment of young formerly logged forest will lead to an artificially disproportionate amount of low-end, type B Spotted Owl habitat in the landscape.

Historically, 100 - 140 year old forests probably represented less than 10% of forests in most of the owls range. Despite the fact that minimal logging has occurred at most high elevation locations on the BC coast, only 6.5% of mountain hemlock forests on the coast of BC are 100 - 140 years old. The overwhelming majority of

forests were well over 140 years of age. Thus, maximum retention and recruitment of very old forests, particularly at low elevations, must be acknowledged as a crucial factor in the owls recovery

SORT claims that the overall impact of habitat loss will decrease as this younger forest is recruited to the 100 year old threshold. The recruitment of low-end type B habitat provides only limited utility to Spotted Owls, primarily for dispersal, movement corridors, and low quality hunting, but it will be more suitable as it ages. Although this low-end habitat does occasionally provide habitat for nesting, roosting, and hunting, this is not generally the case and thus generalizations must not be drawn from exceptions. The value of type B habitat is limited and can in no way be compared to type A habitat in meeting reproductive life history requirements of Spotted Owls.

Restoration of Non Spotted Owl Habitat

Based on current knowledge, Type A Spotted Owl habitat cannot be managed to improve its suitability for Spotted Owls. Type B habitat can be managed to improve its suitability if required, but can not be managed using extractive methods of logging. Thus, typical type B habitat improvement include snag creation and the creation of structure through selective thinning programs which leave all fiber on site for course woody debris retention.

Primary restoration activities must be targeted at younger forests less than 100 years old to enhance structural diversity. This typically involves non-uniform thinning exercises that focus on opening the canopy by removing maturing trees, thus allowing accelerated growth of the stand to achieve old growth like structural characteristics. These restoration procedures will generally take place exclusively in formerly clearcut areas that have not been subjected to advanced silvicultural treatments.

Restoration of habitat would generally not be necessary if clearcut logging was banned. Selective harvest procedures as opposed to clearcutting and variable retention logging, can, if done properly, closely parallel natural disturbance regimes. Natural disturbance regimes generally maintain structure and facilitate the creation of old growth like conditions.

Recovery and Survival Habitat

Survival habitat is the habitat needed to maintain the current population size (ROMAN 2003). However it is extremely implausible to conclude, as SORT has done, that enough survival habitat is currently protected to maintain the species given the owl is in the midst of an unprecedented population crash of -10.4% annually. Although many factors contributed to the owls' endangerment, habitat availability is paramount and habitat protection is thus essential. As it stands, juvenile owls are not physically able to locate new territories on their own because of fragmentation, and many adult owls are stranded in isolated habitat because they cannot find anything better or find a mate. Maintaining future options for these owls means protection of their remaining type A habitat as well as extensive tracts of younger forest pending habitat modeling.

Protecting only a small portion of the habitat of a species undergoing a free-fall population crash seems incredulous. The reality is that the distribution and amount of habitat required to maintain the current estimated population of less than 33 adult pairs [and additional sub-adults and juveniles] is unknown. Therefor, to conclude that enough habitat is protected to maintain the current population is unfounded. The extensive movement patterns and very large home-ranges of Spotted Owls combined with the unknown habitat needs of non-adult owls suggests that extensive tracts of old forests must be immediately protected as survival habitat. Although it will take decades to achieve proper habitat distribution, augmentation (the physical relocation of owls) could provide a bridge to maintain the species until such time as modeling helps define ideal spatial distribution of habitat so that Spotted Owls can move freely between reserves.

639,000 ha of suitable Spotted Owl habitat exist in BC. 379,251 ha of unprotected, high quality type A habitat exist and another 106,207 ha of unprotected low-end type B habitat exist. SOMP only explicitly protected about 70,000 ha of the 639,000 ha of Spotted Owl habitat aged greater than 100 years.

All currently unprotected old growth, regardless of its isolation or occupancy status, could serve as some form of habitat for dispersing owls or may even be occupied without our knowing due to lack of inventory. Additionally, much of this habitat will become less frag-

mented as younger surrounding clearcuts mature and connect isolated patches of old growth once again. Declaring owl habitat open to logging, as SORT has ostensibly done, without knowing the utility of such habitat, may preclude the recovery of the Spotted Owl.

The potential viability of small patches of habitat or habitat of unknown occupancy was highlighted in the Fall of 2003, when a dispersing juvenile Spotted Owl was observed in a small patch of older urban forest by Jericho Beach near downtown Vancouver. This freak occurrence of a Spotted Owl near downtown Vancouver highlights the fact that random dispersal patterns necessitate the protection of vast quantities of habitat. Future habitat modeling should illuminate that random dispersal patterns necessitate the creation of vast tracts of suitable habitat to facilitate the owls' ability to locate a territory suitable for reproductive success. Young owls die precisely because there are not habitat stepping stones enabling them to survive until they locate a large stand of unoccupied old growth forest.

Perhaps the greatest unknown regarding Spotted Owls is the amount of survival habitat needed. The answer to this question will likely never be known. However, the decision on how much survival habitat to protect is probably the single greatest factor that will affect the recovery of the owl. SARA and RENEW are very clear about giving direction in such circumstances. SARA and RENEW clearly state that uncertainty must not be used as an excuse not to protect endangered species habitat and that the best available information must be used. SARA and RENEW also direct the precautionary principle to be used, which in the case of the Spotted Owl, would mean, at the very least, to place a temporary moratorium on logging of all Spotted Owl habitat.

As mentioned, I advocate permanent protection for all type A habitat, temporary protection of type B habitat until such time as modeling clarifies ideal habitat spatial distribution patterns, and, based on the results of spatial analysis, better management of younger forest in key areas.

Ideal conditions for Spotted Owls to maintain maximum vigor have been virtually eliminated. Spotted Owls need large, relatively unfragmented expanses of old growth or otherwise structurally complex forests, which meet the criteria of old growth forests for nesting and roosting. Multiple 500 hectare intact patches of old growth, and interconnected reserves each capable of housing 10 - 15 pairs of owls, are a minimum goal which is thought will assist with successful reproduction. Spotted Owl habitat often exists in a condition of advanced structural complexity for thousands of years due to the low frequency of large scale disturbance regimes. In the more wet CWH subzones, old forests typical of Spotted Owl habitat achieve a steady state or climax condition in which individual or small groups or trees are replaced in small gap regeneration patterns, indefinitely, or until such time as a stand replacing disturbance occurs. In the drier CWH subzones, catastrophic fire occurs every few hundred years but the structural complexity of forests is generally maintained by very frequent, low intensity, stand maintaining fire. In the dry interior zones adequate structural complexity is generally absent due to elevated frequency and intensity of fire regimes, except in very specific and rarely occurring Douglas fir subzones and pockets of fire refugia habitat.

Nesting and Roosting (type A) habitat is used in disproportion to its availability. Further, owls preferentially use high quality low elevation type A habitat despite its extremely limited availability. However, in a ecological “catch 22”, Type A habitat is also often not accessible to owls due to extreme logging induced fragmentation. The reduced numbers of owls and their physical isolation from one another has exacerbated the negative effects of fragmentation.

