PROPOSED

Species at Risk Act
Recovery Strategy Series

Amended Recovery Strategy for the Spotted Owl *caurina* subspecies (*Strix occidentalis caurina*) in Canada

Spotted Owl *caurina* subspecies

2023

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For copies of the recovery strategy, or for additional information on species at risk, including the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) Status Reports, residence descriptions, action plans, and other related recovery documents, please visit the Species at Risk (SAR) Public Registry[1].

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[1] www.canada.ca/en/environment-climate-change/services/species-risk-public-registry.html

Preface

The federal, provincial, and territorial government signatories under the Accord for the Protection of Species at Risk (1996)[2] agreed to establish complementary legislation and programs that provide for effective protection of species at risk throughout Canada. Under the *Species at Risk Act* (S.C. 2002, c.29) (SARA), the federal competent ministers are responsible for the preparation of recovery strategies for listed Extirpated, Endangered, and Threatened species and are required to report on progress within five years after the publication of the final document on the Species at Risk Public Registry.

The Minister of Environment and Climate Change is the competent minister under SARA for the Spotted Owl *caurina* subspecies and has prepared this amended recovery strategy, as per section 37 of SARA. To the extent possible, it has been prepared in cooperation with the province of British Columbia, as per section 39(1) of SARA.

Success in the recovery of this species depends on the commitment and cooperation of many different constituencies that will be involved in implementing the directions set out in this strategy and will not be achieved by Environment and Climate Change Canada or any other jurisdiction alone. All Canadians are invited to join in supporting and implementing this strategy for the benefit of the Spotted Owl *caurina* subspecies and Canadian society as a whole.

This recovery strategy will be followed by one or more action plans that will provide information on recovery measures to be taken by Environment and Climate Change Canada and other jurisdictions and/or organizations involved in the conservation of the species. Implementation of this strategy is subject to appropriations, priorities, and budgetary constraints of the participating jurisdictions and organizations.

The recovery strategy sets the strategic direction to arrest or reverse the decline of the species, including identification of critical habitat to the extent possible. It provides all Canadians with information to help take action on species conservation. When critical habitat is identified, either in a recovery strategy or an action plan, SARA requires that critical habitat then be protected.

In the case of critical habitat identified for terrestrial species, including migratory birds, SARA requires that critical habitat identified in a federally protected area[3] be described in the *Canada Gazette* within 90 days after the recovery strategy or action plan that identified the critical habitat is included in the public registry. A prohibition against destruction of critical habitat under ss. 58(1) will apply 90 days after the description of the critical habitat is published in the *Canada Gazette*.

For critical habitat located on other federal lands, the competent minister must either make a statement on existing legal protection or make an order so that the prohibition against destruction of critical habitat applies.

If the critical habitat for a migratory bird is not within a federal protected area and is not on federal land, within the exclusive economic zone or on the continental shelf of Canada, the

[2] www.canada.ca/en/environment-climate-change/services/species-risk-act-accord-funding.html#2

[3] These federally protected areas are: a national park of Canada named and described in Schedule 1 to the *Canada National Parks Act*, The Rouge National Park established by the *Rouge National Urban Park Act*, a marine protected area under the *Oceans Act*, a migratory bird sanctuary under the *Migratory Birds Convention Act, 1994* or a national wildlife area under the *Canada Wildlife Act* see ss. 58(2) of SARA.

prohibition against destruction can only apply to those portions of the critical habitat that are habitat to which the *Migratory Birds Convention Act, 1994* applies as per SARA ss. 58(5.1) and ss. 58(5.2).

For any part of critical habitat located on non-federal lands, if the competent minister forms the opinion that any portion of critical habitat is not protected by provisions in or measures under SARA or other Acts of Parliament, or the laws of the province or territory, SARA requires that the Minister recommend that the Governor in Council make an order to prohibit destruction of critical habitat. The discretion to protect critical habitat on non-federal lands that is not otherwise protected rests with the Governor in Council.

Acknowledgments

Many people are to be acknowledged for their involvement in the federal recovery planning process for the Spotted Owl *caurina* subspecies. This amended recovery document borrows significantly from the original Recovery Strategy for the Northern Spotted Owl (*Strix occidentalis caurina)* in British Columbia (Chutter et al. 2004), which was adopted as part of the Federal Recovery Strategy for the species in 2006. All those involved in the development of that original document are gratefully acknowledged.

Executive Summary

This document builds on the original Recovery Strategy for the Northern Spotted Owl (*Strix occidentalis caurina)* in British Columbia (Chutter et al. 2004), which was adopted as part of the Federal Recovery Strategy for the species in 2006. However, the original document contained more comprehensive information on the species' life history and early recovery measures, so it should be consulted for background. Detailed planning/strategy documents published since the original recovery strategy (e.g., Sutherland et al. 2007; Fenger et al. 2007) should also be consulted for additional background.

The Spotted Owl *caurina* subspecies (henceforth, the Spotted Owl) is a medium-sized owl with dark brown plumage patterned by small pale spots over most of the body. The species was first assessed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as Endangered in 1986. Its status was re–assessed and re-confirmed in 1999, 2000, and 2008. The species was designated as Endangered due to catastrophic population decline (driven by habitat loss and fragmentation and competition from the closely-related Barred Owl [*Strix varia*]), severely depressed population size, and continued vulnerability to ongoing threats.

The Spotted Owl once occurred throughout mixed-coniferous old-growth forests in southwestern British Columbia (B.C.), and may have numbered as many as 500 pairs prior to the impacts of significant human activity. Its historical range spans three ecological sub-regions that differ in their mean annual precipitation and corresponding habitat characteristics: the wet 'Maritime', moist 'Sub-maritime', and dry 'Continental'. Both the population and the distribution of the Spotted Owl have declined precipitously from historical estimates, with only three individuals detected within one small part of the province (<10,000-ha area in the Sub-maritime sub-region) during surveys in 2020. There are 31 Spotted Owls in captivity. Of these, nine were previously wild birds from BC and three were previously wild birds from the U.S.A. The breeding program has produced a total of 19 birds. It is the intent to restore wild populations with captivel- bred individuals.

Throughout its range, the Spotted Owl is strongly associated with mixed-coniferous forests that are characterized by: an uneven-aged cohort of trees; a multi-layered, relatively closed canopy; numerous large trees with broken tops, deformed limbs, and large cavities; and numerous large snags and accumulations of logs and downed woody debris. The full set of features and attributes needed to support all life functions (nesting, roosting, foraging, and safe movement/dispersal) are most typically associated with old-growth forests. Mature forests more often contain only a subset of these attributes, which may for example support foraging and safe movement/dispersal, but not other life functions such as nesting.

The primary threats to the Spotted Owl in B.C. include: problematic native species (i.e., competition from Barred Owls), logging and wood harvesting, roads and railroads (including logging roads), utility and service lines, and fire and fire suppression.

The population and distribution objective is to recover the Spotted Owl in Canada by restoring a stable population of at least 250 mature individuals distributed within a connected network of habitat representative of all three sub-regions within the species' historical Canadian range, and linked to the larger population in the U.S.A.

Recognizing that the population and distribution objective will take >50 years to achieve, the following short-term statements toward meeting the population and distribution objective have been established:

1. Maintain sufficient critical habitat needed to achieve the population and distribution objective *and* immediately cease human-caused threats where Spotted Owls are detected (i.e., if owls are found outside of, or released capitively-bred owls move to areas outside of existing protected areas).
2. Re-introduce at least 50[4] captive-bred Spotted Owls to the wild within 10 years (by 2033), with at least 10 released individuals surviving to become resident adults.
3. Complete annual Barred Owl surveillance at sites occupied by Spotted Owl and/or where reintroductions are planned, and remove all Barred Owls that are detected.

Broad strategies and general approaches toward addressing the primary threats to the survival and recovery of the species, as well as key knowledge gaps, are presented in section 6. Successful implementation of these broad strategies and approaches will be required for the population and distribution objective to be met.

Critical habitat has been identified to the extent possible, based on the best available information for the Spotted Owl. Given the long recovery timeframe and uncertainty associated with the behaviour of captively-bred and released Spotted Owls, as well as emerging information from various studies and partnerships with First Nations (e.g., the importance of acoustic critical habitat, wildfire risk and dispersal), an incremental approach is proposed to identify additional core critical habitat through time that meets or exceeds the amount sufficient to meet population and distribution objective. A schedule of studies (Section 7.2) has been developed to provide the information necessary to complete the identification of critical habitat that will be sufficient to meet the population and distribution objective.

Three performance indicators were developed to measure progress towards meeting the population and distribution objective. One or more action plans for the Spotted Owl will be posted on the Species at Risk Public Registry within five years of the final posting of the recovery strategy.

[4] This number is derived from current projections by the provincial government (B.C. Ministry of Forests, Lands, Natural Resource Operations and Rural Development [MFLNRORD] 2021) but is subject to adjustment following the pilot phase of the reintroduction (2022-2025), based on the actual annual reproductive output of captive pairs and the survival outcomes of released individuals.

Recovery Feasibility Summary

Based on the following three criteria that Environment and Climate Change Canada uses to establish recovery feasibility, it is considered to be biologically and technically feasible to recover the Spotted Owl in Canada (see *Species at Risk Policy on Recovery and Survival* [Environment and Climate Change Canada 2021]), although there are some significant uncertainties associated with this determination. In keeping with the *Guidelines on Characterizing Recovery and Developing Population and Distribution Objectives* under the *Species at Risk Policy on Recovery and Survival* (Environment and Climate Change Canada 2021), where there is a range of uncertainty associated with the full extent of improvements that are biologically and technically feasible, the determination defaults to the upper bound of what is considered to be within the scope of biological and technical feasibility.

1. **Survival characteristics:** Can survival characteristics be addressed to the extent that the species is no longer at significantly greater risk of extinction or extirpation as a result of human activity?

YES: The Spotted Owl is currently assessed as Endangered on the basis of four key survival characteristics: (i) resilience (D1 COSEWIC quantitative criteria[5]) - its population is estimated to be small (well below the 250-individual threshold for Endangered status) and is in decline; (ii) redundancy and connectivity (linked with COSEWIC B2ab indicators) – its habitat and associated distribution is in decline and fragmented (iii) stability (linked with COSEWIC A2ac, C1+2a, and E indicators) - there is an ongoing decline in the number of mature individuals and area/quality of habitat, and a quantitative analysis showing high probability of extirpation, and (iv) continuing impacts caused by ongoing human-caused threats.

1. Resilience: Prior to impacts of human activity (i.e., in its natural condition), the Spotted Owl population is Canada was approximately 500 mature individuals (Blackburn et al. 2002). This small population size would have meant the species' persistence was somewhat precarious even in its natural condition (e.g., would still be assessed as Threatened under the COSEWIC D1 quantitative criteria, which apply to a species with <1000 mature individuals). However, the results of human activity have put the species at a significantly greater risk of extirpation, such that it is now assessed as Endangered on the D1 indicator (i.e., population below 250-individuals). For recovery to be considered feasible, it must be biologically and technically feasible to improve the resilience of the Spotted Owl such that it exceeds the 250-individual D1 threshold associated with Endangered status, and thus returns to a status of Threatened (on the basis of D1 criteria).

   In 2020, only one nesting pair and one single owl were detected during surveys of 10 previously-occupied sites (J. Gillis, pers. comm. 2020). The Spotted Owl is known to suppress its calling in the presence of the closely-related competitor, the Barred Owl (*Strix varia*; Kelly et. al 2003; Crozier et al. 2006; Van Lanen et al. 2011; Yackulic et al. 2019) and Barred Owls have been detected at all 10 of the recently-surveyed sites that were historically occupied by Spotted Owls, so it is possible that some owls are present at surveyed sites but are going undetected by standard call-playback survey methods.

[5] For COSEWIC quantitative criteria and guidelines see www.cosewic.ca/index.php/en-ca/assessment-process/wildlife-species-assessment-process-categories-guidelines/quantitative-criteria.

Comprehensive, range-wide surveys have also not been undertaken in recent years, so some owls may still exist in unsurveyed areas, although given known rates of juvenile survivorship and recruitment this seems unlikely. However, even accounting for uncertainties about undetected individuals, the wild population is clearly extremely small and would have corresponding low genetic diversity. The population is apparently incapable of recovering on its own, so resilience cannot be addressed without the reintroduction of owls from a captive breeding program (Fenger et al. 2007).

A Spotted Owl captive breeding and reintroduction program has been in operation in B.C. since 2007. This program has had slow initial success rates and has not released any captive-bred owls to date. However, the captive population now stands at 31, and releases are being planned in the near term (J. McCulligh pers. comm. 2021; B.C. MFLNRORD 2021). Assuming that the captive breeding and reintroduction program meets its minimum targets[6] of releasing ~4 individuals/year from 2023 to 2024, ~9 individuals/year from 2025-2030, and ultimately ~14 individuals/year thereafter, the provincial government projects that it is within the scope of biological and technical feasibility to restore a stable population of ≥250 mature individuals within 50 years (B.C. MFLNRORD 2021).

2. Redundancy, connectivity, and stability: Prior to impacts of human activity (i.e., in its natural condition), the Spotted Owl had a relatively restricted distribution, concentrated in southwestern B.C. Although the precise bounds of its historical range (including extent of occurrence and area of occupancy) are unknown, it would have included three ecologically distinct sub-regions (the wet 'Maritime', moist 'Sub-maritime', and dry 'Continental' sub-regions), with connectivity in habitat within these sub-regions and to the U.S.A, to support a stable and genetically diverse population. With connectivity in habitat, and stability in population and distribution characteristics, it is unlikely that any of the COSEWIC quantitative criteria associated with redundancy, fragmentation, and/or stability would have been met for the species in its natural condition. For recovery to be considered feasible, it must be biologically and technically feasible to stabilize the declines in population and distribution characteristics, and to ensure there is a connected network of habitat that will support at least 250 mature individuals. Through captive breeding and reintroduction (see above) and threat mitigation, it is considered to be within the scope of biological and technical feasibility to restore a stable population. Through habitat protection and threat mitigation, it is considered to be within the scope of biological and technical feasibility to ensure that there are no further habitat declines. Based on the configuration regenerating and existing Spotted Owl habitat (see section 7 - Critical Habitat), it is considered to be within the scope of biological and technical feasibility to achieve a connected network of habitat sufficient to support ≥250 mature individuals within 50 years. Connectivity to the U.S.A. will always be reduced relative to historical conditions due to permanent habitat loss within developed portions of the Lower Mainland and Fraser Valley; however, some connectivity still exists and/or can be restored through long-term protection of maturing forest. In its recovered condition, the Spotted Owl should not meet the quantitative criteria for assessment as Endangered or Threatened based on A,B,C, or E COSEWIC indicators.

[6] This number is derived from current projections by the provincial government (B.C. MFLNRORD 2021) but is subject to adjustment following the pilot phase of the reintroduction (2022-2025), based on the actual annual reproductive output of captive pairs and the survival outcomes of released individuals.

3. Protection from human-caused threats: There are ongoing human-caused threats that must be addressed (ceased, mitigated, or avoided) in order for the preceding key survival characteristics to be addressed, and for recovery to be feasible. The most significant ongoing human-caused threats include: competition with a problematic native species (i.e., the closely-related Barred Owl), and habitat impacts caused by logging and wood harvesting, roads and railroads (including logging roads), and fire and fire suppression. It is biologically and technically feasible to cease or mitigate the human-caused threats of logging, road-building, and fire / increased fuel loads resulting from fire suppression. However, addressing the human-caused spread of Barred Owls into habitat that the Spotted Owl would have occupied historically poses a greater biological and technical challenge. Barred Owls are now considered to be one of the highest-level threats to the Spotted Owl both in B.C. and range-wide in North America (section 4 of this document; USFWS 2011). Barred Owl control programs (translocation and lethal removal) have been initiated within both the U.S.A. and B.C. (Diller et al. 2016, Gillis and Waterhouse 2020, Wiens et al. 2021) as an important component of Spotted Owl conservation efforts. Post-treatment monitoring studies in the U.S.A. have shown increases in local Spotted Owl site occupancy, survivorship and productivity within 4.5 years of (lethal) Barred Owl removal (Diller et al. 2016; Wiens et al. 2021). In more northern study areas there were longer lag times before reduced Barred Owl colonization rates and increased Spotted Owl responses were measured (Wiens et al. 2021). The longer lag times in northern sites have been attributed to two potential causes: 1) more established Barred Owl populations in these areas, and 2) lower numbers of Spotted Owls available to recolonize empty territories (Diller et al. 2016; Yackulic et al. 2019). Discernable Spotted Owl responses to Barred Owl removals have not yet been reported in Canada (Gillis and Waterhouse 2020); however, the planned re-introduction of Spotted Owls could help improve re-colonization rates. While there is uncertainty, it is still considered to be within the scope of biological and technical feasibility that impacts of Barred Owl can be managed successfully, to the extent that the preceding survival characteristics can be addressed.

2. Independence: Is the species currently able to persist in Canada independent of deliberate human interventions, and/or will it eventually be able to achieve and maintain independence in the state where condition (1) is met, such that it is **not reliant on significant, direct, ongoing human intervention**?

YES. The Spotted Owl is currently nearing extirpation in Canada and requires significant, direct human interventions (i.e., population augmentation through captive breeding; Barred Owl control) in the short-to-medium term (i.e., within the next 20 years), in order for condition '1' of recovery feasibility to be met. Barred Owl control is the primary intervention that may need to continue for a longer period (i.e., beyond 20 years); however, habitat improvement/recovery is expected to improve Spotted Owl persistence in combination with Barred Owl control and may help reduce the necessary level of investment in Barred Owl removals in the future (Yackulic et al. 2019). Although there is a high level of uncertainty, it is considered to be within the scope of biological and technical feasibility that a point will be reached in the longer term (up to 50 years), where the Spotted Owl population has recovered such that it can remain stable in the absence of ongoing human interventions.

3. **Improvement:** Can the species' condition be improved over when it was assessed as at risk?

YES. It is biologically and technically feasible to meaningfully improve the condition of the Spotted Owl in Canada through addressing one or more key survival characteristics as they pertain to results of human activity, such that the species' risk of extinction or extirpation is reduced. Population stability and resilience may be improved, and population/habitat connectivity and redundancy restored, through a) applying protection to a connected network of habitat, so that the habitat needed to support all life functions for a population of >250 mature individuals is available on the landscape when the recovering/recovered population needs it; b) continuing the captive breeding and reintroduction program, so that protected habitat is repopulated, and c) continuing Barred Owl control efforts, so that Spotted Owls can survive and reproduce successfully within protected habitats.

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1. COSEWIC* Species Assessment Information

Date of Assessment: April 2008

Common Name (population): Spotted Owl *caurina* subspecies

Scientific Name: *Strix occidentalis caurina*

COSEWIC Status: Endangered

Reason for Designation: This owl requires old-growth forests for its survival and has suffered a catastrophic population decline over the past 50 years as habitat is lost and fragmented. With the severely depressed population, an additional threat is the recent arrival of the closely related Barred Owl as a breeding bird in B.C.; this species competes with and hybridizes with the present species. Its historical population of about 500 adult owls in Canada has been reduced to 19, and only 10 of these are in breeding pairs. All adults are old and near the end of their breeding age and there is no recruitment of young owls into the population. If current trends are not reversed, extirpation will likely occur within the next decade.

Canadian Occurrence: British Columbia

COSEWIC Status History: Designated Endangered in April 1986. Status re–examined and confirmed in April 1999, May 2000, and April 2008.

* COSEWIC (Committee on the Status of Endangered Wildlife in Canada)

The above summary reflects population status information as of the 2008 COSEWIC assessment. Since 2008 there has been new information about historical and current population levels (summarized in section 3.2 – species population and distribution).

2. Species Status Information

The legal designation for the Spotted Owl on SARA Schedule 1 is Endangered (2003). Approximately 8% of the global (historical) range of the Spotted Owl is located in Canada (COSEWIC 2008). The species' status ranks, globally and in the different parts of its range, are summarized in Table 1.

Table 1. List and description of various conservation status ranks for the Spotted Owl (*caurina* subspecies) (NatureServe 2021).

Global (G) Rank	National (N) Rank	Sub-national (S) Rank	COSEWIC Status
Rounded global rank (of G3G4T3) = T3 (vulnerable)	Canada (N1 – critically imperiled) United States (N3 - vulnerable)	BC (S1) California (S2) Oregon (S1S2) Washington (S1)	EN (Endangered)

S1: Critically Imperiled; S2: Imperiled; S3: Vulnerable; S4: Apparently Secure; S5: Secure; SNR: Unranked; SNA: Not Applicable; B: Breeding.

3. Species Information

3.1 Species Description

The Spotted Owl is a medium-sized owl averaging 45 cm in length and 90 cm in wingspan. Plumage is dark overall with brown feathers patterned by small pale spots over most of the body. The tail has narrow white horizontal bars and there are no “ear” tufts. Eyes are large, dark brown and are set within lighter brown facial disks (Forsman 1981; Gutiérrez et al*.* 1995). Age cohorts can be identified by differences in plumage characteristics. Juveniles <5 months old are identified by visible down feathers. Sub-adults (1-2 years old) and adults (>2 years) may be differentiated based on tail feathers; sub-adults have pointed tail feathers with white tips whereas adult tail feathers are rounded and usually mottled in colour (Forsman 1981). Males and females have similar plumage but females are ~15% larger (Blakesley et al. 1990; Gutiérrez et al*.* 1995).

3.2 Species Population and Distribution

3.2.1 Population

The global population of the Spotted Owl was estimated at roughly 6000 breeding pairs in the late 1980s (Thompson et al. 1990), with the bulk of the population (>90%) occurring in the U.S.A. (COSEWIC 2008). Local population declines were observed at demographic study areas within Washington, Oregon, and California between 1985 and 2013, with an overall mean annual rate of decline of 3.8% (Dugger et al. 2015). Although no formal global population estimates have been published in recent decades, an approximate current population estimate can be deduced using the annual rates of decline observed in long-term study areas; assuming a 6000-pair starting population and a 3.8-% mean annual decline from 1985-2021, the global population would now be <1500 pairs. An updated analysis of the long-term study area data including data from 1995 to 2017 (Franklin et al. 2021) suggests that declines may have become even sharper than the 3.8-% mean decline reported in Dugger et al. (2015), with some long-term study sites exhibiting mean annual declines as high as 9%. Declines have been most pronounced in Washington, Oregon and B.C., and less pronounced in California (Blackburn and Godwin 2003; Dugger et al. 2015; Franklin et al. 2021).

Before European settlement, the Canadian Spotted Owl population likely did not exceed 500 breeding pairs, or ~10% of the global population (Blackburn et al. 2002). In 1991, it was estimated at fewer than 100 potential breeding pairs (Dunbar et al.1991; Dunbar and Blackburn 1994) and by 2002 it had declined further to fewer than 33 (Blackburn and Godwin 2003). A survey of 10 previously-occupied sites in 2020 found one pair and one single owl at two sites (J. Gillis pers. comm. 2020). Continued occupancy of those two sites was reconfirmed in 2021 (J. Gillis pers. Comm. 2021). This suggests a decline of approximately 99% from estimated historical levels in Canada, with Canada now supporting <0.01% of the global (combined Canada and U.S.A.) population.

However, in addition to the three known birds remaining in the wild (in 2020), there are 31 individuals housed in a captive breeding facility (J. McCulligh, pers. comm. 2021). Of these 9 were previously wild birds from BC and 3 are previously wild birds from the USA. The breeding program has produced a total of 19 birds. It is the intent to restore wild populations with captively bred individuals.

The combined wild and captive population appears relatively static since 2004, where declines in the wild population have in part resulted from individuals periodically being taken into the captive breeding program (Figure 1).

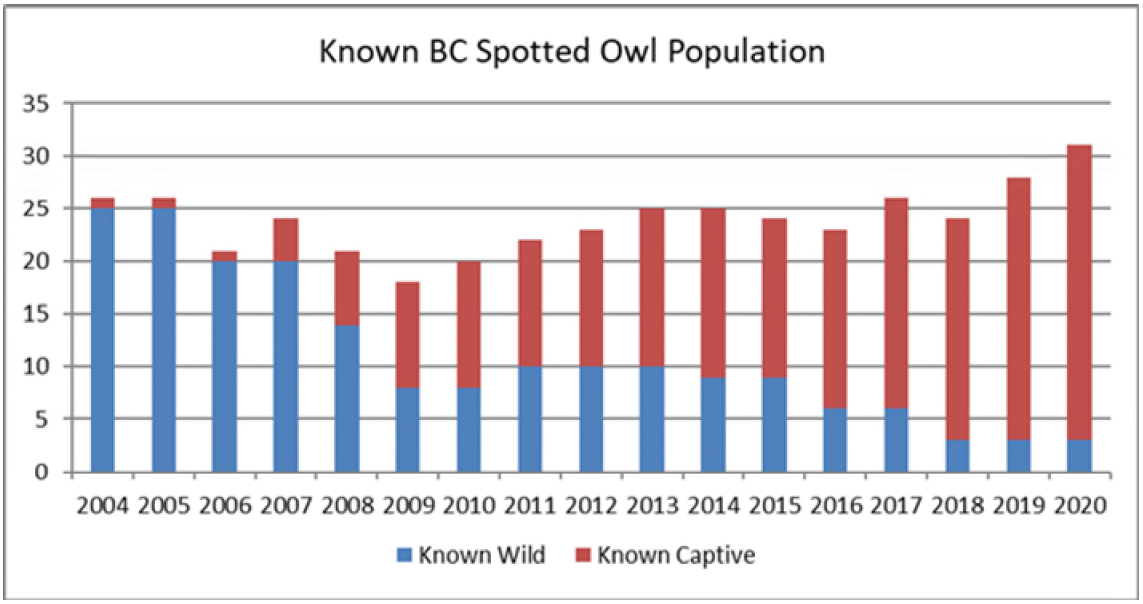

Figure 1. Known Spotted Owl population in Canada from 2004 to 2020 (Government of B.C. 2020). Note that annual inventory effort has varied for wild population counts.

3.2.2 Distribution

The Spotted Owl *caurina* subspecies is one of three subspecies of Spotted Owls found within North America (Figure 2). The *caurina* subspecies is distributed from the southwest mainland of B.C. through western Washington, western Oregon and the west coast of California, south to San Francisco Bay.

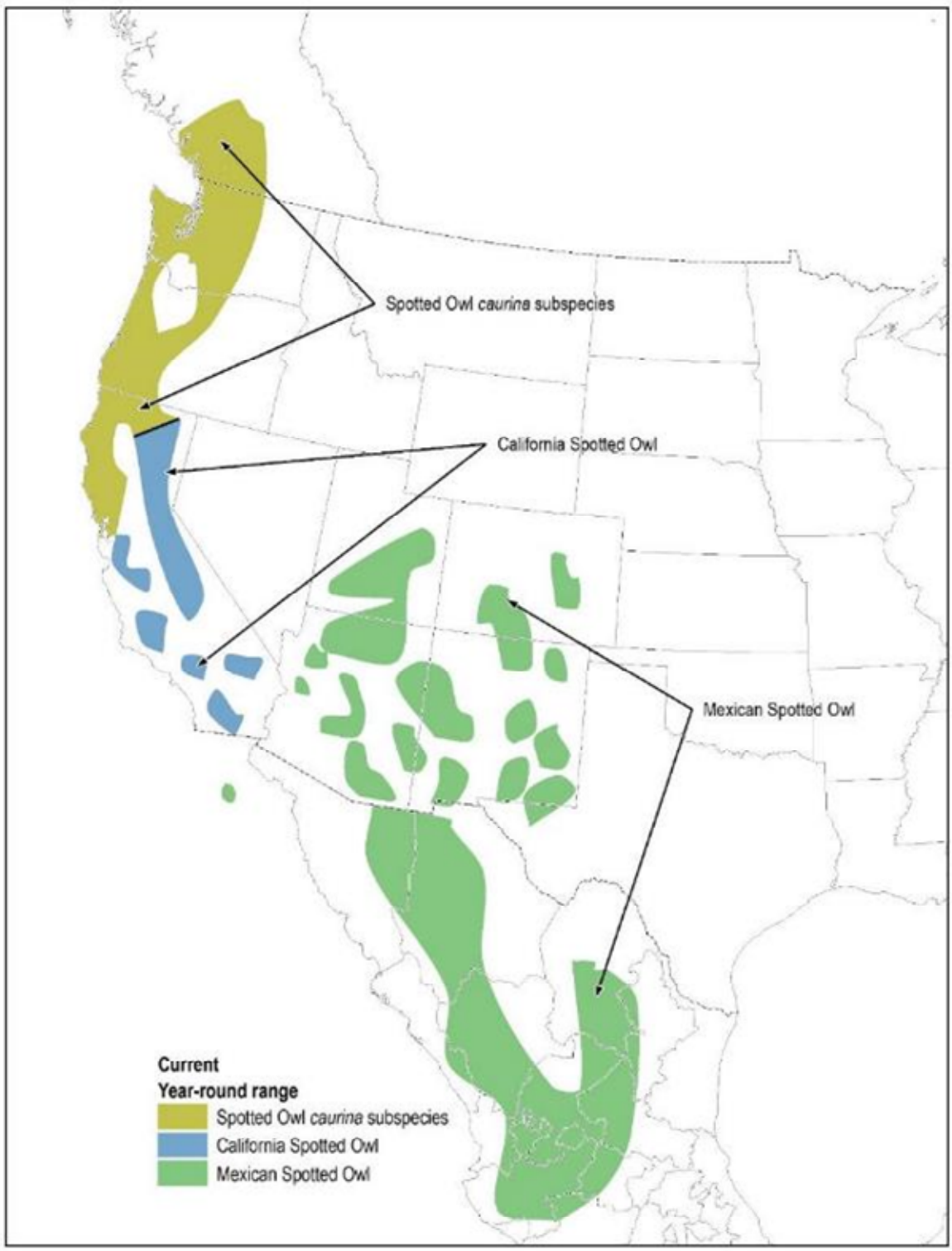

Figure 2. Approximate historical year-round range of Spotted Owls (three subspecies) in North America. (BirdLife International 2018). The *caurina* subspecies is often also referred to as the Northern Spotted Owl.

Historically, the Spotted Owl's range in B.C. extended from the U.S.A. border north ~200 km to Carpenter Lake, and ~160 km from Howe Sound in the west to the Cascade Range in the east (Figure 3; Chutter et al. 2004). Within this range, there are three ecological sub-regions that differ in their mean annual precipitation and corresponding habitat characteristics: the wet 'Maritime', moist 'Sub-maritime', and dry 'Continental'. Permanent range contraction occurred within the Lower Mainland and Lower Fraser Valley where once suitable habitat has been irreversibly lost to human development (Chutter et al. 2004; Figure 3); however, habitat remains within the rest of the historical range and could potentially be re-occupied by Spotted Owls. The remaining known wild individuals can be found within the Sub-maritime sub-region.

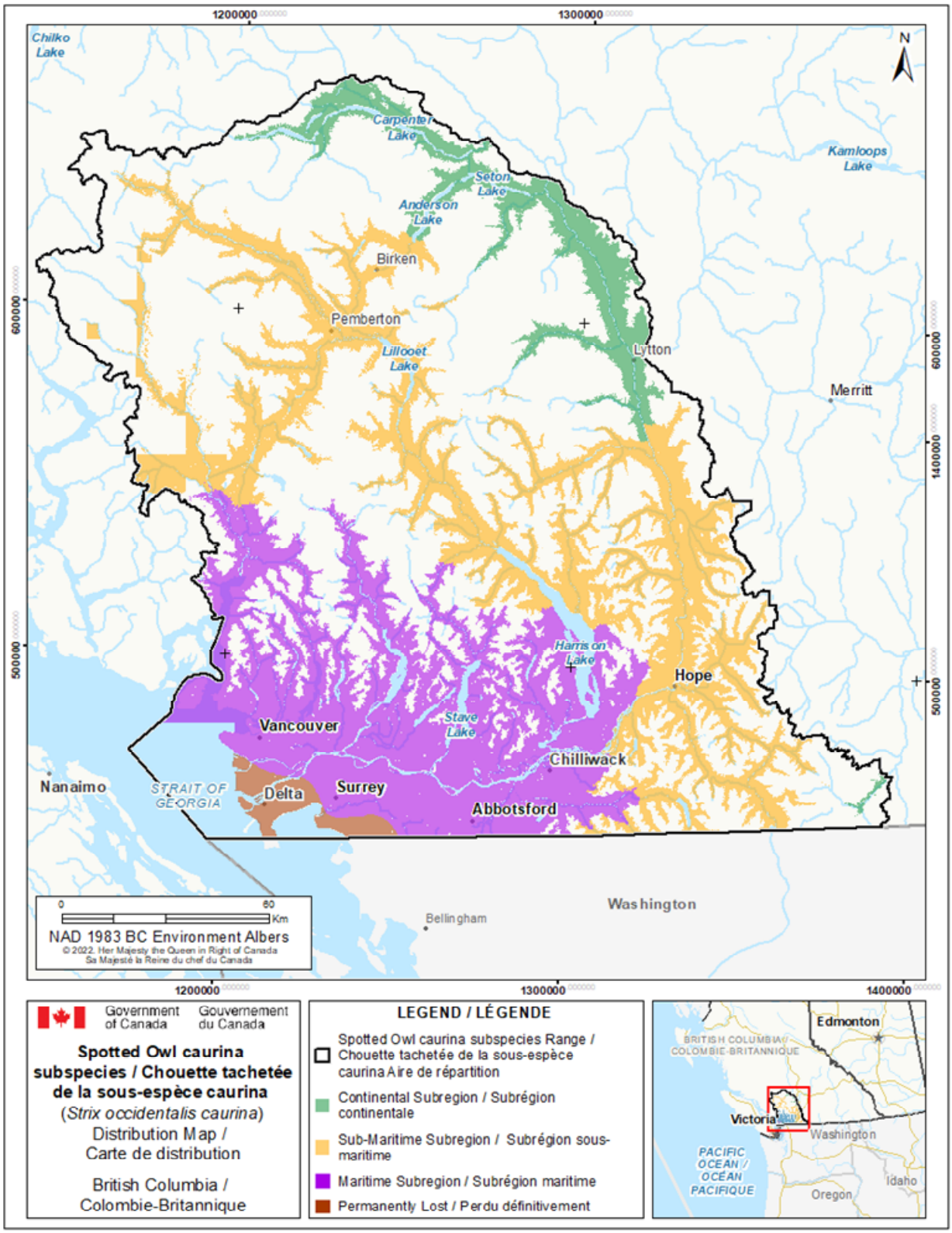

Figure 3. Approximate historical distribution of the Spotted Owl *caurina* subspecies in B.C.

3.3 Needs of the Spotted Owl

Historically, Spotted Owls occurred primarily within the Coastal Western Hemlock (CWH) and Interior Douglas Fir (IDF) biogeoclimatic zones in B.C. (SOMIT 1997; Sutherland et al. 2007). Their historical range would also have included parts of the Coastal Douglas Fir (CDF) zone, although that habitat has been permanently lost to human development (Chutter et al. 2004; Sutherland et al. 2007; Figure 3). The species is associated with mixed-coniferous forests characterized by: an uneven-aged cohort of trees; a multi-layered, relatively closed canopy; numerous large trees with broken tops, deformed limbs, and large cavities; and, numerous large snags and accumulations of logs and downed woody debris (Thomas et al. 1990; USDI 1992).

Habitat configuration

Landscape-level configuration

In order for a stable Spotted Owl population to exist within a landscape, habitat must be configured such that it can support all critical life functions (breeding, roosting, foraging, and safe movement/dispersal) for the entire population. This requires patches of forested habitat capable of supporting the year-round needs of breeding pairs and resident individuals, as well an overall configuration of both the year-round habitat patches and seasonally-used dispersal habitat that maximizes survival/success of dispersing individuals. Juvenile Spotted Owls disperse from their natal site in the late summer / early fall of their first year, and then may disperse several more times and persist in the background as “floaters” for up to five years before settling and beginning to breed (Forsman et al. 2002). Breeding-age owls also occasionally disperse to new locations, particularly when their original location has been disturbed (Forsman et al. 2002; Jenkins et al. 2019; Jenkins et al. 2021).

Simulated landscape population modelling results for the species suggest that larger year-round habitat clusters are most likely to support stable long-term (100-year) occupancy by Spotted Owls due to the ability for individuals to disperse within their natal/original cluster versus having to leave their natal cluster and disperse across a less hospitable matrix (Lamberson et al. 1994; Marcot et al. 2013). Marcot et al. (2013) also found that clusters were more likely to exhibit stable long-term occupancy by Spotted Owls when they were spaced more closely together (<15 km). Being a highly-mobile species, Spotted Owls are capable of dispersing long distances. In an analysis of 1534 dispersal events in Oregon and Washington, Hollenbeck et al. (2018) reported a maximum dispersal distance of 177 km and a mean of 23.8 km (± 19.2 km standard deviation). Dispersal has also been observed across a range of habitat types; large non-forested valleys, high-elevation subalpine forest, alpine tundra and large water bodies are the only features suspected to act as complete barriers to dispersal (Forsman et al. 2002; Chutter et al. 2004; I. Blackburn pers. comm. 2021). However, Spotted Owls must feed and escape predation in order to survive dispersal, and in moving through areas that lack foraging resources and security features, dispersing individuals are expected to incur an increased energetic/survival cost (Lamberson et al. 1994; Buchanan 2004; Sutherland et al. 2007; Marcot et al. 2013; Conlisk et al. 2020). In their simulated landscape population modelling, Marcot et al. (2013) found that as more of the landscape becomes suitable (i.e., overall habitat more contiguous), all cluster size/spacing configuration options become sufficient to achieve low dispersal mortality and high long-term stability. There have been few empirical studies of dispersal habitat use and demographic associations; however, in a study in western Oregon, Miller (1997) showed that juveniles that used more clearcut areas during dispersal had higher mortality rates than those using more intact forest habitat. Similarly, in their analysis of

1534 successful juvenile dispersal events in the U.S.A., Hollenbeck et al. (2018) found that dispersal pathways tended to coincide with the distribution of forested areas along mountain ranges, as opposed to non-forested areas. Overall population stability is therefore most likely when a landscape includes not just large, closely-configured habitat patches to support year-round occupancy, but also habitat occurring in between year-round patches that provides foraging and security opportunities for dispersing birds.

Home range-level configuration

Within suitable landscapes, areas that adult/resident Spotted Owls occupy year-round are represented as home ranges. Home ranges can be occupied by unpaired resident birds, or by a breeding pair. A certain amount of habitat needs to be present in these areas in order to support nesting, roosting, and foraging life history functions (as described below). Connectivity between habitats is important so that it can be accessed without excess energy expenditure and/or exposure to predation (Carey et al. 1992; Courtney et al. 2004; Sutherland et al. 2007). The mean area of habitat estimated to support a resident Spotted Owl home range varies between sub-regions: Maritime – 3010 ha, Sub-maritime – 2224 ha, Continental – 1907 ha (Chutter et al. 2004; Sutherland et al. 2007). In locations with contiguous mature or old-growth forested habitat, these numbers also represent minimum home range sizes. Home ranges become larger as habitat is more fragmented (Carey et al. 1992). The maximum areas across which the abovementioned habitat amounts can occur and thus an energetically-viable home range can be sustained within Canada are estimated at 11,047, 7258, and 6305 ha in the Maritime, Sub-maritime, and Continental sub-regions, respectively (Sutherland et al. 2007). In continuous habitat, adjacent home ranges may overlap up to 25% (Sutherland et al. 2007).

During the breeding season, pairs concentrate their activities within a smaller area of their home range, in close vicinity to the nest grove. In Canada, most breeding season activities are estimated to occur within ~500 m of the nest tree (Blackburn et al. 2009).