Generally, the older the forest, the better habitat it is likely to be for Spotted Owl nesting and roosting. The earliest research confirmed that the majority of owls nest in relatively undisturbed forests 220-600 years old (Forsman, 1972). However at a superficial level, the strength of this correlation seems to be decreasing because the limited availability of old growth is forcing owls to use atypical habitat where fitness likely declines. Scientific analysis is somewhat restricted in this regard because all owl populations currently exist in extremely fragmented landscapes, which are not at all typical of historic conditions. Even protected areas are generally unsuitable for collection of baseline data because protected areas are almost always located in higher elevation, extremely rugged terrain with limited high quality type A habitat. Thus, baseline data collected in a natural condition is not possible. Indeed, data showing decreasing strength of the relationship between owls and intact old forest is to be expected given the extinction crisis facing this species.

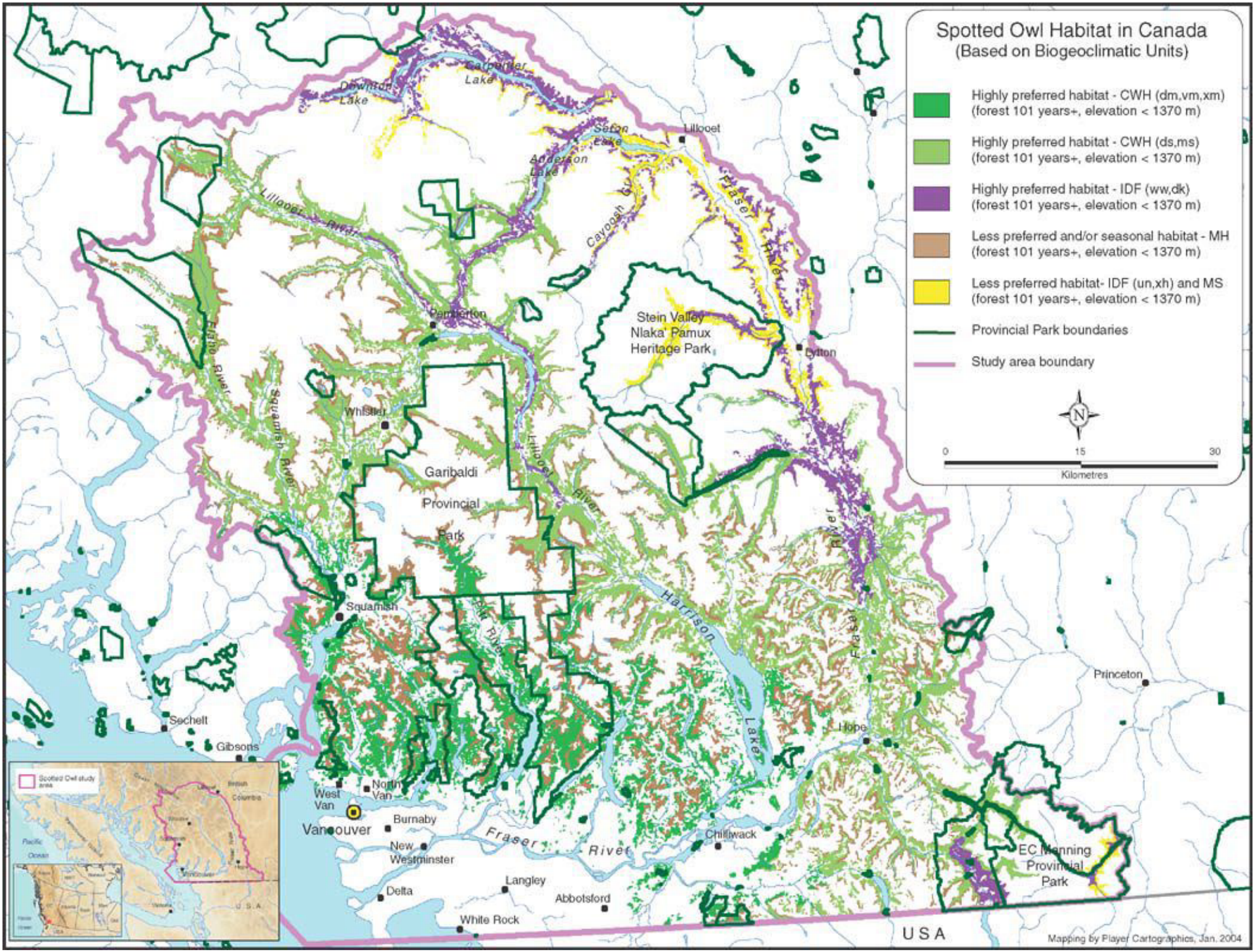
Throughout their global range, owls have been virtually eliminated from the majority of intact, very old, and low elevation, highly productive forests on state and private land, and now reside almost exclusively in lower quality, mountainous, higher elevation public land which is now increasingly becoming fragmented. Thus, baseline data is no longer available for the owls preferred and most productive low elevation forests. Nonetheless, data from mountainous terrain on public land still mostly confirm that owls prefer older forests and data clearly indicates that in most of the owls Canadian range, very old forest once covered the overwhelming majority of the landscape. Current spotted owl habitat pales in comparison to the rich forests that once existed in productive low elevation sites. The recruitment of new Spotted Owl habitat over the next 100 years from the regenerating clearcut landscape, must be a topmost priority.

Activities which destroy habitat

Spotted Owl habitat is principally destroyed by logging. Small amounts of habitat are also lost due to other resource developments. Historically forest fire and insect outbreaks were minor factors in habitat loss but are becoming larger factors. The creation of fire prone, even age stands, caused by rotation clearcut logging combined with the fact that often the majority of fiber cut is left as waste, is creating a situation where the likelihood of fire destroying vast tracts of coastal rainforest is increased.

Natural insect outbreaks in Spotted Owl habitat have been minor to date but could become a larger factor due to climate change. Old growth forests are naturally resilient to insects, disease and fire due to their structural complexity and elevated moisture regimes. Insects and disease generally are more common in forests lacking in structural complexity.

Spotted owl habitat on the eastern boundary of Garibaldi provincial Park. Photo: Joe Foy.


Spotted Owl Habitat in Canada
(Based on Biogeoclimatic Units)
Highly preferred habitat - CWH (dm,vm,xm)
(forest 101 years+, elevation < 1370 m)
Highly preferred habitat - CWH (ds,ms)
(forest 101 years+, elevation < 1370 m)
Highly preferred habitat - IDF (ww,dk)
(forest 101 years+, elevation < 1370 m)
Less preferred and/or seasonal habitat - MH
(forest 101 years+, elevation < 1370 m)
Less preferred habitat- IDF (un,xh) and MS
(forest 101 years+, elevation < 1370 m)
Provincial Park boundaries
Study area boundary
N
0
15
30
Kilometres
Dawson Creek
Tatlayoko Lake
Carpenter Lake
Seton Lake
Anderson Lake
Lillooet
Lillooet River
Cayoosh Creek
Fraser River
Pemberton
Stein Valley
Nlaka' Pamux
Heritage Park
Lytton
Fitzhugh River
Squamish River
Whistler
Garibaldi
Provincial
Park
Lillooet River
Harrison Lake
Fraser River
Squamish
Sechelt
Gibsons
West Van
North Van
Vancouver
Burnaby
New Westminster
Fraser River
Delta
Langley
Abbotsford
White Rock
Chilliwack
Hope
Princeton
EC Manning
Provincial
Park
USA
Mapping by Player Cartographics, Jan. 2004

PART EIGHT

Other Considerations

Ecological Role

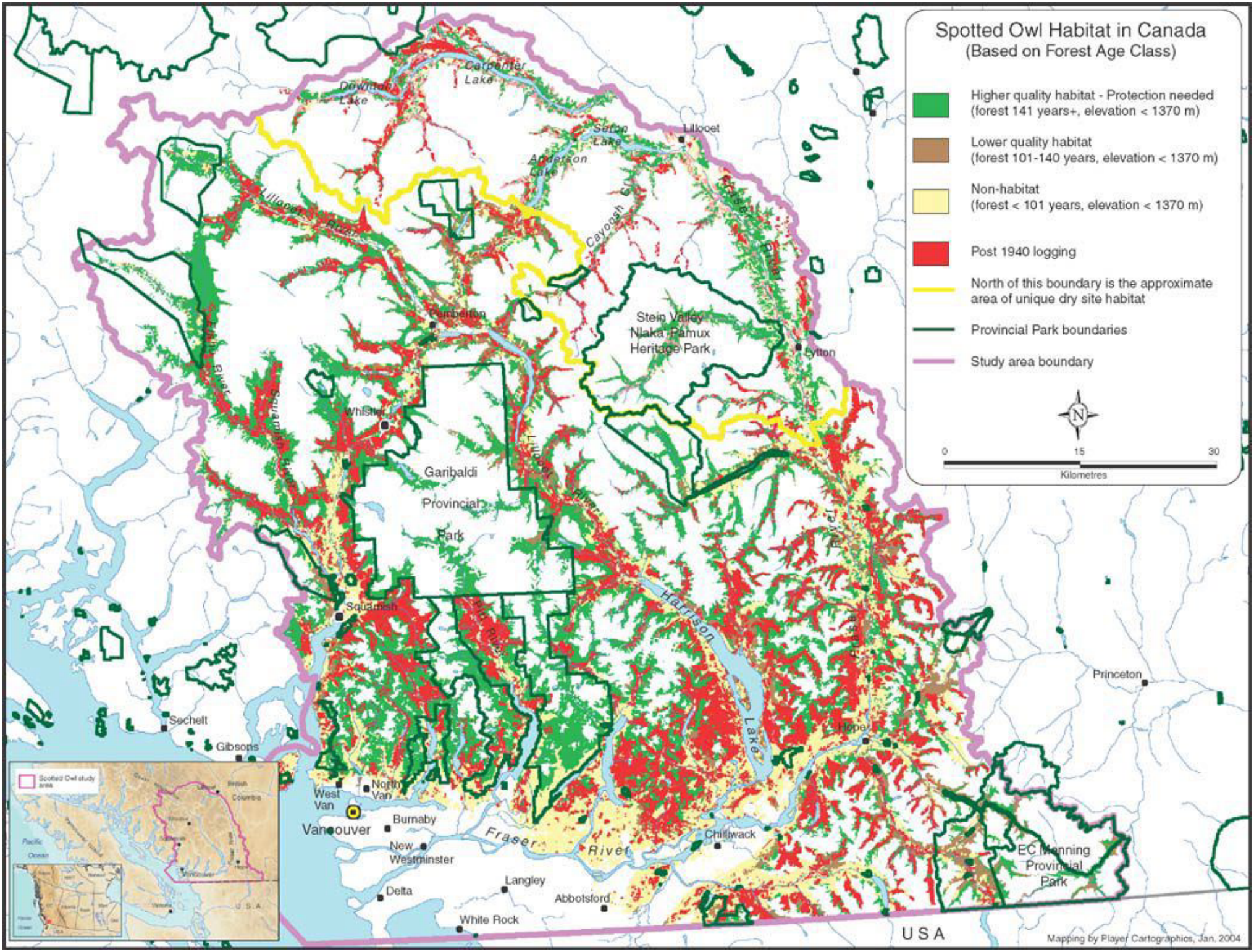
Spotted Owl population decline has ramifications beyond the species. Top level predators such as the Spotted Owl are frequently considered 'indicator species" in that they are sensitive to ecosystem disturbance and may be used to assess the ecological health of natural systems. For example, the US Forest Service has formally designated the Spotted Owl as an indicator species because the federal agency considers that the owl's health mirrors the health of old-growth ecosystems. In turn, the BC Ministry of Environment reports that "threatened or endangered forest [dependent] species are indicators of ecosystem diversity and integrity, which is, in turn, linked to forest productivity and the health of the forest industry (MELP, 1998)."

SOMP states that "Maintaining the owl at the edge of its range is one of the best ways to conserve the genetic diversity of the species. Inhabiting a climatically harsher and less predictable environment, the genetic makeup of the British Columbia population may make it be better suited for adaptation. For these reasons, the northern range of the Spotted Owl may play a critical role in the future survival of the species in North America."

Importance to People

The Spotted Owl is one of the most studied species on earth, yet because of the perceived socio-economic impact of its recovery, it is a highly controversial species (Gutierrez et al. 1995). The owl is a high profile species and well known by citizens. Protection of the Spotted Owl has short term economic consequences to the timber industry. These consequences could be lessened by making value added production more of an emphasis, rather than the current practice of using high quality old growth fibre for the mass export of minimally finished commodities, and raw log exports.

Alternate Recovery Strategy author Andy Miller in frshly cut spotted owl habitat. Photo: Joe Foy.


Spotted Owl Habitat in Canada
(Based on Forest Age Class)
Higher quality habitat - Protection needed
(forest 141 years+, elevation < 1370 m)
Lower quality habitat
(forest 101-140 years, elevation < 1370 m)
Non-habitat
(forest < 101 years, elevation < 1370 m)
Post 1940 logging
North of this boundary is the approximate area of unique dry site habitat
Provincial Park boundaries
Study area boundary
N
0
15
30
Kilometres
Carpenter Lake
Downton Lake
Seton Lake
Anderson Lake
Lillooet
Lillooet River
Cayoosh Creek
Fraser River
Pemberton
Stein Valley Nlaka'pamux Heritage Park
Lytton
Whistler
Garibaldi Provincial Park
Lillooet River
Squamish River
Squamish
Elk River
Harrison Lake
Harrison River
Sechelt
Gibsons
West Van
North Van
Vancouver
Burnaby
New Westminster
Fraser River
Delta
Langley
Abbotsford
White Rock
Chilliwack
Hope
Princeton
EC Manning Provincial Park
USA
Mapping by Player Cartographics, Jan. 2004

PART NINE

Conflicts and Challenges

There are several significant challenges to the recovery of Spotted Owls in British Columbia. The primary short-term challenge is to stop the population decline and prevent extirpation. Difficulties and obstacles to survival and recovery are highlighted by continuing population decline and ongoing clearcutting of Spotted Owl habitat. Survival and recovery are also hampered by the fact that all known Spotted Owl locations that are not in parks or protected areas are currently having, or will soon have, their home-range habitat logged. Additionally, the small provincial population, low recruitment of owls, slow habitat recruitment, competition, and genetic viability present challenges to recovery. Delays in habitat protection and population augmentation, under the auspices of insufficient knowledge, will result in increasing recovery costs as the owl population slips closer towards extirpation.