Patch-level configuration

Due to a combination of both natural and anthropogenic disturbances, remnant Spotted Owl habitat in Canada exists in a range of patch[7] sizes, from large contiguous expanses to patches <1 ha in size. A patch's size may impact whether it can provide functional habitat for a Spotted Owl. Ten hectares has been estimated by experts within Canada as the minimum habitat patch size within which preferred prey can persist and thus Spotted Owls can successfully forage (reviewed in Sutherland et al. 2007). In addition to absolute size, the irregularity of a patch may also impact its utility for Spotted Owls. Research from Pacific Northwest forests has shown that microclimate (including humidity and solar exposure) can be impacted up to ~100 m from an edge (Kremsater and Bunnell 1999). These impacts may be particularly pronounced for species of fungi and lichens, which are often adapted to the cooler, moister, darker conditions associated with interior forest (Crockatt 2012; Gauslaa et al. 2018). Spotted Owls in Canada feed disproportionately (>40% of diet) on Northern Flying Squirrels (*Glaucomys sabrinus*; Horoupian et al. 2004), which in turn feed preferentially on fungi and lichens associated with coniferous forested habitats (Carey 1991; Carey et al. 1992; Waters and Zabel 1995). In small or highly-irregular forest habitat patches with high edge-to-interior ratios, the conditions necessary to sustain foraging resources for Northern Flying Squirrels may not exist. Competitors (of Spotted Owls) that are better-adapted to foraging within diverse habitats may also over-exploit preferred prey species in openings and along edges, further reducing prey

[7] A discrete area of habitat.

availability for Spotted Owls in small or irregular habitat patches (Wilson and Forsman 2013; Wiens et al. 2014).

Habitat attributes

Nesting

Spotted Owls do not build their own nests, but depend on naturally-occurring or previously-constructed (by other raptor species) nest sites (Chutter et al. 2004, Waterhouse et al. 2012; Wilk et al. 2018). Nest sites include broken treetops, tree cavities, abandoned raptor nests, mistletoe brooms, and debris accumulations captured in branches (Forsman et al. 1984, Dawson et al. 1986, Waterhouse et al. 2012; Wilk et al. 2018). In captivity, nesting has occurred in artificial cavities (McCulligh 2019, see also Gutierrez et al. 1995). In general, cavities are more often used in moist climates and platforms are more frequently used in drier climates, particularly where cavities in trees >50 cm in diameter are not available (Chutter et al. 2004). In a survey of 14 known nest trees in B.C., Waterhouse et al. (2012) found that nest cavities were in trees averaging 88 cm in diameter (± 26.8 cm standard deviation). A variety of different tree species are used for nesting within the species' range although large Douglas-fir may be selected more frequently in the drier regions (Waterhouse et al. 2012; Wilk et al. 2018). In the wetter regions, Western Hemlock and Western Redcedar have been used in equal proportion to Douglas-fir (Forsman and Giese 1997; Wilk et al. 2018). Nest site fidelity[8] is high and re-use of nest structures is common (Forsman et al. 1984).

Breeding Spotted Owls may experience stress, reduced reproductive output, and disrupted nesting behaviours when exposed to acute noise within their nesting areas (Wasser et al. 1997, Hayward et al. 2011, USFWS 2020), therefore, in order to successfully carry out breeding functions they also require nesting areas to be free of significant acoustic disturbance during the breeding season. Acoustic disturbance significant enough to impact nesting functions can result from activities that result in an overall sound level above 90 db (e.g., operation of large machinery, use of chainsaws, blasting, operation of large engines and engine brakes, operation of motorized recreational vehicles) or that increase the sound level above ambient conditions by over 20 db (USFWS 2020).

Roosting and escape

Spotted Owls require roosting sites that provide good protective cover, from both inclement weather and predators. The multi-storied nature and high percentage closure of old-growth canopies enables thermoregulation and escape from inclement weather, as well as providing protection from predators (Blackburn et al. 2009). The Spotted Owl is easily subjected to heat stress and reduces its exposure by moving between roosting habitats in different parts of the canopy (Barrows 1981). The closed canopies of old-growth habitats also provide refuge from rain and snow (North et al. 2000). Great Horned Owls (*Bubo virginianus*) are the primary predator of the Spotted Owl (Gutierrez et al. 1995), and favour edge habitats and openings where they have greater access to prey (Artuso et al. 2013). Susceptibility to Great Horned Owl predation may thus be minimized in areas with intact, contiguous old-growth/mature forest (Johnson 1993).

[8] Tendency to return to the same nesting location and/or re-use the same nest structure in subsequent years.

Foraging

Spotted Owls require habitat with characteristics that promote abundant and accessible prey, which is primarily comprised of arboreal and semi-arboreal small mammals (Chutter et al. 2004; Wiens et al. 2014). Studies in western Washington and B.C. showed that Northern Flying Squirrels, Bushy-tailed Woodrats (*Neotoma cinerea*), and Deer Mice (*Peromyscus* sp.) were the most common prey for Spotted Owls in the northern extent of the Spotted Owl's range (Forsman et al. 2001; Horoupian et al. 2004; Wiens et al. 2014). The abundant large coarse woody debris (CWD), standing snags, and diverse shrub layers present within old-growth forests support prey populations by providing moist microclimates, protective cover for movement, nest/burrow sites, and food in the form of fungi, plants and invertebrates (Carey 1991; Carey et al. 1997; Carey et al. 1999; Wilson and Forsman 2013). The open mid-storey structure of old-growth habitats also enables Spotted Owls to have more efficient access to those prey through providing longer sightlines and unimpeded flight paths (Chutter et al. 2004; D'Anjou et al. 2015).

Safe movement / dispersal

Like resident Spotted Owls, dispersing individuals require available prey and security features, therefore, old-growth and mature forests (i.e., the same forests that support nesting/roosting and foraging) are understood to provide ideal conditions (reviewed in Buchanan 2004). Where no habitat capable of supporting foraging and security exists between two natal patches, dispersal success between those patches is likely to be reduced, ultimately reducing long-term patch occupancy and population stability. Safe movement/dispersal is best-supported by nesting/foraging quality habitat located either within year-round forested habitat patches (enabling within-patch dispersal) or in between those patches. Spotted Owls may traverse forested habitat in other seral stages during dispersal; however it is not yet clear what other habitat attributes/configurations may contribute to dispersal success (Buchanan 2004). Research will be required to evaluate drivers of dispersal success in Canada and determine whether additional habitats should be identified as important for supporting safe movement.

Distribution of competitors

In addition to habitat amount, quality and configuration, the distribution and abundance of the Spotted Owl's primary competitor, the Barred Owl, has been shown to strongly influence Spotted Owl occupancy across the landscape (Dugger et al. 2011; Dugger et al. 2015; Yackulic et al. 2019; Jenkins et al. 2019). Barred Owls reduce Spotted Owl occupancy of otherwise suitable habitat through both competition for prey (exploitative competition) and territorial displacement (Dugger et al. 2011; Wiens et al. 2014; Jenkins et al. 2021). See Section 4 (Threats) for more details.

Classification of habitat for the Spotted Owl

The Vegetation Resource Inventory[9] (VRI) geospatial database provides detailed information about the characteristics of forests in B.C. The VRI attributes used to classify forests as

[9] A photo-based, two-phased vegetation inventory design consisting of 1) 1:20,000-scale air photo interpretation and 2) ground sampling. See https://www2.gov.bc.ca/gov/content/industry/forestry/managing-our-forest-resources/forest-inventory.

potentially suitable for the Spotted Owl in B.C. (not accounting for configuration considerations) are summarized in Table 2. ‘Nesting’ quality habitat is characterized by old, tall, low-elevation stands, and ‘foraging’ quality habitat is characterized by mature, moderately tall stands that may extend further upslope. Both ‘nesting’ and ‘foraging’ quality habitats are considered to have characteristics that also support roosting and safe movement / dispersal. Nesting quality habitat is used disproportionately relative to its availability on the landscape, whereas foraging quality habitat is used in proportion with its availability on the landscape (Forsman et al. 1984; Carey et al. 1990; Carey et al. 1992).

The provincial government is also continuing to develop and refine habitat classification approaches as part of its Stewardship Baseline Objectives Tool (Government of B.C. 2020).

Table 2. Summary of attributes used to classify forests as potentially suitable for the Spotted Owl in B.C. using the Vegetation Resource Inventory (VRI) geospatial database (from Sutherland et al. 2007). Note that this does not account for habitat configuration, competitor distribution, or the locations where captive-bred Spotted Owls will be released, which ultimately determine the likelihood that habitat will support recovery of the Spotted Owl.

Function / Class	**Attribute**	**VRI polygon-level selection thresholds**					
		Maritime sub-region *(CWHdm, CWHvm1&2, CWHxm1)**		**Sub-maritime sub-region** *(CWHds1, CWHms1, IDFww)*		**Continental sub-region** *(IDFdc, IDFdk1,2&3, IDFww1, IDFxc, IDFxh1&2, PPxh2)*	
		Structure present**	**Structure absent****	**Structure present**	**Structure absent**	**Structure present**	**Structure absent**
Nesting, roosting and safe movement	Stand age	≥ 140 years	≥ 200 years	≥ 110 years	≥ 200 years	≥ 110 years	≥ 200 years
	Stand height	≥ 28.5 m		≥ 23 m		≥ 23 m	
	Elevation	≤ 900 m		≤ 1000 m		≤ 1200 m***	
Foraging, roosting and safe movement	Stand age	≥ 120 years	≥ 140 years	≥ 100 years	≥ 120 years	≥ 80 years	≥ 100 years
	Stand height	≥ 19.5 m		≥ 19.5 m		≥ 19.5 m	
	Elevation	No limit, other than BEC		No limit, other than BEC		No limit, other than BEC	

***Biogeoclimatic Ecosystem Classification (BEC) zones and variants within which selection occurred. Note: re-mapping of BEC variants in the Continental sub-region since 2004 has resulted in some additions/deletions to the selected variants from the Sutherland et al. (2007) version. For descriptions and definitions see: https://www.for.gov.bc.ca/hre/becweb/resources/classificationreports/index.html

**This distinction is relevant to future projections only, in determining whether a stand that was previously harvested will have the structural characteristics of nesting and foraging class habitat within the 50-year recovery timeframe. Stands that were of natural disturbance origin or that were harvested prior to the advent of clear cut harvesting are assumed to have remnant old forest structure present, and so are expected to have all the attributes required to support Spotted Owl nesting and/or foraging at a younger age. In comparison, stands harvested since the advent of clearcut harvesting will not have old forest structure remaining, so will take longer to re-acquire these characteristics.

***Increased from 1100 m (Sutherland et al. 2007) to 1200 m to accommodate nests found more recently >1100 m in the Continental sub-region (Hobbs 2004).

4. Threats

The Spotted Owl threat assessment is based on the IUCN-CMP (World Conservation Union–Conservation Measures Partnership) unified threats classification system. Threats are defined as the proximate activities or processes that have caused, are causing, or may cause in the future the destruction, degradation, and/or impairment of the entity being assessed (population, species, community, or ecosystem) in the area of interest (global, national, or subnational). Limiting factors are not considered during this assessment process. For purposes of threat assessment, only present and future threats are considered. Historical threats, indirect or cumulative effects of the threats, or any other relevant information that would help understand the nature of the threats are presented in the Description of Threats section.

Table 3. Threat calculator assessment.

Threat #	Threat description	Impact[a]	Scope[b]	Severity[c]	Timing[d]
1	Residential & commercial development	Low	Small	Extreme	High
1.1	Housing & urban areas	Low	Small	Extreme	High
1.2	Commercial & industrial areas	Low	Small	Extreme	High
1.3	Tourism & recreation areas	Low	Small	Extreme	High
2	Agriculture & aquaculture	Negligible	Negligible	Extreme	High
2.1	Annual & perennial non-timber crops	Negligible	Negligible	Extreme	High
2.2	Wood & pulp plantations	Negligible	Negligible	Extreme	High
2.3	Livestock farming & ranching	Negligible	Negligible	Slight	High
3	Energy production & mining	Low	Small	Extreme	High
3.1	Oil & gas drilling	Negligible	Negligible	Moderate	High
3.2	Mining & quarrying	Low	Small	Extreme	High
3.3	Renewable energy	Negligible	Negligible	Extreme	High
4	Transportation & service corridors	Medium	Restricted	Extreme	High
4.1	Roads & railroads	Medium	Restricted	Extreme	High
4.2	Utility & service lines	Medium	Restricted	Extreme	High
4.4	Flight paths	Negligible	Negligible	Negligible	High
5	Biological resource use	High	Large	Extreme	High
5.1	Hunting & collecting terrestrial animals	Negligible	Negligible	Negligible	High
5.2	Gathering terrestrial plants	Negligible	Negligible	Negligible	High
5.3	Logging & wood harvesting	High	Large	Extreme	High
6	Human intrusions & disturbance	Low	Restricted	Slight	High
6.1	Recreational activities	Low	Restricted	Slight	High
6.2	War, civil unrest & military exercises	Negligible	Negligible	Negligible	High

Threat #	Threat description	Impact[a]	Scope[b]	Severity[c]	Timing[d]
7	Natural system modifications	Medium	Restricted	Extreme	High
7.1	Fire & fire suppression	Medium	Restricted	Extreme	High
7.2	Dams & water management/use	Negligible	Small	Negligible	High
8	Invasive & other problematic species & genes	Very High	Pervasive	Extreme	High
8.1	Invasive non-native/alien species/diseases	Negligible	Negligible	Negligible	High
8.2	Problematic native species/diseases	Very High	Pervasive	Extreme	High
8.3	Introduced genetic material	Negligible	Negligible	Negligible	High
8.4	Problematic species/diseases of unknown origin	Unknown	Unknown	Unknown	Unknown
8.5	Viral/prion-induced diseases	Unknown	Unknown	Unknown	Unknown
8.6	Diseases of unknown cause	Unknown	Unknown	Unknown	Unknown
9	Pollution	Negligible	Negligible	Negligible	High
9.1	Domestic & urban waste water	Negligible	Negligible	Negligible	High
9.2	Industrial & military effluents	Negligible	Negligible	Negligible	High
9.3	Agricultural & forestry effluents	Negligible	Negligible	Negligible	High
9.5	Air-borne pollutants	Negligible	Negligible	Slight	High
9.6	Excess energy	Negligible	Negligible	Negligible	High
10	Geological events	Negligible	Negligible	Moderate	High
10.3	Avalanches/landslides	Negligible	Negligible	Moderate	High
11	Climate change & severe weather	Unknown	Unknown	Unknown	Unknown
11.1	Habitat shifting & alteration	Unknown	Unknown	Unknown	Unknown
11.2	Droughts	Unknown	Unknown	Unknown	Unknown
11.3	Temperature extremes	Unknown	Unknown	Unknown	Unknown
11.4	Storms & flooding	Unknown	Unknown	Unknown	Unknown

[a] **Impact** – The degree to which a species is observed, inferred, or suspected to be directly or indirectly threatened in the area of interest. The impact of each threat is based on Severity and Scope rating and considers only present and future threats. Threat impact reflects a reduction of a species population or decline/degradation of the area of an ecosystem. The median rate of population reduction or area decline for each combination of scope and severity corresponds to the following classes of threat impact: Very High (75% declines), High (40%), Medium (15%), and Low (3%). Unknown: used when impact cannot be determined (e.g., if values for either scope or severity are unknown); Not Calculated: impact not calculated as threat is outside the assessment timeframe (e.g., timing is insignificant/negligible or low as threat is only considered to be in the past); Negligible: when scope or severity is negligible; Not a Threat: when severity is scored as neutral or potential benefit.

[b] **Scope** – Proportion of the species that can reasonably be expected to be affected by the threat within 10 years. Usually measured as a proportion of the species' population in the area of interest. (Pervasive = 71–100%; Large = 31–70%; Restricted = 11–30%; Small = 1–10%; Negligible < 1%).

[c] **Severity** – Within the scope, the level of damage to the species from the threat that can reasonably be expected to be affected by the threat within a 10-year or three-generation timeframe. Usually measured as the degree of reduction of the species' population. (Extreme = 71–100%; Serious = 31–70%; Moderate = 11–30%; Slight = 1–10%; Negligible < 1%; Neutral or Potential Benefit ≥ 0%).

[d] **Timing** – High = continuing; Moderate = only in the future (could happen in the short term [< 10 years or 3 generations]) or now suspended (could come back in the short term); Low = only in the future (could happen in the long term) or now suspended (could come back in the long term); Insignificant/Negligible = only in the past and unlikely to return, or no direct effect but limiting.

4.1 Description of Threats

Based on IUCN threat evaluation criteria, the overall range-wide threat impact for the Spotted Owl in Canada is assessed as 'very high'. There is one threat that is assessed as 'very high' impact, one that is assessed as 'high' impact, three threats that are assessed as 'medium' impact, six threats that are assessed as 'low' impact, and numerous threats that were evaluated as having 'negligible' or 'unknown' impacts, within the 10-year IUCN assessment timeframe (Table 3).

Very High Impact Threats

IUCN 8.2 – Problematic native species

The Barred Owl is native to eastern Canada but has expanded its range westward and southward. This is hypothesized as being a consequence of human activities that either directly or indirectly resulted in the introduction of trees across the previously tree-less prairie regions of central North America, e.g., through European settlers excluding fires historically set by First Nations, suppressing wildfires, extirpating American Bison (*Bison bison*), and planting trees (Livezey et al. 2009a&b). In the 1960s Barred Owls began to overlap the range of the Spotted Owl in B.C. (Campbell et al. 1990; Dunbar et al. 1991). Barred Owls were detected at all 10 of the previously-occupied Spotted Owl survey sites visited in 2019 (J. Gillis pers. comm. 2019). They have also been detected extensively along general owl survey routes throughout the Spotted Owl's historical range. Barred Owls thrive in a variety of forest types and seral stages and have adapted to more varied food sources than have Spotted Owls (Livezey et al. 2009a&b; Wiens et al. 2014; Diller et al. 2016; Dugger et al. 2015). Barred Owls threaten the Spotted Owl primarily through competition for habitat and prey (Dugger et al. 2011). This resource competition and competitive displacement has been found to reduce Spotted Owl fecundity and recruitment, leading to overall population declines (Jenkins et al. 2021). Hybridization and predation have also been observed on rare occasions (Leskiw and Gutiérrez 1998; Kelly and Forsman 2004); however, these are not considered serious threats (USFWS 2011).

In recognition of the severity of this threat, Barred Owl control programs have been initiated within the range of both the American and Canadian Spotted Owl populations (Diller et al. 2016; Dugger et al. 2015; Gillis and Waterhouse 2020; Wiens et al. 2021). American programs have employed lethal removal and the B.C. program has employed a combination of translocation and lethal removal. Results from Barred Owl removal studies have varied with more immediate success at the southern edge of the range and slower results at the northern edge of the range. In California, the annual Spotted Owl population growth rate four years after (lethal) removals was 1.029 (increasing) on removal sites versus 0.870 (declining) on control sites (Diller et al. 2016), and in Oregon and Washington, increases in Spotted Owl occupancy and fecundity and decreases in local extinction rates were observed 4.5 years following Barred Owl removals (Wiens et al. 2021). However, a longer lag time was observed in the more northern sites in Oregon and in Washington (Wiens et al. 2021) and in B.C. (lethal and non-lethal) removal efforts have not yet been sufficient to offset Barred Owl recolonization rates (Gillis 2016a&b; Gillis and Waterhouse 2020).

Diller et al. (2016) suggested that Spotted Owl populations further north may experience slower recovery following Barred Owl removal because Barred Owl populations are more

well-established (so require more intensive and sustained removal efforts to overcome recolonization by floaters/dispersers) and Spotted Owl populations are too small to recover quickly (fewer floaters/dispersers waiting to take up available territories). The supplementation of the B.C. Spotted Owl population through re-introduction may counter this effect. Supplemental feeding of released individuals may also bolster post-release survival. Predictive modelling by Yackulic et al. (2019) showed that in most study areas in the U.S.A., the probability of Spotted Owl persistence is projected to increase with increasing habitat condition, suggesting that in areas where habitat protection occurs and thus habitat condition improves over the long term, the level of investment in Barred Owl removals can be reduced over time. Without habitat protection, a high level of investment in Barred Owl control would need to be sustained in perpetuity. It is currently unknown whether this threat can be mitigated or avoided to the extent that Barred Owl removals can be completely ceased (Bodine and Capaldi 2017).