Knowledge and Research Needs

An estimated $100 million (CDN) has been spent on Spotted Owl research and management in the US (Meslow, pers. comm.). Compared to virtually all other wildlife, there is an unprecedented level of ecological knowledge of habitat relationships and habitat requirements of the Spotted Owl. The correlation between old forests, large protected areas, and Spotted Owls, is very strong.

The insufficient spatial and temporal scale distribution of old forests in BC is a major limiting factor for Spotted Owls and implies large scale habitat protection above and beyond the scale of US protection measures. Although secondary causes of endangerment that affect small isolated populations play a large role in the owls' endangerment, these factors do not diminish the primary cause of endangerment which is habitat supply.

Ethical constraints associated with working intensively with an endangered species like the Spotted Owl exist. These constraints must be carefully considered in measuring the effect of intrusive activities (Kurz and Greenough 1996). Invasive research with the BC population is unwarranted because of the high risk this poses to such a small population. If even one owl is killed or stressed the future of the population is at risk.

Some research needs identified by SORT include dispersal behavior, habitat and prey requirements, minimum viable population, immigration, and competition. Although these research needs may be laudable academic exercises for the medium to long term, using lack of absolute scientific certainty at the local (BC) level as an excuse to delay permanent and/or temporary habitat protection has no basis.

One area of research that is immediately required is on the owls' main prey species, the Northern Flying Squirrel, as early efforts by Ransome and Sullivan (2003) suggest a possible decline in flying squirrel numbers in some Vancouver watersheds.

In far eastern extremes of its range, the owl is more tolerant of elevated natural disturbance rates, single tree and very small, group removal selection logging, uses different nesting structures when cavities are not present and exhibits greater diversity of prey selection (Weber, 2002). These factors may, according to Weber (2002), require a modified owl management plan. However, the amount of suitable owl habitat in these eastern extremes of the owls' range in BC is so small as to question the validity of the Weber's proposal for development of unique management strategies. Given the critical nature of the BC owl population, management plans developed for the BC population should be applied to all owls in the short term for the sake of simplicity. Perhaps after the owl recovers, unique management strategies should be applied to the more tolerant eastern owls.

Inventory

Inventory is a priority, but it is also a "red herring" being used to delay other recovery actions. Although no exhaustive inventory of Spotted Owls has been conducted in British Columbia, the majority of higher quality habitats where owls are likely to be found have been repeatedly surveyed over the years (Blackburn pers comm). In addition, known Spotted Owl locations have been surveyed relatively intensively during the last ten years. 150 potential locations thought to be capable of supporting owls have been surveyed. Spotted Owls have been detected at 65 locations in the province. 40 Spotted Owl locations were used to assess the population trend since 1992 (Blackburn et al. 2002). However, many potential habitats of lesser quality remain un-surveyed in the province. There are not high hopes that owls will be found in these lower quality habitats.

A scientifically untenable situation has arisen because many low quality habitat areas have not been surveyed for Spotted Owl. BC government imposed funding cuts have resulted in a situation where the most basic of scientific knowledge, field inventory, has not been conducted with adequate scientific rigor. As a result only high quality habitats were surveyed. However, as a result of the fact that the majority of high quality habitats were surveyed has led scientists to conclude that there is a high degree of certainty that the Spotted Owl population is very small and is crashing. This certainty is based on ongoing monitoring of a subset of the population and on the fact that most high quality spotted owl habitat has been surveyed, and that Spotted Owls rarely occupy low quality habitat.

Although it is acknowledged by SORT that few owls remain to be found, the lack of proof has resulted in a situation where the SORT is unwilling to direct or enable habitat protection, because they do not have results of inventory. Although inventory is normally a crucial ingredient which enables subsequent recovery actions, in the case of the spotted owl, deliberate government under-funding of inventory should not be used as an excuse to delay habitat protection. SORT previously recognized the irony that a lack of inventory could be used as a weapon against the owl and recommended that until such time as inventory is complete all suitable habitat be protected. SORT justified its stance with an elaborate discussion of the merits of the "precautionary principle". However, when it was clear that funds for inventory were not forthcoming, and due to timber industry intervention, SORT removed reference to habitat protection and precaution.

The precautionary principle as applied in SARA and RENEW state that lack of scientific certainty should not be used to postpone recovery actions. It is ironic that we find ourselves in a situation where we have one of the most studied animals on earth, whose population is crashing, yet a key piece of knowledge which ordinarily would be considered a prerequisite for habitat protection (inventory) is missing. SORT is correct to state that inventory is important, but is wrong to conclude that habitat protection must wait until inventory and habitat modeling is complete.

Industry has responded to the lack of inventory by using stalling tactics to delay recovery actions in hope that feasibility of recovery will be re-addressed. In response, the BC government has taken the highly unusual action of returning the final, approved, and signed-off recovery strategy to SORT for editing. BC Government is asking SORT to "clarify" the technical and biological feasibility of recovery of the Spotted Owl, and to dispute false allegations leveled at SORT by the timber industry as per the Keystone Report. This report ostensibly claims that because only a subset of the owl population was monitored, that trend data showing a plummeting population can not be applied to the population as a whole because survey efforts and methodologies were not consistent.

Ecological and Technical Feasibility of Species Recovery

Spotted Owls in North America face a number of daunting challenges to recovery, most notably the lack of habitat protection and other factors associated with extreme habitat fragmentation. Limited habitat protection has not stopped the population decline.

Recovery efforts will continue to be feasible only if adequate habitat protection measures and augmentation measures are undertaken. Many scientists predicted the decline of the owl because the habitat protection measures as per SOMP only had a 5% impact on timber supply. In addition to loss and fragmentation of habitat, other factors include predation, competition, low re

productive output, juvenile survival and dispersal success, in addition to stochastic environmental, demographic and genetic events.