High Impact Threats

IUCN 5.3 – Logging and wood harvesting

Logging has had and continues to have severe impacts on the Spotted Owl, including direct loss of old forest habitat (loss of nesting, roosting, and foraging habitat attributes) and fragmentation (COSEWIC 2008, Chutter et al. 2004). The primary impact of forestry-related habitat fragmentation appears to relate to foraging energetics (reviewed in Courtney et al. 2004). As foraging patches become more dispersed following forest harvest, they may no longer be accessible within an individual's energetic budget, and so the individual may starve or be forced to disperse to a new location (Sovern et al. 2014; Jenkins et al. 2019). Further, as residual patches become smaller and more irregular, they may no longer be able to support adequate numbers of the Spotted Owls' preferred prey species (see section 3.3 – Needs of the Spotted Owl). Additional impacts of logging can include noise disturbance associated with logging operations, when operations take place within 400 m of nesting areas (Wasser et al. 1997, Hayward et al. 2011, USFWS 2020). The conversion of the landscape from old-growth coniferous forest to other habitat types may also increase the exposure of Spotted Owls to their primary predator, the Great Horned Owl (Johnson 1993). Competitive pressure may also be greater within harvested landscapes as Barred Owls are better able to adapt to the more varied seral stages and food sources present in harvested landscapes than are Spotted Owls (Hamer et al. 2007; Wiens et al. 2014; Yackulic et al. 2019).

Improved forestry practices on Crown Land under the *Forest and Range Practices Act* as well as Spotted Owl-specific habitat protection initiatives under the Spotted Owl Management Plans (1 and 2) have partially reduced forestry impacts on Spotted Owl and other old forest-dependent species by requiring or promoting the retention of veteran trees, snags, and riparian areas; reducing cut block size; increasing retention area size; and providing some measure of habitat protection for tracts of old forest through the designation of Wildlife Habitat Areas (WHAs), Old Growth Management Areas (OGMAs) and Ungulate Winter Ranges (UWRs) (Government of B.C. 2009). However, a large amount of nesting and foraging class habitat within the Spotted Owl's range still falls within the unprotected portions of the Timber Harvesting Land Base (THLB), and harvesting continues to both remove and isolate habitat.

Medium Impact Threats

IUCN 4.1 – Roads and railroads

Spotted Owl nesting habitat is located within low-land forests where there has been increasing concentration of roads for logging and other purposes. Major railway corridors also fall in these areas. Road-building and expansion results in direct and often permanent habitat loss through eliminating old forest habitat within the immediate road surface and managed right-of-way. Roads and railways also expose individuals to risk of collisions (Forsman et al. 2002), and noise disturbance from road and rail traffic can increase individual stress levels and reduce reproductive output when it occurs near nesting areas (Wasser et al. 1997, Hayward et al. 2011) as well as potentially altering nesting behaviours (USFWS 2020). Great Horned Owls may also be more prevalent along linear corridors such as roads and railways, putting Spotted Owls at greater risk of predation when these features transect their habitat (Johnson 1993). Road-building will continue to accompany resource extraction/development activities (e.g., forest harvesting). New rail lines are not being planned within the Spotted Owl range.

IUCN 4.2 – Utility and service lines

As with roads, habitat clearing associated with utility and service line construction (which includes pipelines) will result in some direct habitat loss and the linear edge habitats created could impact prey populations and increase predator exposure. There is currently one major pipeline project, the Transmountain Expansion Project (TMEP), which, once fully constructed, will bisect the southern portion of the species' range. Any Spotted Owls nesting or foraging within the vicinity of utility or service lines during construction or maintenance could also be disturbed by machine noise. This noise disturbance also applies to the owls in the captive breeding centre in Langley, which is directly adjacent to the TMEP, where construction has been ongoing since October, 2022.

IUCN 7.1 – Fire and fire suppression

Within the drier Sub-maritime and Continental sub-regions, vigorous fire protection by the B.C. Forest Service between the 1960s and 1990s extended fire return intervals well beyond their historical range, creating an accumulation of woody fuels, which can lead to more intense, stand-replacing wildfires (Wong et al. 2003, ESTR Secretariat 2014). Within the American portion of the range, Davis et al. (2016) estimated that 191,900 ha of nesting and roosting habitat on federal lands had been lost to wildfires between 1994 and 2013, four times the amount of habitat that was harvested. A similar analysis in the Canadian portion of the species' range by the Canadian Wildlife Service using annual fire disturbance mapping from 1985 to 2015 (Hermosilla et al. 2015a&b, 2017), indicated that 47,915 ha of forests within the areas classed as suitable for the Spotted Owl has been detectably[10] impacted by fire across that 30-year period, primarily within the drier Sub-maritime and Continental sub-regions, with annual burn areas as large as 4156 ha. Fire impacts are expected to increase in the Spotted Owl range under climate change (reviewed in Spies et al. 2018). Within the wetter regions (i.e., Maritime sub-region in Canada), overall area impacted by fire is expected to remain relatively low due to the naturally very low fire incidence there, even when multiplied according to climate projections (Littell et al. 2010). However, in the drier sub-regions, where existing fire intervals are shorter and fire extents larger, the increase will translate into more significant habitat impacts (reviewed

[10] Fire impacts were significant enough to result in changes to the forest canopy that could be detected within satellite imagery.

in Spies et al. 2018). Applying an assumption that future annual burn rates under climate change are likely to approximate the upper end of the annual burn rates observed in the previous 30 years (i.e., up to 4156 ha per year), it is estimated that as much as 207,800 ha of Spotted Owl habitat within Canada will be impacted by fire within the 50-year recovery timeframe. This projection was supported during the 2021 fire season when as much as 7700 ha of Spotted Owl habitat may have been impacted by fire (based on B.C. Fire Perimeters mapping). Although not all of these fires will be stand-destroying and result in long-term habitat loss, projections of increasing incidence and area of catastrophic fire under climate change do indicate that fire will be a significant driver of habitat loss in the future (reviewed in Spies et al. 2018; Price and Daust 2016).

Wildfire risk reduction efforts could counter this risk; however, such efforts also have the potential to impact Spotted Owl habitat directly (through loss of potential nesting trees and the features required to support prey populations).

Low Impact Threats

IUCN 1.1 – Housing and urban areas & IUCN 1.2 – Commercial and industrial areas

Historically (prior to the 1930s), urbanization (and associated commercial and industrial development) resulted in broad-scale loss of mixed-coniferous forests throughout the Lower Mainland (Boyle et al. 1990) as well as portions of the Lower Fraser Valley where agricultural development did not predate urbanization. However, most old forest habitat within range of these population centers has now been converted to urban areas (Chutter et al. 2004; Sutherland et al. 2007), so this is not expected to represent a significant, broad-scale threat in the next decade.

IUCN 1.3 – Tourism and recreation areas

Several large ski resorts exist within the Maritime sub-region in areas with habitat for the Spotted Owl. Expansion of resort infrastructure within existing ski areas could lead to additional, localized, habitat loss. Planning is also underway for one new ski resort in the Sub-maritime sub-region, although proposed development is largely within the footprint of an existing mine, so additional habitat impacts may be minimal. Use of provincial parks and other accessible Crown lands within all three sub-regions has also increased dramatically in the last decade (B.C. Parks 2018; J. Hirner, pers. comm. 2020), creating pressure to expand trails and park infrastructure into potential Spotted Owl habitat. Acoustic threats from helicopter activities (both industrial and recreational), particularly during breeding may also impact spotted owls. However, this threat applies to a relatively small percentage of the species' range, so the overall impact is assessed as low.

IUCN 3.2 – Mining and quarrying

Mining and mineral exploration activities are uncommon in the Spotted Owl range; however, because they are exempt from the prohibitions on forest harvest under the General Wildlife Measures in WHAs (Government of B.C. 2019), such activities have the potential to cause habitat loss even in areas under timber harvest constraints. Any Spotted Owls nesting or foraging within the vicinity of mining or quarrying operations could also be disturbed by operational noise. However, this threat applies to a relatively small percentage of the species' range, so the overall impact is assessed as low.

IUCN 6.1 – Recreational activities

Backcountry recreation use has increased dramatically within Southern B.C. Visitor numbers at B.C. Parks in southern regions increased by 60% between 2007 and 2017 (B.C. Parks 2018). Recreational use of other accessible Crown lands has also increased dramatically in the last decade (J. Hirner, pers. comm. 2020). As more backcountry users visit parks and recreation areas where Spotted Owls nest, the potential for human disturbance increases. Motorized recreation, in particular, could disturb Spotted Owls nesting in the vicinity of recreational trails/areas. However, this threat applies to a relatively small percentage of the species' range, so the overall impact is assessed as low.

Negligible and Unknown Impact Threats

Eleven individual threats or complete IUCN threat categories were classified as having a negligible impact on the Spotted Owl based on limited spatial overlap with the species' range and habitat and/or no anticipated impacts within the 10-year IUCN-CMP assessment timeframe.

A further five threats were classified as having unknown impacts within the 10-year assessment timeframe; most related to climate change. Climate change impacts could be significant, particularly within the 50-year recovery timeframe, but there remains considerable uncertainty around the direction and magnitude of climate change-mediated shifts in weather, natural disturbance, and forest health within the Spotted Owl range, as well as the likely response of Spotted Owls to those changes (reviewed in Courtney et al. 2004; Spies et al. 2018).

A comprehensive review of climate modelling research has been undertaken for the Northwest Forest Plan (in the U.S.A.), which is focused on management of old-growth forests for Spotted Owl recovery (Spies et al. 2018). Most models assessed within that review project that the region will experience warmer, drier summers and potentially warmer and wetter winters. Conditions are projected to exceed the 20th-century range of variability by the 2050s. These predictions are supported by modelling that also covers the Canadian portion of the Spotted Owl's range (Wang et al. 2016). A comprehensive analysis of Spotted Owl survival and recruitment in relation to predictors including climate (Dugger et al. 2015) found an association between climate variables and both juvenile recruitment and adult annual survival. Recruitment was lowest when conditions during the previous winter were cold and wet, and highest when the previous winter was cold and dry. Observed survival rates were higher when winters were relatively warmer and drier. Summer temperature extremes could also impact recruitment rates; the heat dome of 2021 had significant impacts on juveniles in the fledge stage (J. Gillis, pers. comm. 2021). However, given that predicted temperature and precipitation patterns under climate change could lead to both positive and negative changes to different demographic rates, it is difficult to generate an overall prediction of how Spotted Owl populations may be impacted.

When it comes to habitat impacts from climate change, lower elevation, moist vegetation zones (e.g., those within much of the Maritime sub-region in Canada) are expected to experience decreased growth and productivity, especially where tree species are already water limited during the growing season (reviewed in Spies et al. 2018). Within drier forests (e.g., those within the Continental sub-region and some portions of the Sub-maritime) most models predict an increased role of fire, including more area burned and larger patches of high-severity fire (reviewed in Spies et al. 2018; Price and Daust 2016), which will increase the rate of fire-related habitat loss, relative to past decades (e.g., see IUCN-CMP 7.1, above). A preliminary assessment of anticipated climate change vulnerability for a number of species in B.C. was conducted in 2016 (Price and Daust 2016). Although the Spotted Owl was not amongst the

species assessed, other old forest-associated species with similar ranges were assessed as having moderate-high climate change vulnerability, primarily due to increased climate change-mediated natural disturbance within their old forest habitats.

5. Population and Distribution Objectives

Population and Distribution Objective:

To recover the Spotted Owl in Canada by restoring a stable population of at least 250 mature individuals distributed within a connected network of habitat representative of all three sub-regions within the species' historical Canadian range, and linked to the larger population in the U.S.A.

Rationale:

Historically, the Spotted Owl's restricted range and small population size would have made it naturally precarious (i.e., naturally falling within COSEWIC's Threatened status); however, the population was believed to be large enough to be stable, with connectivity/representation across its range. In contrast, the species is now assessed as Endangered on the basis of compromised stability, redundancy, connectivity, and resilience.

There has been permanent loss of habitat within the Lower Mainland and Lower Fraser Valley (now a major human population center), which both reduces the overall area available to the species in Canada and restricts the potential for continued gene flow between Canada and the U.S.A. (Chutter et al. 2004). However, portions of habitat within the remainder of the range, across all three historically-occupied sub-regions, are either still intact or are close to re-acquiring the attributes of Spotted Owl habitat, such that if they are protected now they will contribute to habitat patch size, quality and connectivity, and help to restore historical representation. Other limitations to recovery are also believed to be manageable over the long term, given current/anticipated tools (Chutter et al. 2004; Government of B.C. 2020; B.C. MFLNRORD 2021). Assuming that planned actions are undertaken to i) protect and restore sufficient Spotted Owl habitat; ii) control Barred Owls to reduce interspecific competition; iii) breed Spotted Owls in captivity, and iv) release captive-born Spotted Owls to supplement wild populations and achieve successful breeding of reintroduced owls in the wild, the provincial government projects that it is within the scope of biological and technical feasibility to achieve the COSEWIC threshold for Threatened status (i.e., ≥250 mature individuals) within 50 years (B.C. MFLNRORD 2021). The amount, configuration and attributes of habitat that is necessary to achieve this population target in context of distribution objectives (connectivity and representation) are described in section 7 of this document. Recovery of Spotted Owls will require significant targeted interventions in the form of population augmentation and competitor control in the short- to medium-term (10-30 years), therefore, short-term statements toward meeting the objective are set out below, to facilitate recovery implementation.

Short-term Statements Toward Meeting the Population and Distribution Objective:

1. Maintain sufficient critical habitat needed to achieve the population and distribution recovery objective and immediately cease human-caused threats where Spotted Owls are detected (i.e., if owls are found outside of, or released capitively-bred owls move to areas outside of existing protected areas).

2. Re-introduce at least 50[11] captive-bred Spotted Owls to the wild within 10 years (by 2033), with at least 10 released individuals surviving to become resident adults.
3. Complete annual Barred Owl surveillance at sites occupied by Spotted Owls and/or where reintroductions are planned, and remove all Barred Owls that are detected.

6. Broad Strategies and General Approaches to Meet Objectives

6.1 Actions Already Completed or Currently Underway

Habitat protection, enhancement and stewardship

Management planning

In 1997, a Spotted Owl Management Plan (SOMP) was developed with a goal of stabilizing (and optimistically improving) the population over the long-term, without exceeding a 4% reduction in the THLB (i.e., SOMIT 1997). SOMP established 21 Special Resource Management Zones (SRMZs) that included pre-existing protected areas as well as Crown forest land. Within the SRMZs that fell outside protected areas, 67% of the habitat was to remain suitable for the Spotted Owl, while the remaining 33% was eligible for harvest using specific prescriptions.

In 2009, an updated version of SOMP ('SOMP2') was released, which involved transferring most SRMZs into Long Term Owl Habitat Areas (LTOHAs; managed for Spotted Owl conservation) and Managed Future Habitat Areas (MFHAs; managed for forest harvest with consideration for long-term Spotted Owl habitat development), adjusting some managed area boundaries, and creating updated harvesting guidelines/designations (Blackburn et al. 2009; Government of B.C. 2009). The requirement to limit impacts on the THLB to <4% remained, so there was no increase in the area managed for Spotted Owl recovery under the new plan. In 2012, the LTOHA and MFHA areas under SOMP2 became legally-designated Wildlife Habitat Areas (WHA) with General Wildlife Measures (GWM). Thirty-two WHAs are now in place to provide a measure of protection to areas large enough to support one or more breeding pairs of Spotted Owls (Government of B.C. 2019). Within the LTOHA WHAs forest harvest is largely prohibited, and within the MFHA WHAs harvest is permitted subject to conditions.

Additional regulatory measures

In addition to provincial WHAs, other protected area designations[12] provide some measure of protection for Spotted Owl habitat. These include: Provincial/Municipal/Regional Parks; Provincial Protected Areas, Recreation Areas, Ecological Reserves and Conservancy Areas; Sea-to-Sky Wildland Areas; Metro Vancouver Watersheds; Ungulate Winter Ranges, Old

[11] This number is derived from current projections by the provincial government (B.C. MFLNRORD 2021) but is subject to adjustment following the pilot phase of the reintroduction (2021-2025), based on the actual annual reproductive output of captive pairs and the survival outcomes of released individuals.

[12] These forms of habitat protection do not necessarily qualify as effective protection of critical habitat under SARA. Such a determination can only be made following a Critical Habitat Protection Assessment (Environment and Climate Change Canada 2016).

Growth Management Areas, and Wildlife Habitat Areas for other species; and National Wildlife Areas.

Active population management

In order to achieve a self-sustaining population of Spotted Owls, active population management, both, captive breeding and release as well as Barred Owl control, will be required.

Captive breeding and release

In 2007, the Spotted Owl Population Enhancement Team, an arm's-length independent panel that was established by the provincial government, determined that the wild population was so small and isolated that extirpation was a certainty. It therefore made the recommendation to capture either all or a subset of the remaining wild individuals and establish a captive-bred population whose offspring could be re-introduced into the wild (Fenger et al. 2007). The provincial government elected to capture only a subset of the remaining wild individuals to establish the captive breeding program and allow a small wild population to persist. The home ranges that owls were removed from to establish the captive breeding program were all designated as LTOHAs at that time. They were then converted into WHAs in 2012.

The Spotted Owl captive breeding program has been in operation in B.C. since 2007. It has had slow initial success rates and has not released any captive-bred owls to date. However, a now younger breeding population and improvements in husbandry techniques have resulted in higher breeding output in recent years, and the first release of three owls was completed in August 2022 (McCulligh 2019; B.C. MFLNRORD 2021). There were 31 individuals in captivity at the time of publication (see Figure 3; J. McCulligh, pers. comm. 2021). Release locations will be aligned with operational Barred Owl control (B.C. MFLNRORD 2021).

Barred Owl control

In 2007, the provincial government initiated a Barred Owl removal program, with target sites including active Spotted Owl territories and sites planned for re-establishment through the release of captive-bred owls (Fenger et al. 2007). From 2007-2021, the provincial government removed a total of 188 Barred Owls from active (i.e., currently occupied) Spotted Owl territories and from proposed Spotted Owl re-establishment sites (Gillis and Waterhouse 2020; J. Gillis pers. comm. 2021). Removals were a combination of capture and translocation (at re-establishment sites) and lethal removal via shooting (at active sites). One hundred and eight Barred Owls were captured and translocated away from proposed re-establishment sites and 80 were removed from active Spotted Owl sites using lethal methods. The combined removal effort reduced the number of detected Barred Owls overall, but as of 2016 had not been sufficient to overcome local re-colonization rates. Moving forward, adaptations to removal methods could improve the effectiveness of Barred Owl removal efforts in B.C. (Gillis and Waterhouse 2020). The augmentation of the wild population through the release of captive-bred owls may also increase the rate of Spotted Owl recolonization of removal sites. Habitat improvement/recovery is also expected to improve Spotted Owl persistence in combination with Barred Owl control, reducing the necessary level of investment in Barred Owl removals in the future (Yackulic et al. 2019).

Inventory, monitoring, and population evaluation

Owl population inventory and monitoring

From the 1990s to 2008, inventories were conducted to determine the range, distribution, and abundance of the Spotted Owl in B.C., as well as to assist in resource management decisions (Blackburn et al 2002; Hobbs 2004&2005; J. Gillis pers. comm. 2019). An organized banding program (attaching unique leg bands) was initiated in 1998 to identify individuals and monitor their movements and habitat occupancy. Between 1998 and 1999, transmitters were affixed to several breeding pairs to monitor habitat use and home range sizes (Chutter et al. 2004). Between 2003 and 2014, juvenile owls were affixed with transmitters to ascertain their dispersal movements and overwinter survival (Hobbs 2004&2005; J. Gillis pers. comm. 2019). Beginning in 2015, inventory/monitoring efforts became focused on revisiting previously-known Spotted Owl sites to assess re-occupancy, as well as inventory of sites identified for potential re-introduction through release of captive-bred owls (Gillis 2016a&b; 2017; 2018). Starting in 2016, a pilot program was launched to assess the utility of Autonomous Recording Units (ARUs) in Spotted Owl and Barred Owl monitoring (Gillis 2016a&b; 2017; 2018).