If all forest aged 140 years plus was protected, and 100-140 year old forests temporarily protected until habitat modeling helps define a type B and C habitat protection plan, as well as population augmentation implemented, it is likely that the Spotted Owl population would stabilize. A major problem, however, is that current spatial distribution of habitat is insufficient to sustain the population and completely inadequate to downlist. The recruitment of new habitat to fill in patches of existing habitat is thought to be a prerequisite for stabilization, recovery and the maintenance of genetic diversity. As well, increasing the amount of habitat by retaining newly recruited habitat will increase reproductive output, survivorship and population size. Within 50 years, significant amounts of low-end habitat will be recruited, facilitating the movement of owls between blocks of high quality habitat but meeting only few other habitat requirements.

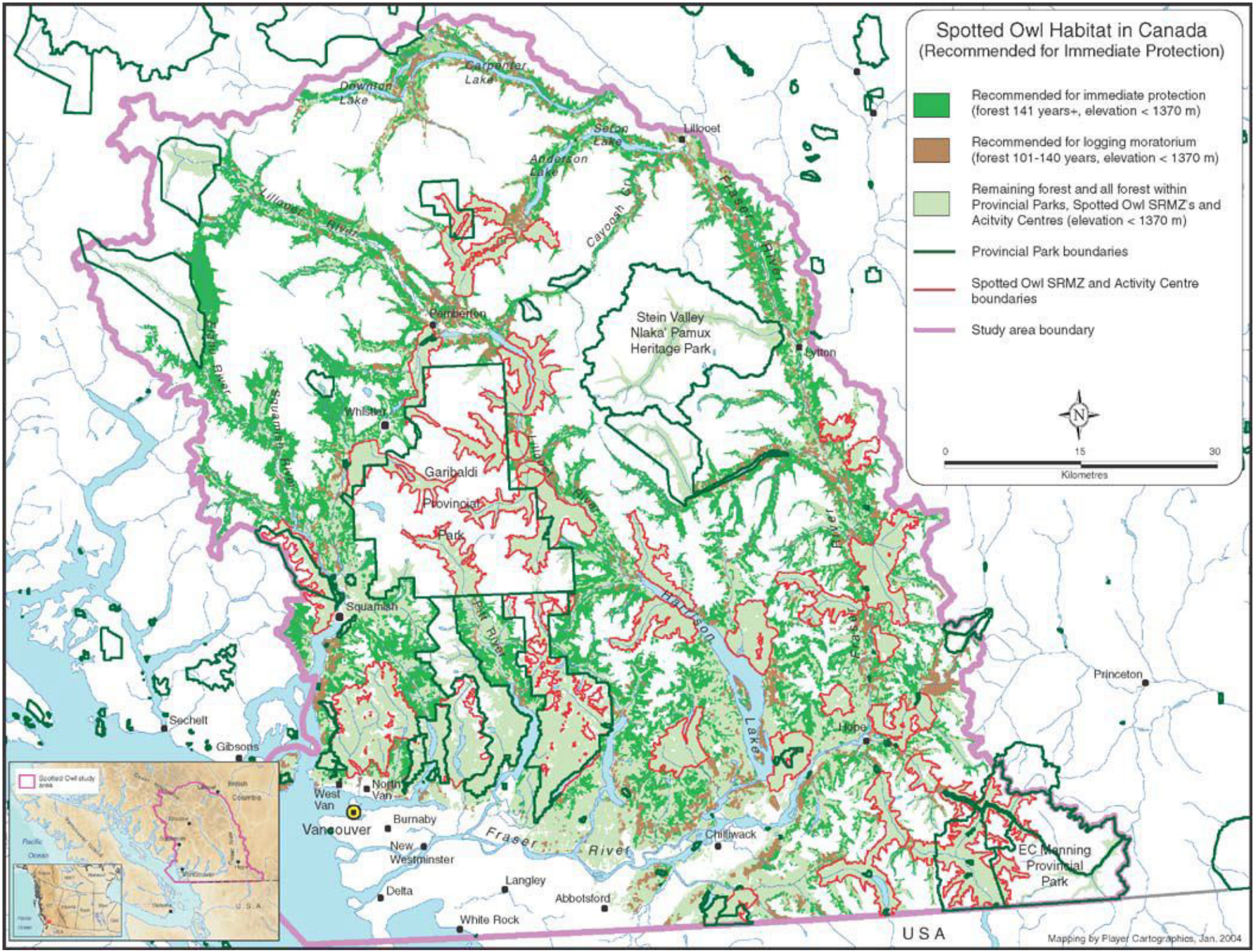
I agree with the SORT belief that "Biologically, if left alone, the potential for natural recovery in British Columbia is thought to be low due to the sparse distribution of owls. Population augmentation measures are needed to offset these limitations until habitats and owl populations are both sufficiently distributed across the landscape. Translocation is necessary to enable owls to find mates and to achieve adequate spatial distribution within their range. By avoiding their first winter, capture and over wintering of juveniles may increase juvenile survival and recruitment of breeding owls. If population conditions do not improve, then captive breeding programs may be necessary to restore the population, but such radical measures must be complemented by a government commitment to achieve forest age class structure throughout the range of the owl which seriously considers pre-European disturbance regimes in which up to 90% of most forests in the range of the Spotted Owl were in an old growth condition.

The recovery of the Spotted Owl in BC is thought to be biologically and technically feasible, however the large scale efforts and financial resources needed to achieve recovery are substantial and are required immediately. A high risk of extirpation exists until successes of these efforts are demonstrated.

Despite policy directives instructing SORT to define the owl as recoverable unless proven otherwise, the BC government requested in December, 2003 that SORT re-visit their completed recovery strategy to re-address the feasibility of Spotted Owl recovery. As of press time, SORT had not yet completed this task.

Recommended Approach/Scale for Recovery

In their recovery strategy, SORT states that "Recovery of Spotted Owls will require an integrated approach at a large geographic scale. A single-species landscape-level approach is warranted because of the level of endangerment and the scale at which Spotted Owls utilize the landscape. Within the context of land use planning processes in British Columbia (Province of British Columbia 2002), the current management plan was developed at a sub-regional scale (1:100,000) to address management across the entire range. At the large scale landscape level (1:20,000), management units within the plan are based around territories and clusters of territories in order to address territorial needs of breeding pairs and the dispersal requirements of their young. Habitat enhancement efforts are focused at the stand level. All three scales will need to be continued to be considered simultaneously during the recovery process."


Spotted Owl Habitat in Canada
(Recommended for Immediate Protection)
Recommended for immediate protection (forest 141 years+, elevation < 1370 m)
Recommended for logging moratorium (forest 101-140 years, elevation < 1370 m)
Remaining forest and all forest within Provincial Parks, Spotted Owl SRMZ's and Acitvity Centres (elevation < 1370 m)
Provincial Park boundaries
Spotted Owl SRMZ and Activity Centre boundaries
Study area boundary
N
0
15
30
Kilometres
Carpenter Lake
Downton Lake
Seton Lake
Anderson Lake
Lillooet
Lillooet River
Cayoosh Cr.
Fraser River
Pemberton
Stein Valley Nlaka' Pamux Heritage Park
Lytton
Fitzsimmons River
Squamish River
Whistler
Garibaldi Provincial Park
Lillooet River
Harrison River
Fraser River
Squamish
Pitt River
Harrison Lake
Princeton
Hope
Sechelt
Gibsons
West Van
North Van
Vancouver
Burnaby
New Westminster
Fraser River
Chilliwack
EC Manning Provincial Park
Delta
Langley
Abbotsford
White Rock
USA
Mapping by Player Cartographics, Jan. 2004

PART TEN

Recovery: Goals & Objectives

Recovery Goal

To achieve a stable or increasing, self-sustaining population (greater than 250 adult individuals [and associated sub-adults and juveniles]) that is distributed throughout its natural range. Successful achievement of this goal will lead to the down-listing of the Spotted Owl in British Columbia from its current "Endangered" status to "Threatened".

Recovery Objectives

Recovery objectives 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.

Objective 1.
Stop the Spotted Owl population crash to prevent extirpation

Extirpation appears imminent within the next few years following a 67% population crash from 1992-2002, and a historic population decline of between 90% and 99%. For survival and recovery to occur, biologically limiting factors must be addressed and factors that threaten survival must be eliminated.

Objective 2.
Increase the number of Spotted Owls to maintain a stable, self-sustaining population throughout its BC range.

Increasing the population size throughout the owls' range to meet COSEWIC downlisting requirements of 250 adult owls [and associated sub-adults and juveniles] will lower vulnerability to extirpation and increase resiliency to habitat perturbations.

Objective 3.
Preserve all remaining high quality habitat and model lower quality habitat to determine total habitat protection and management needs to achieve a self-sustaining population of owls.

The quantity and quality of habitat and its spatial distribution is inadequate to maintain the current low population. The amount, distribution and quality of habitat influence population size and stability. To stop the population decline and recover the species throughout its range, high quality type A habitat must be protected, low quality type B and C habitat modeled, managed accordingly, and restored.

Strategies to Meet Recovery Objectives

A. Stop the decline and recover the species

This recovery strategy recommends some specific habitat and owl site protection measures while at the same time recommending further analysis in recovery action plans regarding habitat protection and or management for lower quality habitat.

Strategy 1.
Immediately protect all Spotted Owl habitat through emergency interim measures

Based on the extensive scientific knowledge of the owl and its endangerment, it is recommended that emergency interim management measures be implemented which:

1. permanently protect all of the owls remaining type A (high quality) habitat (including all approved

category A cutblocks). Type A habitat is largely known and mapped.

2. implement a temporary logging moratorium on all low-end type B habitat and younger forest until habitat modeling helps confirm which of these forests must be protected and/or managed for the owl.

Strategy 2.
Immediately protect all Spotted Owls

Due to the small population size, there is a critical need to protect all historic Spotted Owl sites dating to the initiation of intensive surveys in 1985 in British Columbia as the highest priority recovery action. Metapopulation theory asserts that populations flux through time. Thus, regardless of whether a historic owl site is currently occupied or is of unknown occupancy, these sites warrant protection owing to the biological reality that owl sites may or may not be active from year to year. Maintaining options for these sites to become active again involves outright protection of these sites. Such action is needed immediately to prevent extirpation. All remaining individuals, whether or not they are currently occupying a given site, are essential to provide the genetic diversity and act as a "seed" source to increase and recover the population.

Eric Forsman, the world's pre-eminent Spotted Owl scientist responded to BC's Recovery Strategy with the following words:

> *A plan that only protects habitat as long as it is occupied is a prescription for extinction. Habitat must be protected regardless of whether it is occupied at any particular point in time or there is no hope for recovery of the species.*

Strategy 3.
Conduct Inventory to locate all Spotted Owls

All remaining Spotted Owls must be located to comply with standard species management protocols. To effectively manage a species, especially an endangered species, without basic inventory information is highly atypical. However, it must be stressed that according to SARA's recommendations regarding precaution, this lack of data should in no way limit implementation of habitat protection measures. As per SORT's Recovery Strategy, "This [inventory] 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 on."

Strategy 4.
Protect Survival Habitat

Exactly what constitutes minimum habitat will likely never be known. Minimum habitat protection thresholds are notoriously difficult to determine for wide ranging, elusive habitat specialists like the Spotted Owl. Given that so little original, low elevation, high quality type A habitat remains, the logical precautionary approach to habitat management in the short term is to permanently protect all remaining type A habitat and temporarily protect all type B habitat until such time as habitat modeling is complete. For example to manage for the current estimate of less than 33 pairs means that we must also manage for an unknown number of sub-adults and juveniles which are required to maintain the estimated current population. Thus we are really managing not for only 66 owls but, assuming that there is an equal number of young non-territorial birds, possibly as many as 66 additional owls. Given that young owls use habitat at different spatial scales and tend to be much more wide ranging even than adults, then the habitat required to maintain the current population is quite possibly more than which is currently available.

Technically, 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 enable the 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.

B. Strategies to support population growth

Comprehensive monitoring of the population must begin immediately and continue until the population recovers to evaluate habitat protection and management

to recover the species.

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 adults. To achieve this goal, population and habitat modeling must be continuous to determine the ideal spatial distribution of owls, timeframes required to achieve population goals, and also to determine minimum self-sustaining population size required for long-term maintenance of the population in BC. Models must also factor in the range of population augmentation options discussed. Target date for model completions is no later than August 31, 2004.

Strategy 5.
Artificially increase owl recruitment through population augmentation

For the population to naturally increase requires that owls find mates and sufficient habitat to support regular breeding. Due to 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 habitat are thought to low. As a result, natural population growth may 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 Spotted Owl population, it is recommended that population augmentations be considered immediately and implemented to prevent further declines and extirpation. Augmentation measures may include the capture, over-wintering, and subsequent release in Spring of juvenile owls. Owls would be released into vacant long-term Activity Centers or otherwise un-occupied large patches of suitable habitat. Single adult owls which have become isolated due to fragmentation would be captured and immediately relocated to areas of inter-connected suitable habitat or areas where single owls of the opposite sex exist in habitat of sufficient quality to enable pair bonding and reproduction.

Finally, public awareness and education must be a primary strategy to gain support for recovery actions. SORT has recommended that a spotted owl website be developed and intensive educational campaigns to communicate directly with affected parties. Further a multi-faceted economic evaluation of impacts and options must be developed with full public representation.

C. Other Strategies

Strategies to support the protection of low-end type B habitat aged 100-140 years includes the development and implementation of a peer-reviewed and monitored plan to protect and recruit suitable habitat. This would be achieved through analysis of habitat modeling results and implementation of non-timber extractive methods of habitat manipulation such as snag creation and specific methods of thinning.

Strategies to restore unsuitable habitat include the development and implementation of silvicultural techniques to accelerate the recruitment of new habitat. This involves the implementation of logging methods which retain at least 50% of the standing volume and the extension of stand rotation ages two-fold. The management of unsuitable habitat for Spotted Owl will be determined, in part, by habitat supply modeling exercises.

Strategies to support recovery actions in the long-term and to clarify habitat protection needs are consistent with SORT's strategies and include "habitat supply modeling" and "promoting habitat and owl population stewardship, financial resource assistance, adaptive management and research, public awareness, and innovative solutions to address social and economic consequences."