Habitat and population evaluation

In 2007, the Canadian Spotted Owl Recovery Team (CSORT), with the support of Cortex Consultants and Andrew Fall Gowlland Technologies Ltd, developed an integrated modelling framework designed to inform the Spotted Owl recovery program in B.C. and associated habitat management (Sutherland et al. 2007). The framework included models for spatial landscape projection, ecological classification, cross-scale habitat assessment, population dynamics, and reserve selection. This work informed changes / refinements in habitat protection under SOMP 2 (Government of B.C. 2009 & 2020) as well as the approach for the identification of critical habitat in this document.

6.2 Recovery Planning Table

Table 4. Recovery Planning Table.

Threat or Limitation	Priority[a]	Broad Strategy to Recovery	General Description of Research and Management Approaches
Habitat loss and fragmentation (IUCN #1, 3.2, 4.1, 4.2, 5.3, 7.1)	High	Habitat protection, enhancement and stewardship	Work between governments (federal, Indigenous, provincial) to establish or confirm protection[b] and minimize risk for identified critical habitat, and protection of habitat outside of critical habitat where monitoring shows use by Spotted Owls.
	Medium		Pursue wildfire risk-reduction efforts that align with Spotted Owl habitat requirements.
	Low		Develop/expand silvicultural guidelines to create, enhance and/or maintain suitable conditions for Spotted Owls within younger forests that fall within or between critical habitat patches.
			Promote habitat stewardship with forest companies that operate within the Spotted Owl range in Canada to improve overall ecosystem health and increase rate of critical habitat recruitment.
			Promote Spotted Owl population stewardship with stakeholders.
Barred Owls (IUCN #8.2)	High	Active population management	Continue the operational Barred Owl control program with annual adaptations informed by results of the B.C. program and those of similar efforts within the U.S.A.
Lack of natural recruitment	High		Publish the Release Strategy for Spotted Owls in B.C. and continue the Spotted Owl captive breeding and reintroduction program, including post-release measures such as supplemental feeding and satellite tracking of released individuals.
	Medium		Work with government agencies within the U.S.A. to improve international coordination of Spotted Owl recovery efforts and increase the likelihood of cross-border immigration/gene flow.

Threat or Limitation	Priority[a]	Broad Strategy to Recovery	General Description of Research and Management Approaches
Knowledge gaps	High	Research, inventory, monitoring and population evaluation	Validate critical habitat models through ongoing monitoring and assess priority areas for critical habitat recruitment that maximizes availability and optimizes the configuration of those habitats through time, while also minimize risks of, or response to wildfire as well as other uncertainties (e.g., climate change and Barred Owl competition). Outcomes of validation and prioritization can inform Forest Landscape Plans and improve the configuration of legally protected and conserved areas in partnership with First Nations. This information will provide the foundation of an incremental management approach to ensure protection of critical habitat through time.
			Continue to pilot new monitoring technologies such as ARUs in order to enable comprehensive inventory of the entire Spotted Owl range and timely detection/monitoring of Barred Owls.
	Medium		Establish a periodic, recurrent, standardized survey (counts by age class; number of active territories, recruitment surveys; DNA samples) to monitor the status and composition of the Spotted Owl population.
			Pursue additional research on impacts of acoustic disturbance on Spotted Owls, including impacts outside of the breeding season.
	Low		Pursue research on the relative contribution of forested habitats of different seral stages to survival of dispersing Spotted Owls, to improve management of dispersal corridors.
			Pursue research on climate change impacts for Spotted Owls and better-integrate climate change resilience/mitigation strategies into recovery planning.

[a] *"Priority" reflects the degree to which the broad strategy contributes directly to the recovery of the species or is an essential precursor to an approach that contributes to the recovery of the species. High priority measures are considered those most likely to have an immediate and/or direct influence on attaining the population and distribution objective for species and thus considered to be most urgently needed to ensure the species survival or of highest importance for the species' recovery. In some cases, a high priority action may need the completion of another stated high priority action before it can be accomplished. Medium priority measures may have a less immediate or less direct influence on reaching the population and distribution objectives, but are still important for recovery of the population. Low priority recovery measures will likely have an indirect or gradual influence on reaching the recovery objectives, but are considered important contributions to the knowledge base and/or public involvement and acceptance of species. This may be reflected in the timeline for completion.*

[b] *Legal or effective protection under SARA (Environment and Climate Change Canada 2016).*

6.3 Narrative to Support Recovery Planning Table

Habitat protection and research to inform incremental additions to critical habitat

The success of Spotted Owl recovery is dependent on both the protection and recruitment of suitable habitat and the successful release of captive-born Spotted Owls. Released owls must establish territories and form breeding pairs in order to achieve recovery as a self-sustaining population.

Several management actions are required and must be sustained, likely over several decades, to achieve recovery. Given the timeframe and uncertainty, an incremental management approach will be used to review the effectiveness of Spotted Owl releases and the Barred Owl control program in supporting the establishment, survival and breeding success of captive-born Spotted Owls, as well as the recruitment of suitable habitats and assessment of habitat use. Results from these monitoring and research efforts will inform revisions to the Release Strategy and, as necessary, boundaries for spatial habitat protections (e.g., wildlife habitat areas, old growth management areas, etc). In addition to this, the provincial government has identified benefits with proposing legal objectives through a new Land Use Order(s) (Land Use Objectives Regulation (gov.bc.ca)) to ensure the adequate recruitment and conservation of habitat for the dispersal and movement of Spotted Owls between spatial protections (i.e., habitat referred to as 'dispersal habitat').

Forest landscape planning is a new tactical level of forest planning on Provincial Crown land in B.C. that was recently introduced as part of changes to *the Forest and Range Practices Act* (FRPA). Forest landscape planning is a process of establishing clear objectives and outcomes for the management of forest resource values over a defined area and will replace current Forest Stewardship Plans. Land Use Objectives Regulation Orders (made under the *Land Act*) inform planning, both by individual forest tenure holders, as well as the coordination among multiple tenure holders operating in the same areas.

Forest Landscape Plans will identify where and how forest management activities can occur (i.e. timber harvesting, road building, silviculture and restoration investments); provide clarity on overlapping direction from strategic plans and land use objectives, such as Species Recovery Plans, Wildfire Risk Reduction Plans and Access Management Plans; address changing landbase conditions in a timely manner (e.g. climate change, wildfires); address potential environmental impacts from timber harvesting activities on wildlife habitat and multiple other values; and, consider cumulative effects to prepare for possible future forest conditions. Forest Landscape Plans are developed in partnership with Indigenous Nations, with participation from forest licensees and engagement with communities and stakeholders.

Land Use Objectives will also help to support the broad goal of prioritizing ecosystem health (see above under #1). The Great Bear Rainforest Order (https://www2.gov.bc.ca/gov/content/environment/natural-resource-stewardship/great-bear-rainforest) is an existing example. A broad range of spatially identified targets for certain forest attributes are defined and must be maintained through time; however, the spatial configuration of forests that contribute to these targets varies. The amount and distribution of contributing areas will be monitored and reported so that development planning is coordinated and the targets are achieved.

The effectiveness of Barred Owl lethal removals in established release areas will be assessed using several short- and long-term performance metrics, including: a) monitoring

changes in Barred Owl density and recolonization via acoustic monitoring, b) surveying changes in Spotted Owl prey populations, and c) assessing the physical health condition, population structure, and diet of removed Barred Owl carcasses. This initial work will occur prior to Spotted Owl release to ensure sites are suitable for captive-bred Spotted Owls, but also to understand the effects of Barred Owl control in the absence of Spotted Owls. Active monitoring of released Spotted Owls will also help understand the effects of Barred Owl Control in the presence of Spotted Owls.

Monitoring will help inform effectiveness of Land Use Orders, as well as situations where Spotted Owls establish territories outside of protected areas. In these instances sites will be assessed for disturbance risk and adjustments to existing, or addition of new protections may be necessary. New protections will require collaborative development and consultation as per the requirements established in regulations (e.g., Government Actions Regulation).

Addressing climate change and climate change-mediated fire risk

Although it is difficult to predict the full magnitude of climate change-mediated impacts on Spotted Owls and their habitat, it is possible to anticipate and implement strategies for reducing/mitigating those impacts whilst contributing to national and global solutions towards climate change mitigation. Old-growth forests have the potential to buffer local warming, and thus function as local refugia for species reliant on cooler conditions (Spies et al. 2018; Dinerstein et al. 2019). In addition, many old forests, including those known to support nesting for Spotted Owls, have reached an advanced age without being impacted by stand-destroying disturbance because they exist within areas that are naturally less prone to catastrophic disturbances such as fires (e.g., moist riparian zones, cooler/more shaded aspects; Krawchuk et al. 2020; USGS 2021; Lesmeister et al. 2021). As such, on a local level, these existing old forest patches are more likely to continue to experience less disturbance (than the surrounding matrix) under climate change and function as microrefugia, enabling species to persist and recolonize even as average disturbance rates increase. On a broader scale, landscapes dominated by old forests are also predicted to exhibit relatively low climate sensitivity (compared to landscapes dominated by younger forest) and act as macrorefugia (Thom et al. 2019). Within B.C., there is significant spatial overlap between the low-elevation old-forest-dominated habitat throughout the Spotted Owl range and landscapes with high predicted climate change resilience and macrorefugia potential (Beckers and Carroll 2020). In their 2016 climate change vulnerability assessment, Price and Daust recommended maintaining “sufficient old forest habitat to buffer changes in temperature and moisture and allow for dispersal” and “to maintain sufficient habitat as disturbance rate increases” as strategies to mitigate the effects of climate change for other old forest-associated species. They also recommended maintaining “landscape connectivity noting that natural landscapes provide the best opportunities for dispersal”. Ensuring protection of highly-connected networks of old-forest Spotted Owl habitat, which could function as refugia in an increasingly disturbance-prone landscape, will be an essential component of mitigating climate change-mediated disturbance and maintaining climate change resilience for Spotted Owls and other forest-dependent species (Gayton 2008; Spies et al. 2018; Thom et al. 2019; Krawchuk et al. 2020; USGS 2021; Lesmeister et al. 2021).

Addressing the risk of fire and climate change-mediated increases in fire impacts to the Spotted Owl will require a number of strategies, including increasing the overall availability of habitats that have characteristics consistent with the Spotted Owl recovery to account for projected fire impacts and mitigating the impacts of fire-risk reduction efforts within current and potential future habitat. Actions should include ensuring adequate representation within

and connectivity to the wetter western portion of the range (where disturbance rates are expected to re lower); a high level of connectivity as well as alternate connections to provide refugia and enable recolonization/recovery following disturbance; and employing carefully-managed wildfire risk reductions efforts (e.g., avoiding irreplaceable old forest elements such as snags and CWD and focused reduction of ladder fuels) in more fire-prone regions that have surplus fuel loads as a consequence of historical fire suppression.

7. Critical Habitat

Section 41 (1)(c) of SARA requires that recovery strategies include an identification of the species' critical habitat, to the extent possible, as well as examples of activities that are likely to result in its destruction. This federal recovery strategy identifies critical habitat to the extent possible, based on the best available information for the Spotted Owl. It is recognized that the acoustic critical habitat identified below is insufficient to achieve the population and distribution objectives for the species. A schedule of studies (Section 7.2) has been developed to provide the information necessary to complete the identification of acoustic critical habitat (defined below) that will be sufficient to meet population and distribution objectives. Given the long recovery timeframe and uncertainty associated with the behaviour of captively-bred and released Spotted Owl, as well as emerging information from various studies and partnerships with First Nations (e.g., the importance of acoustic critical habitat, wildfire risk, dispersal), an incremental management approach is proposed to identify additional core critical habitat through time that meets or exceeds the amount sufficient to meet population and distribution objectives.

This incremental management approach is proposed to continuously improve the amount and quality of critical habitat through time. It will include validation of critical habitat models to support the assessment of priority areas identified as gaps in current protection or recruitment, as well as the quality of existing protection measures. Based on the outcomes of this assessment, options to optimize the configuration of critical habitat through time, while still managing for uncertainties (e.g., wildfire risk, climate change and barred owl competition) will be developed. This information will be used to inform Forest Landscape Plans and new, or amendments to existing, protected and conserved areas in partnership with First Nations. In addition to these actions, released Spotted Owls will be monitored and if these owls are detected outside of existing protected areas, new measures will be put into place to ensure protection. The identification of critical habitat will be updated when the information becomes available, in a revised recovery strategy or action plan.

7.1 Identification of the Species' Critical Habitat

The Spotted Owl requires habitat for nesting, roosting, foraging and safe movement (see Section 3.3 – Needs of the Spotted Owl). Mature and old-growth stands already possess the attributes required to support these functions, and some previously-disturbed habitat has the potential to acquire the necessary attributes within the 50-year timeframe needed to meet the population and distribution objective. A portion of this habitat has been formally verified by the provincial government (through inclusion in its SOMP2 areas) and is considered by the provincial government to have a very high likelihood of supporting Spotted Owl recovery. The remainder has not been formally verified by the provincial government; this verification process is outlined within Table 6. A 400-m area surrounding nesting areas must also be

protected from acoustic disturbance during the breeding season in order to ensure that acoustic disturbance does not result in loss of breeding habitat function.

The currently-identified critical habitat is comprised of two formal subtypes:

1. **Core critical habitat**: habitat that either already possesses, or will develop (within a 50-year period), the features required by the owls to successfully nest, roost, forage and move safely, where it overlaps with SOMP2.

2. **Acoustic critical**: habitat surrounding nesting areas that functions to maintain the acoustic environment within those areas during the breeding season.

A third subtype will be considered for addition to core critical habitat following the verification process outlined in Table 6:

3. **Potential future critical habitat**: habitat that either already possesses, or is expected to develop (within a 50-year period), the features required by the owls to successfully nest, roost, forage and move safely, where it does not overlap with SOMP2.

The geospatial areas that may contain critical habitat for the Spotted Owl are presented in Figures 3-8. Within these geospatial areas, critical habitat is identified wherever the following biophysical attributes occur.

Biophysical features and attributes of critical habitat

A description of the known biophysical features and attributes of the species' habitat that are required to support life-cycle processes (functions) are summarized in Section 3.3, Needs of the Spotted Owl, and form the basis of the biophysical attribute description in Table 5 below.

Table 5. Functions, biophysical features, and attributes of Spotted Owl critical habitat. Attributes represented within VRI mapping act as criteria for selecting core critical habitat polygons (see Table 2). The presence of these attributes should be assessed at the scale of the component VRI polygon. Some or all of the attributes listed here are expected to either be present, or in the process of developing (within the 50-year recovery timeframe), within the core critical habitat polygons; however, due to the scale of VRI, there can be some uncertainty, so on-the-ground verification of attributes is important. Minimum quantitative thresholds are from the minimum definition of 'moderate/suitable' habitat in Appendix 5 of Chutter et al. (2004). This should not be confused with quantitative definitions of 'superior' habitat (e.g., in Blackburn et al. 2009; Waterhouse et al. 2012; D'Anjou et al. 2015).

Type	Function	Biophysical features	Attributes	
			Maritime sub-region	**Sub-maritime and Continental sub-regions**
Core critical habitat and potential future critical habitat	Nesting	Nest trees	Large (>50 cm dbh) snags or trees with deformities (e.g., large cavities, broken tops, dwarf mistletoe infections)	Large (>30 cm dbh) snags or trees with deformities (e.g., large cavities, broken tops, dwarf mistletoe infections)
	Roosting and safe movement	Closed, multi-storey canopy to provide thermoregulation opportunities and protection from inclement weather and predators	>60% canopy closure	>50% canopy closure
			≥2 horizontal canopy layers	
	Foraging and safe movement	An open understory structure (characteristic of stands dominated by tall, large-diameter trees) to enable efficient access to prey	Canopy dominated by overstorey trees >50 cm dbh	Canopy dominated by overstorey trees >30 cm dbh
			≥19.5 m stand height	
		Accumulations of fallen trees or other CWD and shrubs to support prey.	Abundant CWD and a diverse shrub layer	
Acoustic critical habitat	Maintenance of suitable acoustic levels within nesting areas	Anthropogenic noise level that does not interfere with life functions within nesting areas, resulting in loss of habitat availability or function.	Noise level not exceeding 90 db and/or not exceeding ambient conditions by >20 db during the Spotted Owl nesting season (February 1st to July 31st)	

Within the geospatial areas mapped as core and potential future critical habitat only unsuitable areas that do not possess any of the features and attributes required by the Spotted Owl at any time - either currently, or within the 50-year recovery timeframe - are excluded from consideration as critical habitat. Examples of excluded areas include cultivated and/or landscaped areas, buildings, roads and artificial surfaces, or forested areas that have been recently harvested or subject to stand-destroying disturbance (e.g., catastrophic fire), and so will not acquire the critical features and attributes of critical habitat within the 50-year recovery timeframe (see Table 2 for stand age thresholds specific to each sub-region).

7.1.1 Information and methods used to identify critical habitat

Core critical habitat

Core critical habitat represents habitat that either already possesses, or is expected to develop (within a 50-year period), the features required by the owls to successfully nest, roost, forage and move safely (see below), where that habitat overlaps with SOMP2.

SOMP2's identification of recovery habitat was built upon best available scientific information at the time, produced/provided by biologists and species experts participating on the Canadian Spotted Owl Recovery Team (CSORT) and other experts. CSORT worked closely with a team of systems analysts to develop tools to project and test possible biological outcomes towards informing the development of an updated Recovery Strategy including an evaluation of their recovery objectives under the 1997 Spotted Owl Management Plan (SOMP1) and the identification of critical habitat (survival and recovery). The methods and considerations used to delineate SOMP2 are outlined in the following reference documents:

1. A Framework to Support Landscape Analyses of Habitat Supply and Effects on Populations of Forest-dwelling Species: A case Study Based on the Northern Spotted Owl (Sutherland et al. 2007);
2. Guidance and Some Components of Action Planning for the Northern Spotted Owl in BC (Chutter et al. 2007).

A summary of this process was provided by the provincial government (Appendix B).

Core and potential future critical habitat

The location and spatial configuration of both core and potential future critical habitat is based on three principle assumptions:

- **Quantity**:
    - *Minimum starting polygon size*: in order to support foraging and nesting, noting that the species' arboreal prey has a home range size of ~10 ha (Sutherland et al. 2007), core critical habitat must be configured around nesting class habitat polygons that are at least 10 ha in size.
    - *Overall core critical habitat area*: in order to support the long-term population objective, the summed area of core critical habitat identified must be sufficient to:

- support the home ranges of at least 125 pairs[13] of owls, noting that the mean amount of habitat to support a pair's home range is estimated at 3010, 2224, and 1907 ha for the Maritime, Sub-maritime, and Continental sub-regions, respectively, and that adjacent home ranges may overlap up to 25% (Chutter et al. 2004 & 2007; Sutherland et al. 2007); and
- account for up to 207,800 ha of habitat being impacted by fire within the 50-year recovery period (see Section 4.1).

- **Support for all critical life functions (i.e., biological value)**: In order to support all critical life functions for a recovering population, habitat must be prioritized for inclusion within the critical habitat geospatial area based on its:
  - **a)** contribution to a core patch that can support multiple home ranges and enable successful nesting, roosting, foraging, and safe movement within the patch:
    i. vicinity/degree of connectivity to recovery origins (existing locations and proposed re-introduction sites) or historical anchors (historical locations of resident birds);
    ii. proportion of nesting class habitat; and
    iii. size; or
  - **b)** contribution to a potential connective corridor that can enable safe movement between core patches.

- **Representation across the three ecological sub-regions**: In order to restore pre-human-impact patterns of representation, critical habitat must be identified across all the three ecological sub-regions within the species' historical range (Maritime, Sub-maritime, Continental).