After all type A habitat aged greater than 140 years is protected and 100 - 140 year old low end type B and other non-habitat is modeled to help determine which stands are needed to meet the COSEWIC recovery goal of 250 adults [and associated sub-adults and juveniles], then the highest subsequent priority action upon which all subsequent recovery actions will be based is continued population inventory and monitoring (commencing in spring 2004).

SORT estimates that less than ten additional Spotted Owl sites (harbouring either a pair or an individual owl) will be located as a result of intensive inventory efforts. This is based on the fact that the majority of high quality and large habitat patches have been surveyed already and that the chance of locating spotted owls in smaller, more fragmented patches of habitat is low.

Recovery actions already underway include the socio-economic based, Spotted Owl Management Plan (SOMP), implemented in 1995, a peer-reviewed analysis of SOMP which denounced its efficacy, limited in-

ventory, new habitat and population modeling, GIS habitat mapping, experimental capture, release and subsequent death of a juvenile owl, ongoing capture, radiotagging, and monitoring of owls born in 2003. Additionally, two major logging companies have deferred logging in Spotted Owl habitat due to citizen pressure.

Evaluation criteria for the recovery strategy include several performance measures regarding prevention of extinction, protecting type A habitat, managing type B habitat, and restoring non-habitat to maintain a viable population and to prepare action plans.

Impacts of Recovery on other Species/ Ecological Processes

Conservation of habitat for Spotted Owls will additionally benefit a multitude of vertebrate, invertebrate and plant species that use old and late successional coniferous forests. 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, 16 were considered to be at risk, either nationally or provincially. Furthermore, Harper and Milliken (1994) list a total of 76 bird species that are known to use older forests within the Spotted Owl's range, as well as 138 invertebrates. Other species, such as deer, will also benefit for the protection of habitats.

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 it will help regulate water and nutrient cycles. It also provides protection for watersheds and human values related to water quality of streams (e.g., drinking water, flood control). 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 the owls' existence.

LITERATURE CITED

Barrows, C.W. 1981. Roost selection by Spotted Owls: an adaptation to heat stress. *Condor* 83:302-309.

Bart, J. 1995. Amount of suitable habitat and viability of Northern Spotted Owls. *Conservation Biology* 9:943-946.

Blake, J.G. and J.R. Karr. 1984. Species conservation of bird communities and the conservation benefit of large versus small fragments. *Conservation Biology* 30:173-187.

Blackburn, I.R. 1991. The distribution, habitat selection and status of the Northern Spotted Owl in southwestern British Columbia, 1991. Unpubl. rep. B.C. Min. Environ., Lands and Parks, Wildl. Br., Surrey, BC.

Blackburn, I.R. and S. Godwin. 2003. Status of the Northern Spotted Owl in British Columbia. Ministry of 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 Min. of 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 Min. of 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.

Bond, M.L., R.J. Gutiérrez, A.B. Franklin, W.S. LaHaye, C.A. May and M.E. Seamans. 2002. Short-term effects of wildfires on Spotted Owl survival, site fidelity, mate fidelity, and reproductive success. *Wildlife Society Bulletin* 30:1022-1028.

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.

Campbell, E.C. and R.W. Campbell. 1984. Status report on the Spotted Owl in Canada, 1983. COSEWIC, Ottawa.

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, Volume 2, Nonpasserines: diurnal birds of prey through woodpeckers. Royal British Columbia Museum and Canadian Wildlife Service. Mitchell Press, Vancouver, BC. 636pp.

Cannings, R.J. 1998. The birds of British Columbia – a taxonomic catalogue. BC Ministry of Environment, Lands and Parks, Victoria, BC. *Wildlife Bulletin* No. B-86. 252pp.

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. 459 pp.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2000. COSEWIC: Organization and procedures manual.

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, R.D. and G.R. Bortolotti. 2000. Effects of hematozoans parasites on condition and return rates of American Kestrels. *Auk* 117:373-380.

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.

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, University of British Columbia, Vancouver, BC.

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

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 Min. of Environ. Lands and Parks, Surrey, BC. 180pp.

Forest Ecosystem Management Assessment Team (FEMAT). 1993. Forest ecosystem management: an ecological, economic and social assessment. Report of the Forest Ecosystem Assessment Team. U.S. Department of Agriculture, U.S. Department of the Interior.

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., R.G. Anthony, J.A. Reid, P.J. Loschl, S.G. Govern, 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 Monograph* 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., 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. Sovern 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. Unpublished 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 north-western California: annual results, 2001. Annual Progress Report for Region 5, USDA Forest Service. 18 pp.

Freemark, K and H. Merriam. 1986. Importance of area and heterogeneity to bird assemblages in temperate forest fragments. *Conservation*

Biology. 36:115-141

Green, R.N. and K. Klinka. 1994. A field guide to site identification and interpretation for the Vancouver Forest Region. Research Branch, BC Ministry of Forests, Victoria, BC. 285 pp.

Grinnell, J. 1917. Field tests and theory concerning distributional control. *American Naturalist*: 51:115-128

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. 28 pp.

Hamer, T.E. 1988. Home range size of the Northern Barred Owl and Northern Spotted Owl in western Washington. MS thesis, Western Washington University, Bellingham, WA.

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. 65 pp.

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.

Hanson, E., D.. Hays, L. Hicks, L. Young and J. Buchanan. 1993. Spotted Owl habitat in Washington. Washington Forest Practices Board. Washington. 116 pp.

Harper, W.L. and R. Milliken. 1994. Other species associated with late successional forests. Appendix C. *in* 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 Min. of Environ. Lands and Parks, Surrey, BC. 180 pp.

Hobbs, J. 2002. Spotted Owl nest searches in the Lillooet Forest District – 2002. Summary of results. Unpub. Report for Ministry of Water, Land and Air Protection, Victoria, BC.

Hodum, P. and S. Harrison. 1997. Ecological assessment of the British Columbia Spotted Owl management plan. Unpub. Report, University of California, Davis, CA.

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.

Kirk, D.A. 1999. COSEWIC status report on the Northern Spotted Owl, *Strix occidentalis caurina*. Committee on the Status of Wildlife in Canada. 24 pp.

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 Ministry of Forests and BC Ministry of Environment, Lands and Parks, Victoria, BC. 39 pp.

Lenihan, C. Personal communication. 2001. Wildlife Inventory Specialist, BC Ministry of Sustainable Resource Management, Surrey, BC.

Lint, J., B. Noon, R. Anthony, E. Forsman, M. Raphael, M. Collopy, and E. Starkey. 1999. Northern Spotted Owl effectiveness monitoring plan for the Northwest Forest Plan. Gen. Tech. Rep. PNW-GTR-440. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, Portland, OR. 43 pp.

Manley, I.A. and S.A. Cullen. 2003. Marbled Murrelets in British Columbia's Lower Mainland: a summary of historical and current distribution. Abstract. Pacific Seabird group, 30th Annual Meeting, 19-22 February, 2003, Parksville, BC.