The geospatial delineation process summarized below aims to create a highly-connected critical habitat network large enough to support 125 pairs, accounting for home range overlap and predicted fire impacts, prioritizing habitat with the potential to support all critical life functions and restore pre-human-impact patterns of representation. The geospatial delineation process is founded upon chapter 6 of the integrated population and habitat modelling framework developed under the direction of CSORT (Sutherland et al. 2007). It is summarized below and outlined in greater detail in an accompanying technical document (available upon request).

The information used in the geospatial delineation of core and potential future critical habitat for the Spotted Owl includes:

a) provincial VRI mapping (2018 version);

[13] The 250-adult-bird population target has been translated into a critical habitat target of 125 home ranges for simplicity; however, it is acknowledged that 250 adult birds does not necessarily equate to 125 pairs. A normal population includes a certain number of adult, non-breeding, non-territorial 'floaters' whose habitat use may overlap with that of territorial breeders (Franklin 2001). Further, not all resident adults are paired, so some home ranges may be occupied by single birds. However, 125 home ranges is being interpreted as a reasonable benchmark for the amount of habitat needed to support 250 adults, in the absence of more detailed information on eventual population structure and space use by the recovered population.

b) a Spotted Owl *caurina* subspecies habitat suitability classification produced by CSORT to be applied to VRI (Table 2);
c) a 50-year future projection of VRI (BC MFLNRORD 2019);
d) a least-cost/resistance landscape created through applying habitat-specific cost categories[14] to VRI polygons;
e) a set of contiguous habitat clusters created through:
    i. applying a connectivity analysis to link all ≥10-ha nesting class polygons via least-cost pathways (based on the resistance landscape);
    ii. selecting all habitat (either nesting class or foraging class) from the 50-year future projected VRI that intersects the least cost pathways; and
    iii. dissolving polygons to create discrete clusters;
f) origins/anchors of recovery comprised of:
    i. habitat occurring within the estimated maximum home range area of extant and historical locations of resident Spotted Owls, both within Canada (I. Blackburn, pers. comm. 2021) and in northern Washington; and
    ii. habitat occurring within the estimated maximum home range area of the currently-proposed re-introduction locations for captive-bred Spotted Owls (I. Blackburn, pers. comm. 2021); and
g) potential connective corridors created through:
    i. applying a connectivity analysis to link all origins/anchors of recovery via least-cost pathways (based on the resistance landscape); and
    ii. selecting all habitat (either nesting class or foraging class) from the 50-year future projected VRI that is located within 500 m of a least-cost pathway.

A summary of the geospatial delineation process is as follows:

1. Merge origins/anchors with any contiguous habitat clusters that intersect them to delineate origin/anchor habitat patches. Retain those that contain enough habitat to support at least one home range, within an area no larger than the maximum home range area estimated for that sub-region (see Section 3 - Species Needs).
2. Assess the biological value of the contiguous habitat clusters occurring outside of origin/anchor habitat patches and potential connective corridors.
3. Build critical habitat that will accommodate 125 home ranges (accounting for 25% overlap between adjacent ranges), enable safe movement between origin patches, and remain sufficient to support home range and safe movement targets after accounting for anticipated fire impacts (up to 207,800 ha; see Section 4.1 - Threats):
    a. include all functional[15] origin/anchor habitat: 272,793 ha (125 home ranges + ~65,000 ha towards fire impacts);
    b. include all functional[15] potential corridor habitat linking origins/anchors: 99,585 ha (safe movement + fire impacts); and

[14] Based on Table 1 in Sutherland et al. (2007) with adjustments to treatment of roads and high elevation areas following expert review.
[15] Habitat polygons with insufficient interior habitat could fail to support adequate prey (see section 3.3 – Needs of the Spotted Owl). Within origin/anchor patches and dispersal corridors, an additional 100-m area of surrounding habitat was included around all polygons that had an interior area <10 ha to ensure that all habitat patches identified as critical habitat will maintain sufficient interior habitat to support prey, even if forested habitat is removed along their boundaries. Patches that were still <10 ha even after the additional surrounding habitat was added were not considered functional, so were excluded from potential identification.

   c. include additional contiguous habitat clusters occurring outside of origin/anchor and corridor habitat, by biological value score, until the fire impact target is met: 43,387 ha.
4. Build acoustic critical habitat to counter acoustic disturbance within nesting areas:
   a. delineate nesting areas as all habitat polygons intersecting a 500-m area around nest sites (Blackburn et al. 2009); and
   b. establish a 400-m (horizontal distance) acoustic influence zone around the delineated nesting area(s).
5. Apply critical habitat sub-type classifications:
   a. designate all habitat identified through steps 1-3 that overlaps with SOMP2 as core critical habitat;
   b. designate all habitat identified through steps 1-3 that does not overlap with SOMP2 as potential future critical habitat; and
   c. designate the habitat identified through step 4 as acoustic critical habitat.

7.1.2 Geospatial Location of Areas Containing Critical Habitat

Critical habitat for Spotted Owl is identified within three sub-regions in B.C. (Figures 4-9):

- Overview map (all sub-regions): Figure 4
- Maritime sub-region: Figure 5
- Sub-maritime sub-region: Figures 6-8
- Continental sub-region: Figure 9

The 10 km x 10 km UTM grid overlay shown on these figures is a standardized national grid system that highlights the general geographic area containing critical habitat, for land use planning.

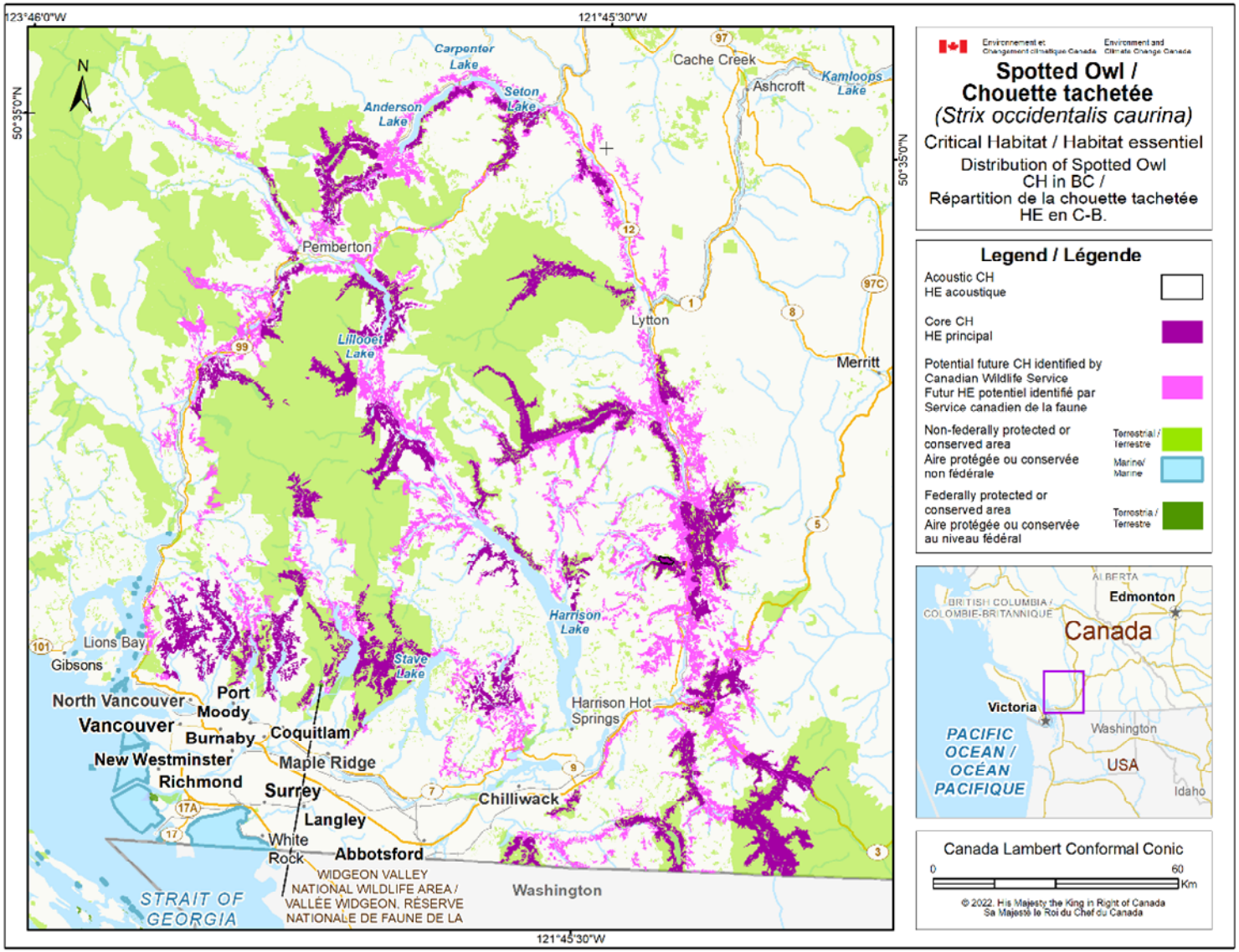

Figure 4. Overview of the core and potential future critical habitat for the Spotted Owl within B.C. Core critical habitat is represented by the dark purple polygons and potential future critical habitat is represented by the light purple polygons, where the criteria and methodology set out in this section are met. The area below the hatched line is the U.S.A. land base.

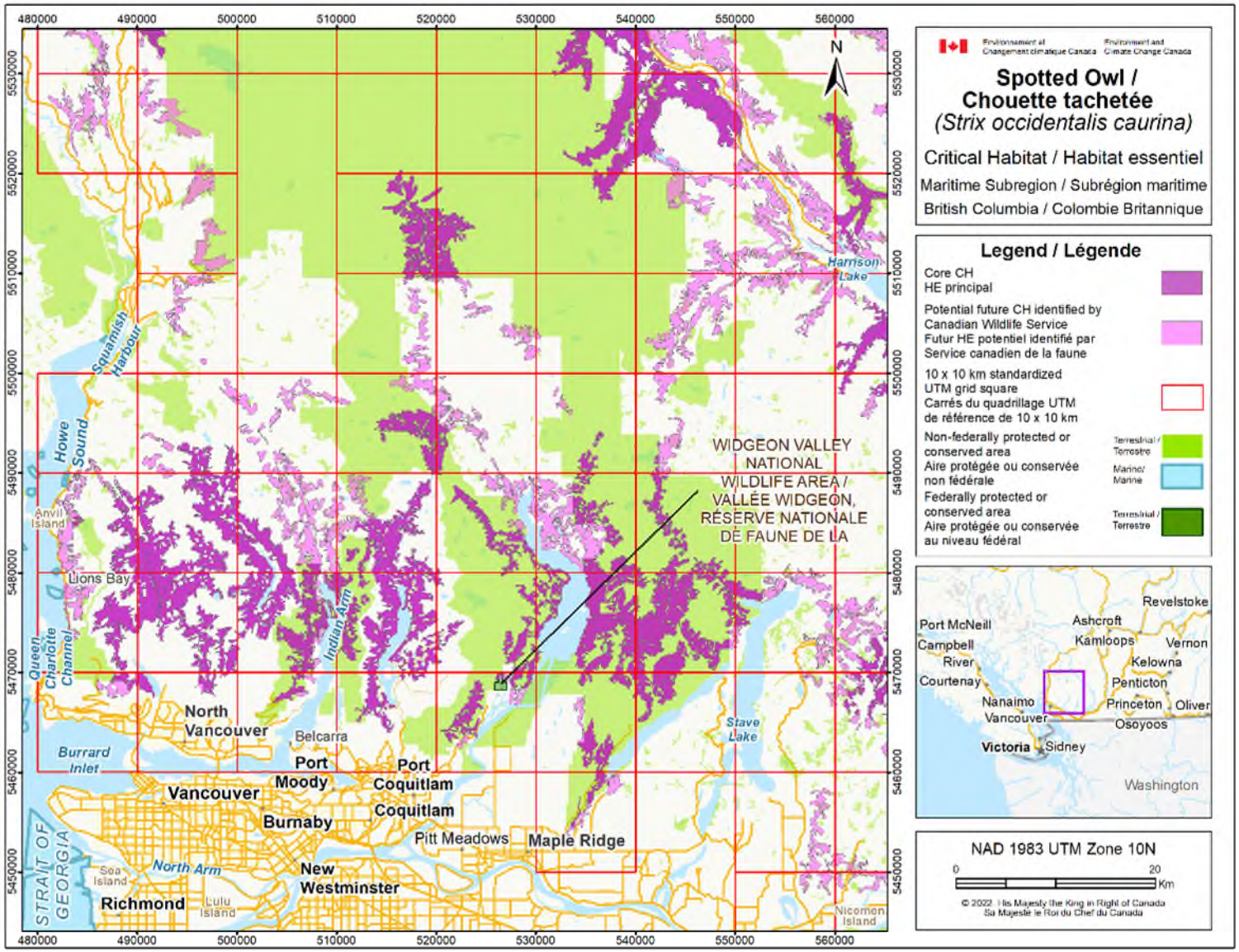

Figure 5. Critical habitat for the Spotted Owl within the Maritime sub-region is represented by dark purple (core) and light purple (future potential) shaded polygons where the criteria and methodology set out in this section are met. The 10 km x 10 km UTM grid overlay shown on this figure is a standardized national grid system that indicates the general geographic area containing critical habitat.

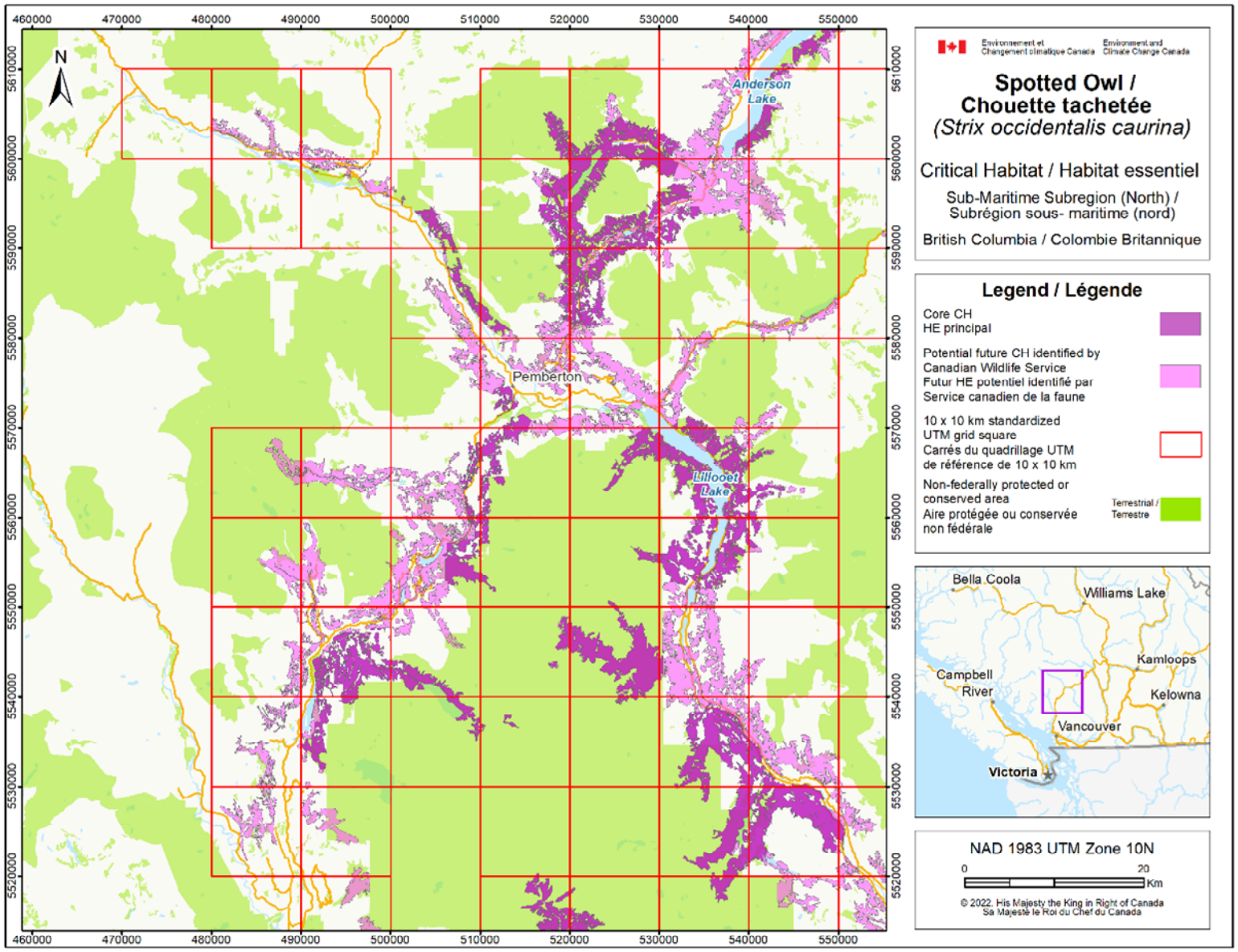

Figure 6. Critical habitat for the Spotted Owl within the northern Sub-maritime sub-region is represented by the dark purple (core) and light purple (potential future) shaded polygons where the criteria and methodology set out in this section are met. The 10 km x 10 km UTM grid overlay shown on this figure is a standardized national grid system that indicates the general geographic area containing critical habitat.

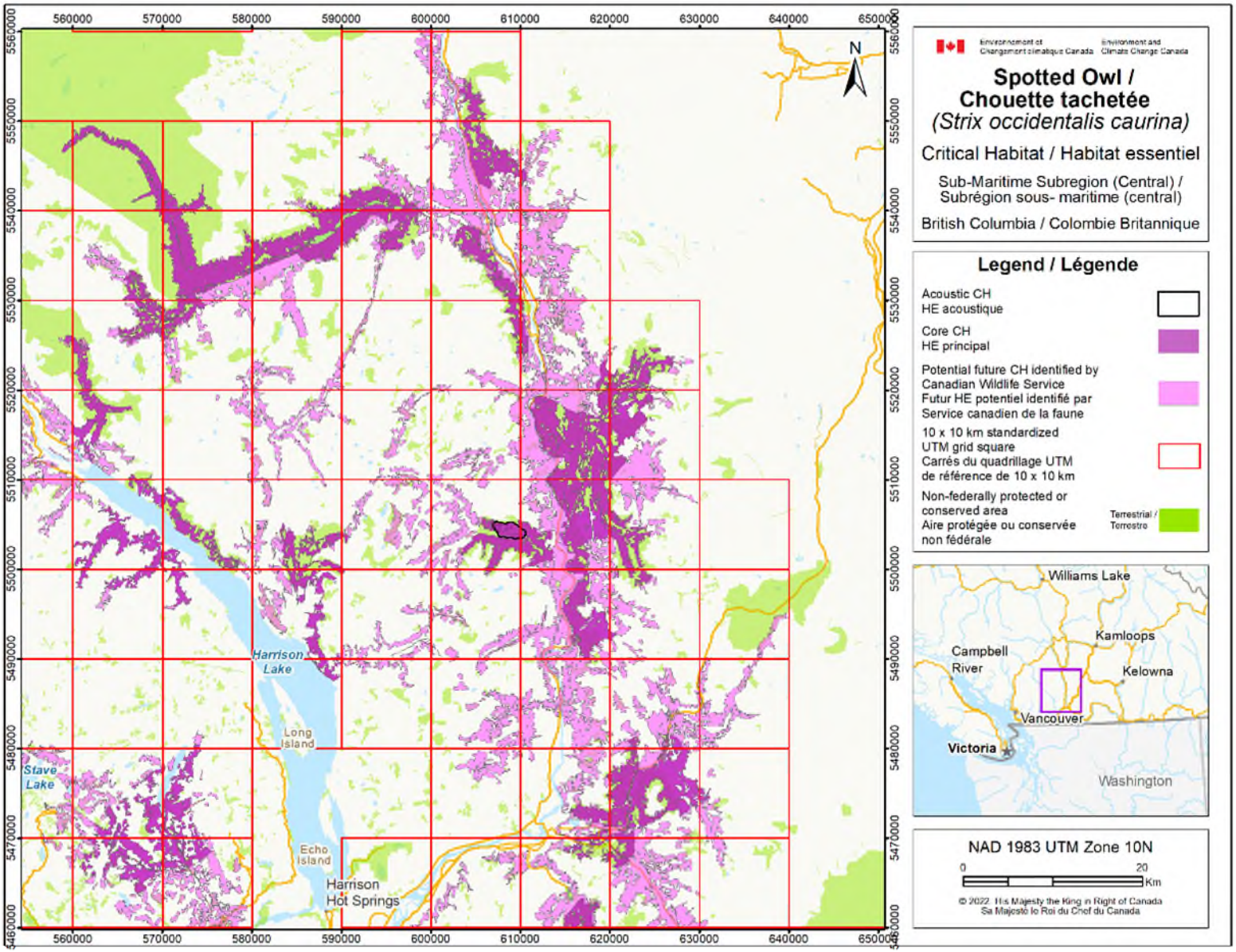

Figure 7. Critical habitat for the Spotted Owl within the central portion of the Sub-maritime sub-region is represented by the dark purple (core) and light purple (potential future) shaded and black outlined (acoustic) polygons where the criteria and methodology set out in this section are met. The 10 km x 10 km UTM grid overlay shown on this figure is a standardized national grid system that indicates the general geographic area containing critical habitat.

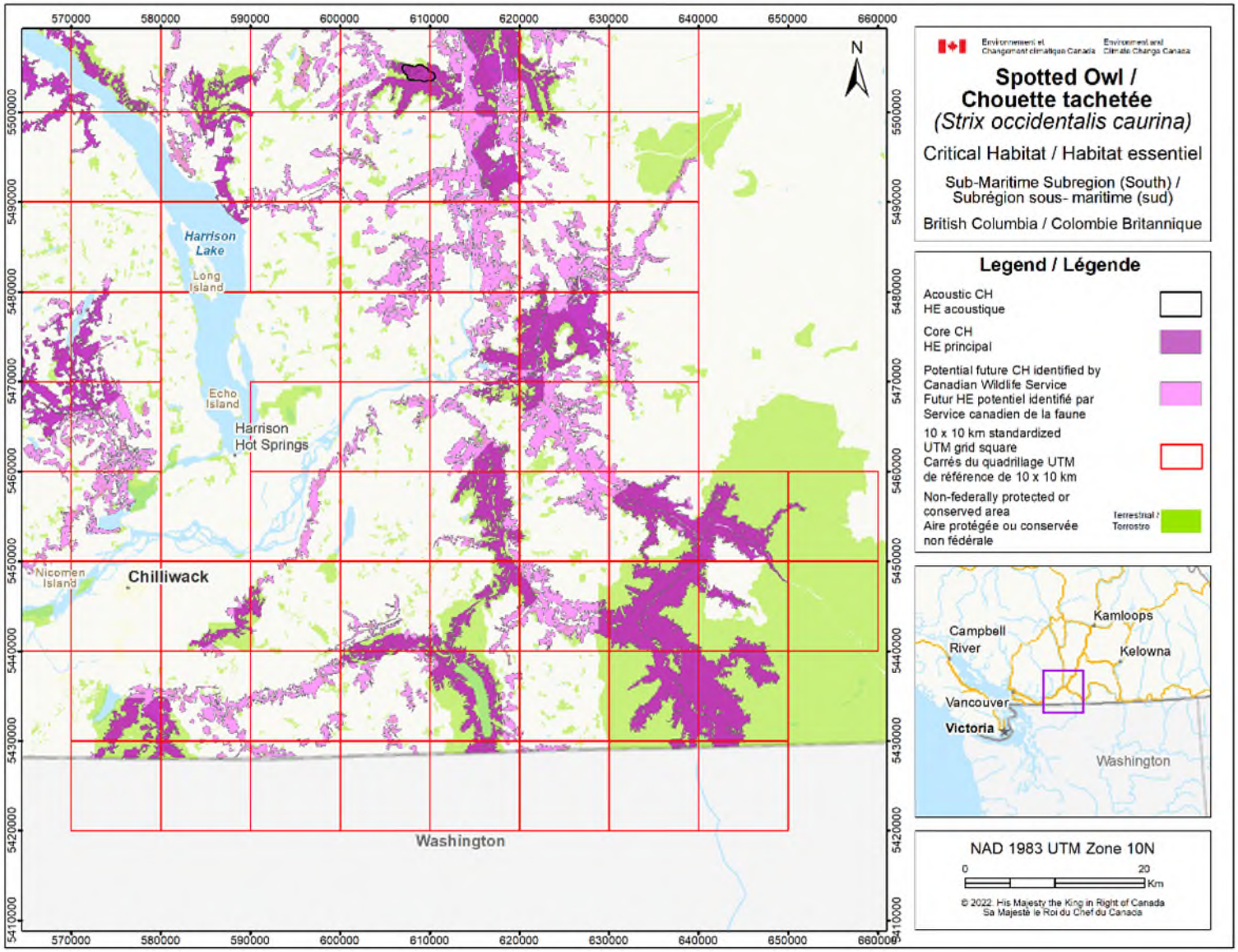

Figure 8. Critical habitat for the Spotted Owl within the southern portion of the Sub-maritime sub-region is represented by the dark purple (core) , light purple (potential future) shaded and black outlined (acoustic) polygons where the criteria and methodology set out in this section are met. The 10 km x 10 km UTM grid overlay shown on this figure is a standardized national grid system that indicates the general geographic area containing critical habitat. The hatched line in the southern extent of the map is the border with the Continental U.S.A.

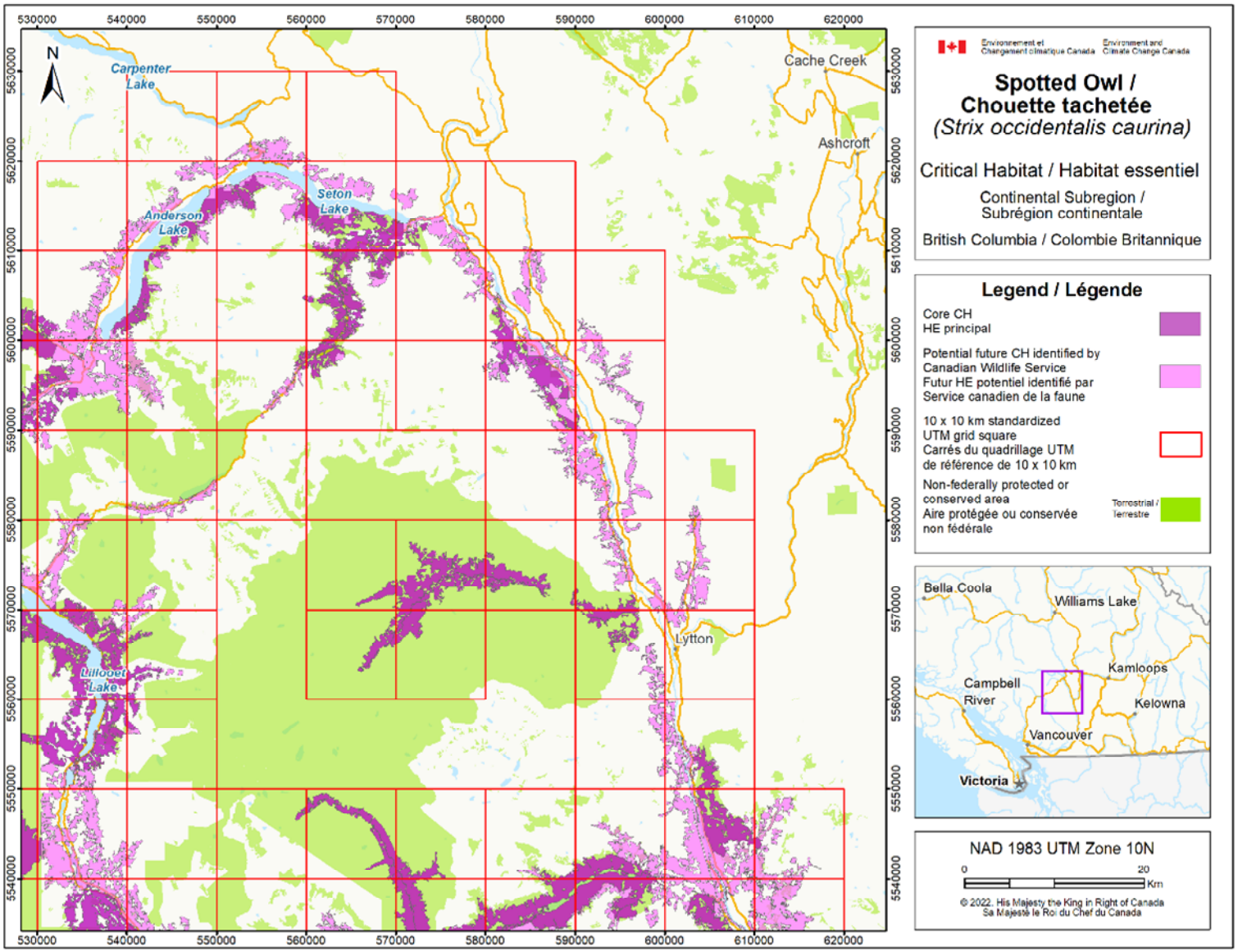

Figure 9. Critical habitat for the Spotted Owl within the Continental sub-region is represented by the dark purple (core) and light purple (potential future) shaded polygons where the criteria and methodology set out in this section are met. The 10 km x 10 km UTM grid overlay shown on this figure is a standardized national grid system that indicates the general geographic area containing critical habitat.

7.2 Schedule of Studies to Identify Critical Habitat

The following schedule of studies (Table 6) is required to complete the identification of acoustic critical habitat for the Spotted Owl and to implement an incremental approach to completing the identification and protection of core critical habitat.

Table 6. Schedule of studies to complete the identification of critical habitat for the Spotted Owl.

Description of Activity	Rationale	Timeline
Incrementally complete the identification and protection of **core critical habitat**	There is always uncertainty with modelled approaches to critical habitat identification. There are also uncertainties associated with uncontrolled disturbances (e.g., wildfire), as well as the behaviour of captively bred owls that are released into the wild. To maximize the critical habitat options through time and to minimize the risk of these uncertainties affecting the feasibility of recovery, an incremental approach to recruiting and protecting the critical habitat necessary to achieve the population and distribution objectives is proposed. This will require validation of critical habitat models as described in section 7.1.1 and monitoring of Spotted Owl populations. Information will be used to inform forest management, including Forest Landscape Planning, outside of protected and conserved areas, as well as the possibility of new or amendments to existing designated areas through time.	2023-2083
Identify **acoustic critical habitat** surrounding additional nesting areas as they become established	Currently it is unknown precisely where and when Spotted Owl reintroductions will be successful and where the recovering population will establish nesting areas. As new nesting areas become established, additional **acoustic critical habitat** must be identified to support those breeding pairs.	2023-2083

7.3 Activities Likely to Result in the Destruction of Critical Habitat

Table 7. Description of activities likely to result in destruction of the two currently-identified critical habitat subtypes for the Spotted Owl. These same activities would be likely to result in destruction of habitat within areas identified as potential future critical habitat.

Description of Activity	Description of Effect	Details of Effect
Any activity involving removal or disruption of natural vegetation and ground cover within **core critical habitat**, e.g., logging and wood harvesting; road-building; residential and commercial development; deliberate setting of stand-replacing fires	Activities resulting in destruction or removal of natural vegetation and ground cover (vegetation, snags, CWD) can result in destruction of core critical habitat through causing direct and permanent loss of the critical features and attributes required for all life functions (nesting, roosting, foraging, and safe movement).	Related IUCN-CMP Threat # 1, 4, 5.3, 7.1 The collective features and attributes of core critical habitat take >100 years to develop and are required annually (i.e., nest trees) or year-round (i.e., roosting and foraging attributes), so cannot be removed without resulting in destruction.
Fire management activities that involve removal of snags and CWD within old forest portions of **core critical habitat**	Removal of downed wood (CWD) and snags during fire management activities can result in destruction of core critical habitat through causing direct and permanent loss of the critical features and attributes required for nesting (i.e., nest trees) and foraging (i.e., features required to support prey populations).	Related IUCN-CMP Threat # 7.1 In some cases, it may be necessary to safeguard the longer-term integrity of core critical habitat in areas that are at high risk of catastrophic fire as a consequence of long-term fire suppression, through wildfire risk reduction practices. These may be undertaken without resulting in destruction of core critical habitat provided that removal of irreplaceable old forest attributes such as snags and CWD is avoided.
Activities emitting sounds resulting in an overall sound level ≥90 db or in an increase above ambient levels by >20 db* within **acoustic critical habitat** (e.g., operation of large machinery, use of chainsaws, blasting, operation of large engines and engine brakes, operation of motorized recreational vehicles)	Acoustic disturbance can result in destruction of core critical habitat within nesting areas through displacing Spotted Owls from the habitat and/or disrupting their behaviour such that they can no longer successfully carry out nesting functions.	Related IUCN-CMP Threat # 1, 4, 5.3 Applies only during the Spotted Owl breeding season (February 1st to July 31st).

*See https://www.fws.gov/arcata/es/birds/nso/documents/2020_MAMU_NSO_Disturbance_Guide_Combined_Final_signed.pdf for guidance on interpretation.

8. Measuring Progress

The performance indicators presented below provide a way to define and measure progress toward achieving the population and distribution objectives.

1. Human-caused threats that would cause further loss of habitat needed for recovery (i.e., the critical habitat) have been ceased.
2. At least 50 captive-bred Spotted Owls have been reintroduced to the wild by 2033, and at least 10 have survived to become resident adults.
3. Annual Barred Owl surveillance has taken place within all sites occupied by Spotted Owls and/or where reintroductions are planned, and all detected Barred Owls have been removed.

9. Statement on Action Plans

One or more action plans for the Spotted Owl will be published on the Species at Risk Public Registry within 5 years of the finalization of this document.

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Joel Gillis. *Spotted Owl Biologist – B.C. Ministry of Forests, Lands, Natural Resource Operations and Rural Development.* 2019.

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Joanna Hirner. *Conservation Specialist – B.C. Parks.* 2020.

Jasmine McCulligh. *Coordinator - Northern Spotted Owl Captive Breeding Program*. 2021.

Appendix A: Effects on the Environment and Other Species

A strategic environmental assessment (SEA) is conducted on all SARA recovery planning documents, in accordance with the *Cabinet Directive on the Environmental Assessment of Policy, Plan and Program Proposals*[16]. The purpose of a SEA is to incorporate environmental considerations into the development of public policies, plans, and program proposals to support environmentally sound decision-making and to evaluate whether the outcomes of a recovery planning document could affect any component of the environment or any of the Federal Sustainable Development Strategy's[17] (FSDS) goals and targets.

Recovery planning is intended to benefit species at risk and biodiversity in general. However, it is recognized that strategies may also inadvertently lead to environmental effects beyond the intended benefits. The planning process based on national guidelines directly incorporates consideration of all environmental effects, with a particular focus on possible impacts upon non-target species or habitats. The results of the SEA are incorporated directly into the strategy itself, but are also summarized below in this statement.

Conservation of habitat for the Spotted Owl will benefit a multitude of vertebrate, invertebrate, and plant species that use mature and old-growth 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 (four amphibians, 34 birds, 17 mammals, and 16 fish). Examples of other species at risk whose habitats overlap with those of Spotted Owls include Marbled Murrelet (*Brachyramphus marmoratus*), Northern Goshawk (*Accipiter gentilis*), and Western Screech-Owl (*Megascops kennicottii) kennicottii* and *macfarlanei* subspecies. 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 the Spotted Owl will help maintain functioning late-successional forest ecosystems, and help regulate water and nutrient cycles. Further, many of the old-growth stands conserved for the Spotted Owl are likely to function as refugia as climate change-mediated disturbances increase in frequency and extent. Protection of these areas for Spotted Owls will also improve the climate change resilience of other old-forest-dependent species.

Barred Owls are also known to compete with or prey upon a number of other native species, including species at risk. Predation by Barred Owls is one of the highest-level IUCN-CMP threats for Western Screech-Owl *kennicottii* and *macfarlanei* subspecies, the ranges of which overlap significantly with that of the Spotted Owl. Control of Barred Owls within the Spotted Owl range will therefore also support recovery of Western Screech-Owl.

[16] www.canada.ca/en/environmental-assessment-agency/programs/strategic-environmental-assessment/cabinet-directive-environmental-assessment-policy-plan-program-proposals.html
[17] www.fsds-sfdd.ca/index.html#/en/goals/

Appendix B: SOMP2 - Spotted Owl Critical Habitat Science Rationale Summary DRAFT Version 09/22/22

1. Background

In 1994, the Canadian Spotted Owl Recovery Team (CSORT 1990 to 1995), published Management Options for the Northern Spotted Owl in British Columbia (Dunbar and Blackburn, 1994). Foundational to these options were the Spotted Owl Conservation Areas (SOCAs – Figure AB1) that were designed by CSORT that followed the biological principles established by species experts described in A Conservation Strategy for the Northern Spotted Owl (Thomas et al. 1990). Based on a recovery population target of 250 adult owls, each SOCA was designed to sustain multiple breeding pairs, located close enough to other SOCAs to support the movement of owls between SOCAs, and distributed throughout the known species range in British Columbia. Management options presented did not alter the design or location of SOCAs, rather each management option focused on varying the extent of the species' range to protect and/or the amount of suitable habitat[18] to protect within each SOCA. Each option was independently assessed for its likelihood of recovering the Spotted Owl by a panel of experts.

[18] For the purposes of this report, Suitable Habitat refers to both nesting and foraging habitat types.

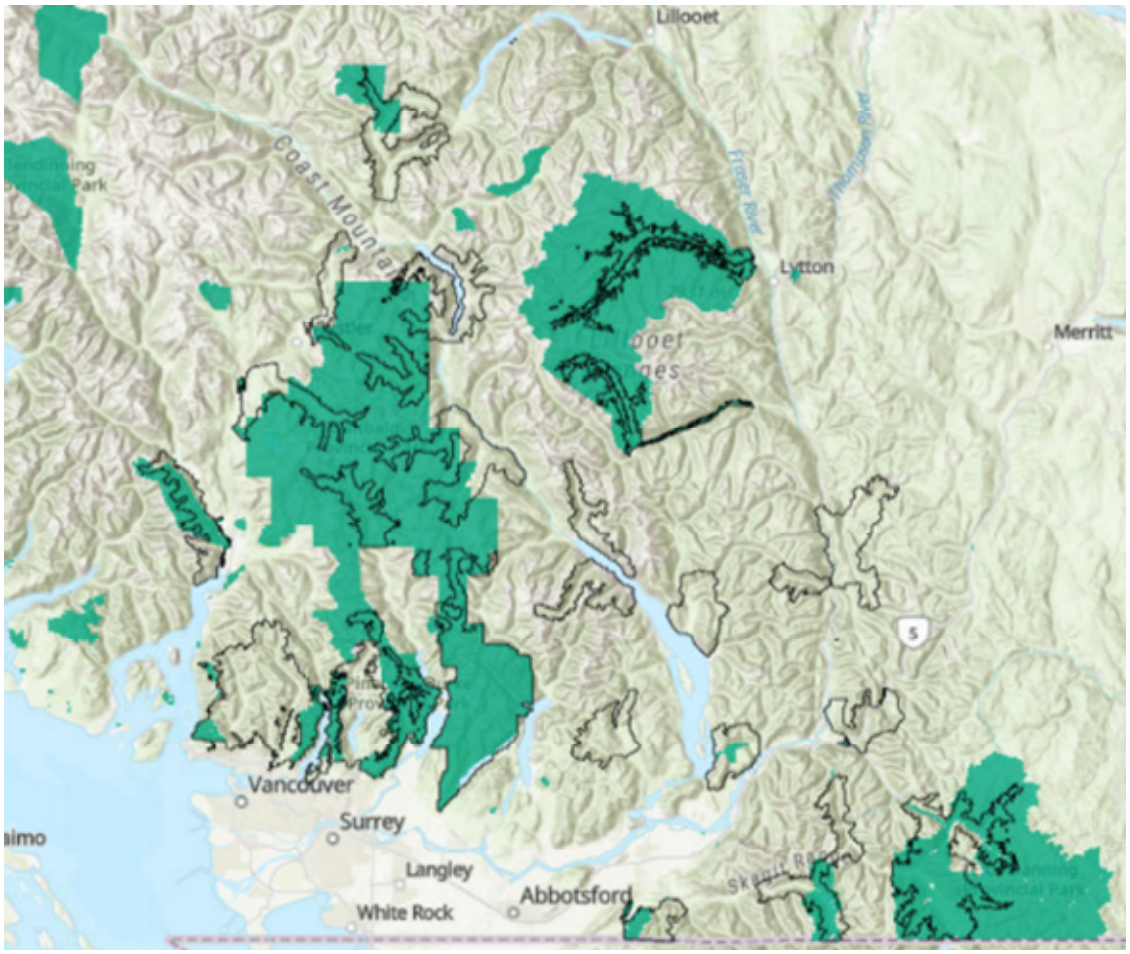


Figure AB1: Spotted Owl Conservation Areas (outlined in black) established by CSORT in 1994 (Dunbar and Blackburn 1994)

The BC Government chose a management option to balance the conservation needs of the Spotted Owl with socio-economic needs. In 1997, the "Spotted Owl Management Plan" (SOMP 1) was implemented (SOMIT 1997). The plan's recovery objective was to maintain and recruit a minimum 67% suitable habitat within all SOCAs (renamed Special Resource Management Zones under the Forest Practices Code), with the exception of 2 SOCAs in the Whistler corridor which were not protected. Only owl breeding territories that occurred entirely within protected areas were afforded 100% habitat protection.