Meidinger, D. and J. Pojar. 1991. Ecosystems of British Columbia. BC Ministry of Forests, Victoria, BC. 330 pp.

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.

MOF (Ministry of Forests). 2002. Growing Together. Ministry of Forests, 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

Ripple, W., Johnson, D., Hershey, K., and E. Meslow. 1991. Old-growth and mature forests near Spotted Owl nests in western Oregon. *J. Wildlife Management* 55:316-318.

ROMAN (Recovery Operations Manual). 2003. Renew recovery operations manual. Working Draft, 30 January 2003. RENEW Secretariat, Canadian Wildlife Service, Environment Canada, Ottawa.

Sierra Legal Defence Fund. 2002. Logging to extinction: the last stand of the Spotted Owl in Canada. Vancouver, BC.

Small, M and M. Hunter. 1988. Forest fragmentation and avian nest predation in forested landscapes. *Oecologia*: 76:62-64

SORT (Spotted Owl Recovery Team – Chutter, M. et al.), 2003. Northern Spotted Owl Recovery Strategy – final draft submitted to BC Government. 89pp.

Spotted Owl Management Inter-Agency Team (SOMIT). 1997a. Spotted Owl Management Plan: Strategic Component. Ministry of Environment, Lands & Parks and Ministry of Forests, Victoria, BC. 81pp.

Spotted Owl Management Inter-Agency Team (SOMIT). 1997b. Managing Spotted Owl Habitat: Operational Guidelines Component of the Spotted Owl Management Plan. Ministry of Environment, Lands & Parks/Ministry of Forests, Victoria, BC. 39pp.

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. Report of the Interagency Scientific Committee to Address the Conservation of the Northern Spotted Owl (Portland, Oregon) 427 pp and maps.

U.S. Department of the Interior (USDI). 1992. Recovery plan for the Northern Spotted Owl – Draft. U.S. Fish and Wildlife Service, Washington, DC. 662 p. and maps.

Weathers, W, P. Hodum, and J. Blakesley. 2001. Thermal ecology and ecological energetics of California Spotted Owls. *Condor*. 103:678-690.

Wilcove, D. 1987. Public lands management and fate of the Spotted Owl. *American Birds* 41:361-367.

APPENDIX I

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 BC, 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 is 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 threshhold 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 II

Suitable Spotted Owl Habitat Definitions for British Columbia

(SOMIT 1997, SORT, 2003)

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	· three or more canopy layers, multi-species canopy dominated by large (>75 cm dbh) overstory 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 (> 268 m3/ha) of fallen trees and other coarse woody debris on the ground.	· two or more canopy layers, multi-species canopy dominated by large (>50 cm dbh) overstory 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 (> 100 m3/ha) of fallen trees and other coarse woody debris on the ground.
Drier 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 increase frequency of stand initiating events.		
Suitable habitat characteristics	· three or more canopy layers, multi-species canopy dominated by large (>50 cm dbh) overstory trees (typically 173-247 stems/ha, although densities as low as 86 stems/ha are possible where large diameter trees are present).	· two or more canopy layers, multi-species canopy dominated by large (>30 cm dbh) overstory trees (typically greater than 247 stems/ha). · stands must contain 20% Fd and/or Hw in the overstory.

Drier ecosystems continued...

- 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 (> 268 m3/ha) of fallen trees and other coarse woody debris on the ground.

- 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 (> 100 m3/ha) of fallen trees and other coarse woody debris on the ground.

APPENDIX III

History of Spotted Owl Management in Canada

The first Spotted Owl Recovery Team was established in 1990 with the goal of creating a national recovery plan, but was disbanded in 1995 after the BC provincial government announced a separate plan to manage Spotted Owls which was scientifically unacceptable to SORT. The plan, called the Spotted Owl Management Plan (SOMP), was designed specifically to limit impacts on the timber industry to 10% (impacts were, in practice, limited to 5%) . The BC government then replaced SORT with a team of team of bureaucrats called SOMIT (Spotted Owl Management Interagency Team). SOMIT intended the BC government to implement SOMP as a high-level plan. However, this never occured and the implementation of SOMP was and remains voluntary.

From 1993-1997, an interim conservation strategy for Spotted Owls protected 67% of forests, aged at least 120 years, within a 3200 ha area around each known owl site. In 1997 this management plan was replaced by SOMP which protected more forest but also included lower quality forests aged at least 100 years. SOMP explicitly protected about 75,000 ha for Spotted Owls (about 11% of the total amount of Spotted Owl habitat in existence at the time) The goal of SOMP was to maintain 67% of the forest in 17 SRMZ's (Special Resource Management Zones). Each SRMZ contained from 2-13 Long Term Activity Centres (LTACS's), 3200 ha each in size. Each of the 99 LTAC's was theoretically capable of housing 1 pair of owls. However not all LTAC's met the 67% guideline. On average, each LTAC contained only about 50% old growth forest. 55 LTACS met the 67% threshold and 45 were below. Officially, SOMP applied only to Spotted Owls located between 1992 and 1995. 19 sites with Spotted Owls were located after 1995 and received no protection. 66 historic owl sites are known, but SOMP applied to only 40 sites. SOMP was intended to be a high level management plan with mandatory compliance from forest companies but this high level designation never occurred.

SORT was re-initiated in 2002 because owls were declining at a faster rate than anticipated. SORT submitted emergency Interim Management Guidelines to BC government in 2003 but were not implemented. The 8 out of 17 owl sites recommended for emergency protection by SORT remain unprotected as of January, 2004. SORT has recommended trading protected for unprotected habitat to gain protection for these sites. SORT has recommended that SOMP remain in place until such time as a new management plan is developed at some point in the future. Based on current timelines, a new management plan could be implemented by 2006, about the same time the owl is forecast to be extinct in Canada (extirpated).

APPENDIX IV Evaluation Criteria

Performance measures include:

1. Prevention of extirpation of the Spotted Owl from British Columbia.
2. All historic spotted owl sites protected regardless of current occupancy by March 31, 2004
3. Protection of all type A habitat by March 31, 2004
4. Temporary protection to all type B habitat until such time as population and habitat modeling clarifies type B habitat protection needs by March 31, 2004
5. Sufficient habitat must be protected and managed to maintain, in the long-term, the target number of owls (250 adults plus an estimated 250 subadults and juveniles) by March 31, 2005
6. Preparation of action plans for long term habitat protection and conservation, inventory, research, population augmentation and funding by the dates proposed. By Dec 30, 2004
7. The use of silvicultural techniques to speed up recruitment of habitat. An assessment of actual silvicultural treatments conducted will be required, that includes both audit and effectiveness evaluation components. By Dec 30, 2004
8. An evaluation of any population augmentation techniques used including an assessment of the increased the number of juveniles recruited into the population and increased the number of owls in the wild. By Dec 30, 2005
9. Initiation of research on vital topics identified in the research action plan. By Dec 30, 2004