In 2003, following a review of the status of the SPOW population (Blackburn et al. 2002), a new Canadian Spotted Owl Recovery Team (2003 to 2008) was established to produce a Recovery Strategy to address the continued declines of the Spotted Owl population in British Columbia. Following the completion of the Recovery Strategy for the Northern Spotted Owl in Canada (Chutter et al. 2004), CSORT embarked on defining Critical Habitat that included the identification of 125 breeding territories throughout the species range to attain a self-sustaining population of 250 adult owls in the future.

2. CSORT's Modelled Critical Habitat

The following is a high-level overview of the various modeling components and outputs presented in Sutherland et al. (2007) that help constitute the strategic identification of where Critical Habitat occurs within the province, now and in the future. These modeled outputs are considered as guidance as they reflect an array of assumptions and inputs spatially projected over time, are built on various landscape and disturbance scenarios, and are limited to best available data, scientific knowledge, modeling capabilities and expert opinions. As much as possible, learning experiments and sensitivity analyses were undertaken to test the various assumptions within the CSORT timeframe.

A series of spatial models (Figure AB2) and Bayesian Belief Network (Figure AB3) to estimate integrated habitat quality were developed to map potential critical habitat. A Resource Location model was also developed to identify and prioritize locations for protection to meet the recovery objective (Figure AB4).

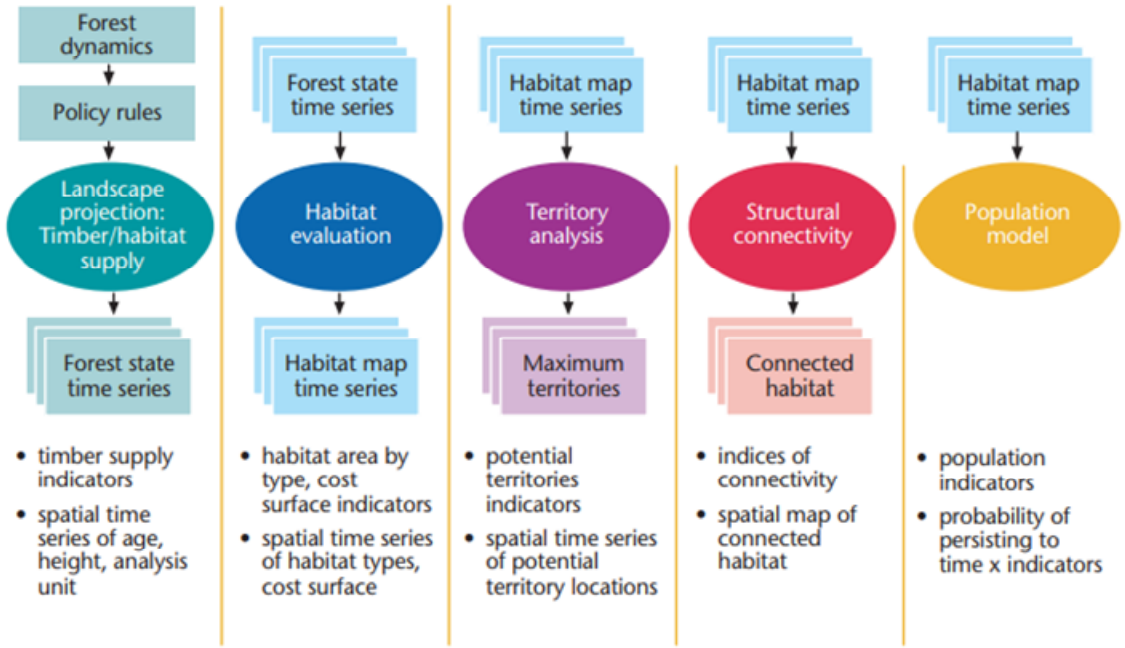


Figure AB2. Implementation of the modelling components of the analysis framework (Sutherland et al. 2007).

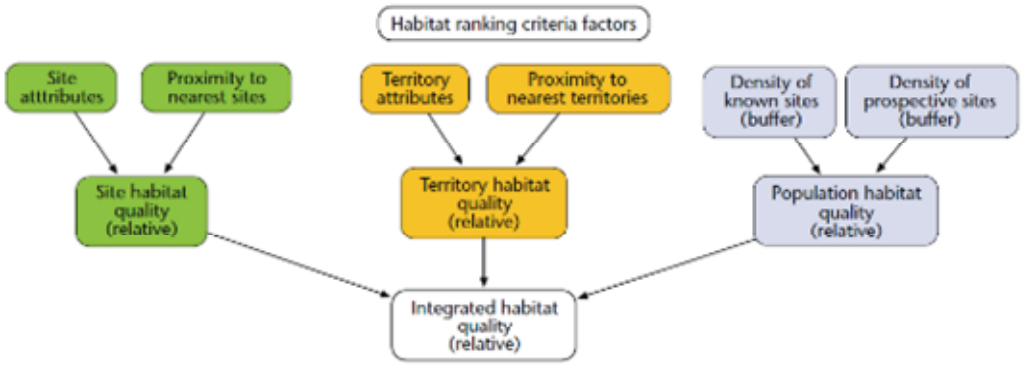
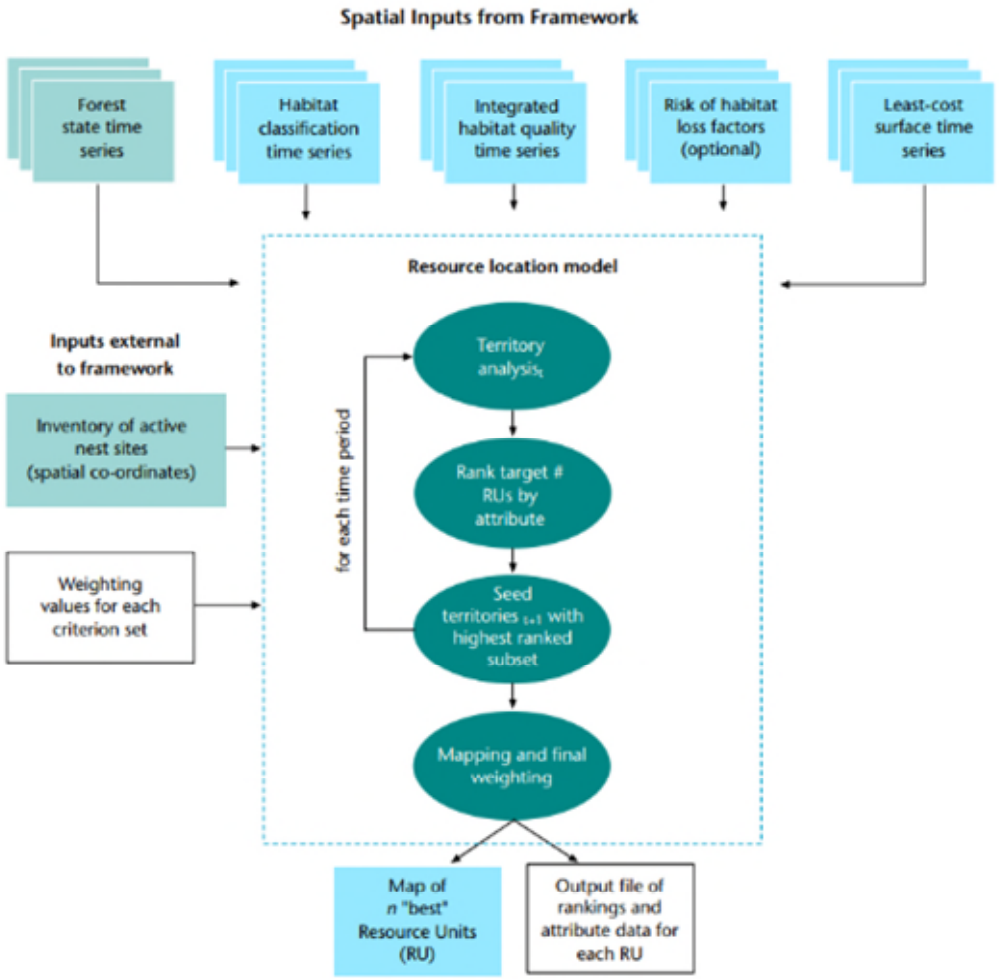


FIGURE 21 *A conceptual structure of the BBN developed for ranking habitat quality for each cell using outputs from other components of the framework and weighting rules specified within the BBN. Colours shown identify nodes specific to each scale context – green = site-scale; orange = territory-scale; light blue = population scale.*

2103

2104 **Figure AB3**. Conceptual Structure of the Bayesian Belief Network (Sutherland et al. 2007)
2105



2106
2107 **Figure AB4.** Conceptual diagram of the RLM's components, main inputs and outputs, and logic
2108 flow (Sutherland et al. 2007).

The following briefly describes outputs and inputs used in the identification of the Critical Habitat framework.

1. Habitat Supply

   The landscape dynamics model first projects forest growth and stand-replacing natural disturbances that is capable of spatialized timber supply analyses. The model combines a spatially explicit forest state model with a stand-replacing natural disturbance model to estimate sustainable harvest flows and to project spatial time-series of forest-state indicators (e.g., stand age, height, structure, disturbances). This enables a more realistic projection of habitat supply over time under various management scenarios. Suitable habitat is then evaluated, classified, and mapped.

   The habitat supply model classification included consideration of Biogeoclimatic zone/variant, elevation, top tree height in a stand and average stand age (Figure AB5).

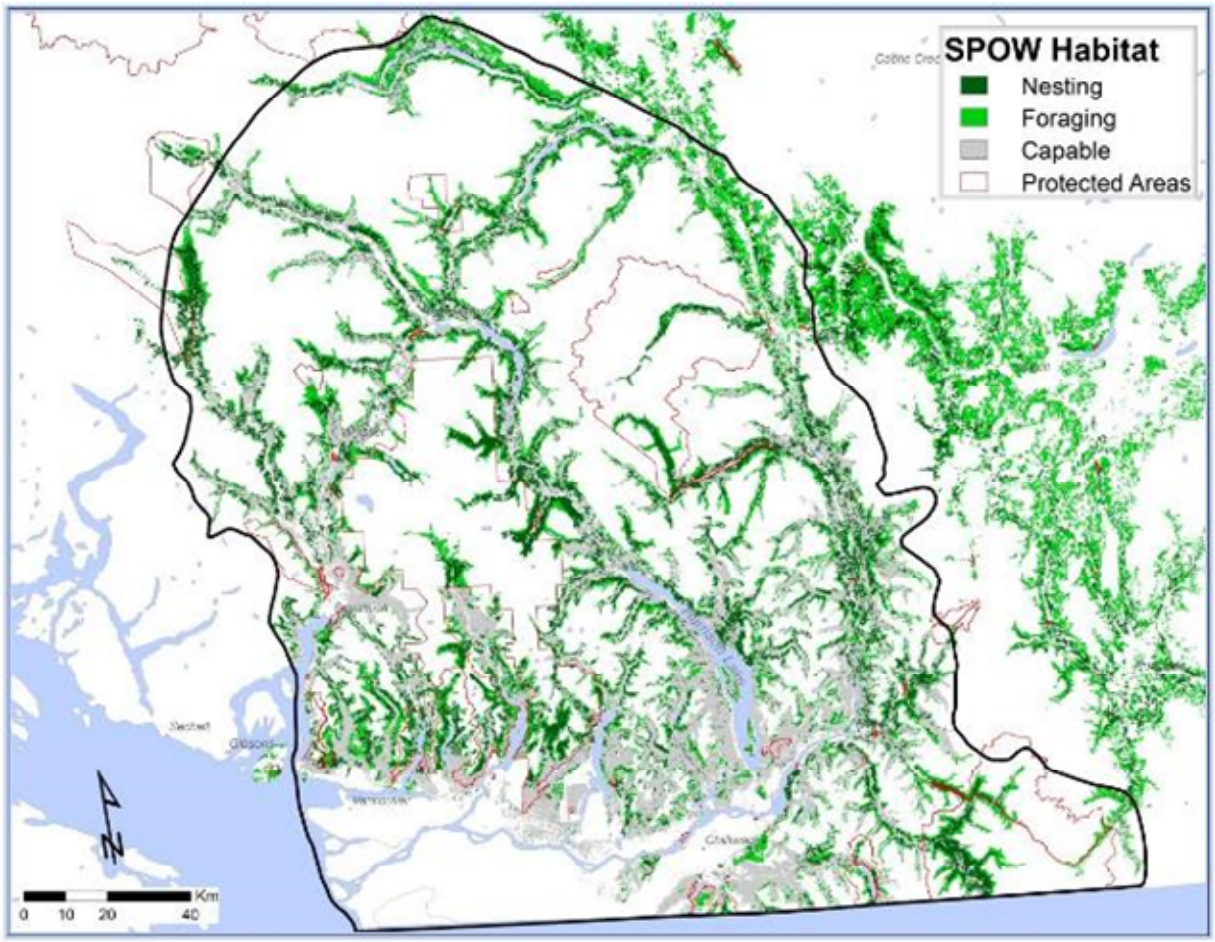


Figure AB5: Habitat Supply model: distribution of suitable habitat (nesting and foraging habitat) and capable habitat within the range of the Spotted Owl in BC (black line) at year zero (Sutherland et al. 2007).

2. A structural connectivity model

The structural connectivity model assesses the spatial arrangement and proximity of suitable habitat for individual movement or potential population movement through identification of corridors. The structural connectivity model (Figure AB6) applies the least-cost path method that consists of pathways between habitat patches that have a minimum overall accumulated movement cost to the owl by using a modelled cost surface. Movement costs within suitable habitat is considered low. Movement costs within capable habitat increase as the age of the forest stand decreases. Non-forested cells (such as water bodies) and high elevation forests also have higher cost to movement. Habitats with low movement cost between patches are better connected and more likely to be used by owls (and selected by the models) than patches with higher cost.

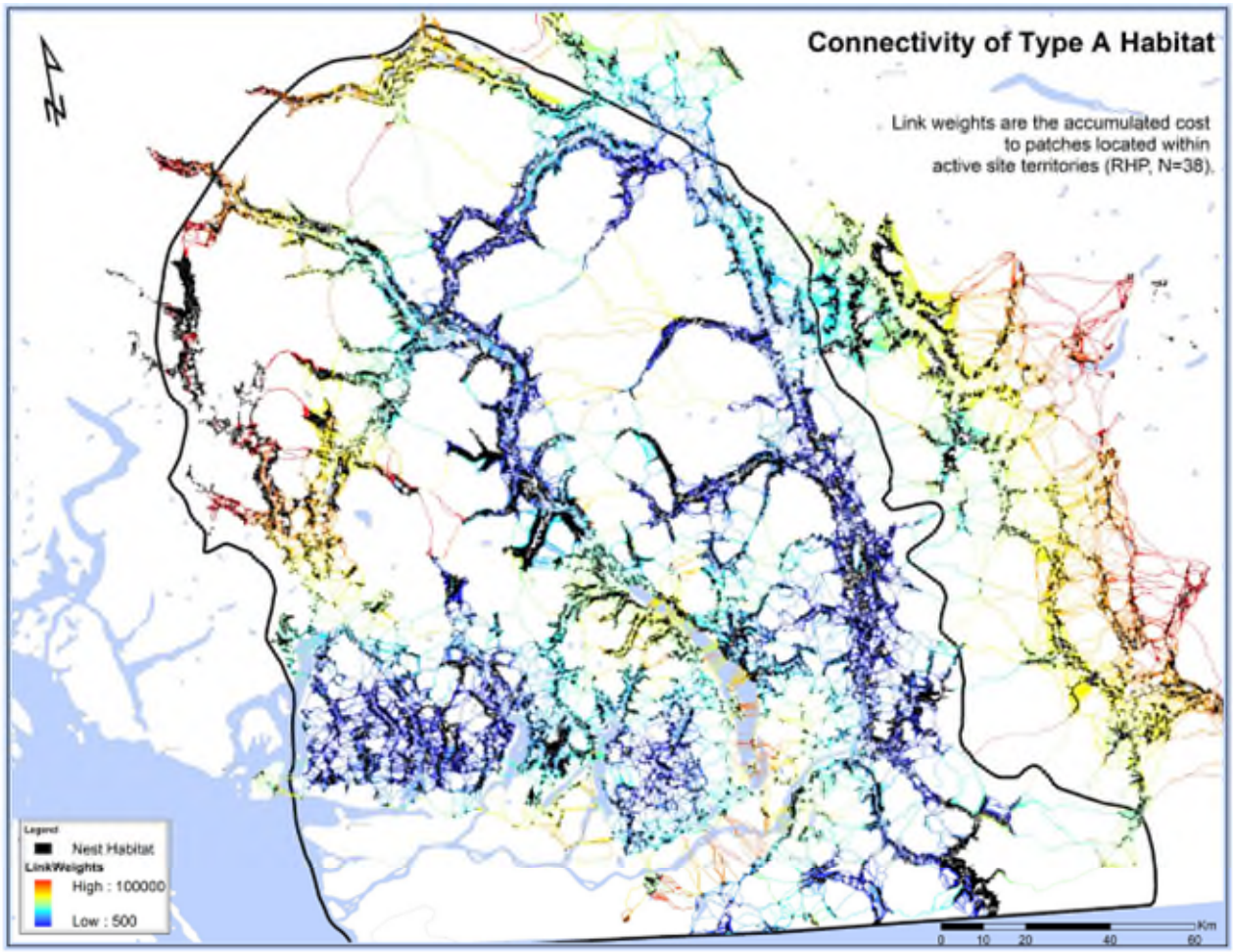


Figure AB6: Connectivity model of Nesting Habitat within the range of the Spotted Owl (black line) in British Columbia (Sutherland et al. 2007).

3. A spatial model for calculating locations of potential territories

Under the various parameters (such as median amount of suitable habitat needed to establish a breeding territory) and initiation points (such as nest locations), the territory

model grows out from these initiation points spreading quickly over low-cost pathways and slowly over higher cost pathways. The territory grows until it reaches its suitable habitat target or its maximum territory size. Once a territory has been established, the model limits any adjacent territory overlap to a maximum of 25% overlap. If the territory reaches its maximum territory size but does not contain enough suitable habitat, it is deleted. The model then randomly selects another initiation point and tries to establish another territory. For the packed territory scenario, intended to examine maximum capacity for supporting owl territories, the model continues this process until no more territories can be built (Figure AB7). The territories can then be ranked based on various parameters (such as the percentage of habitat) or priority territory locations identified by selecting locations more often included in a territory based on multiple random runs.

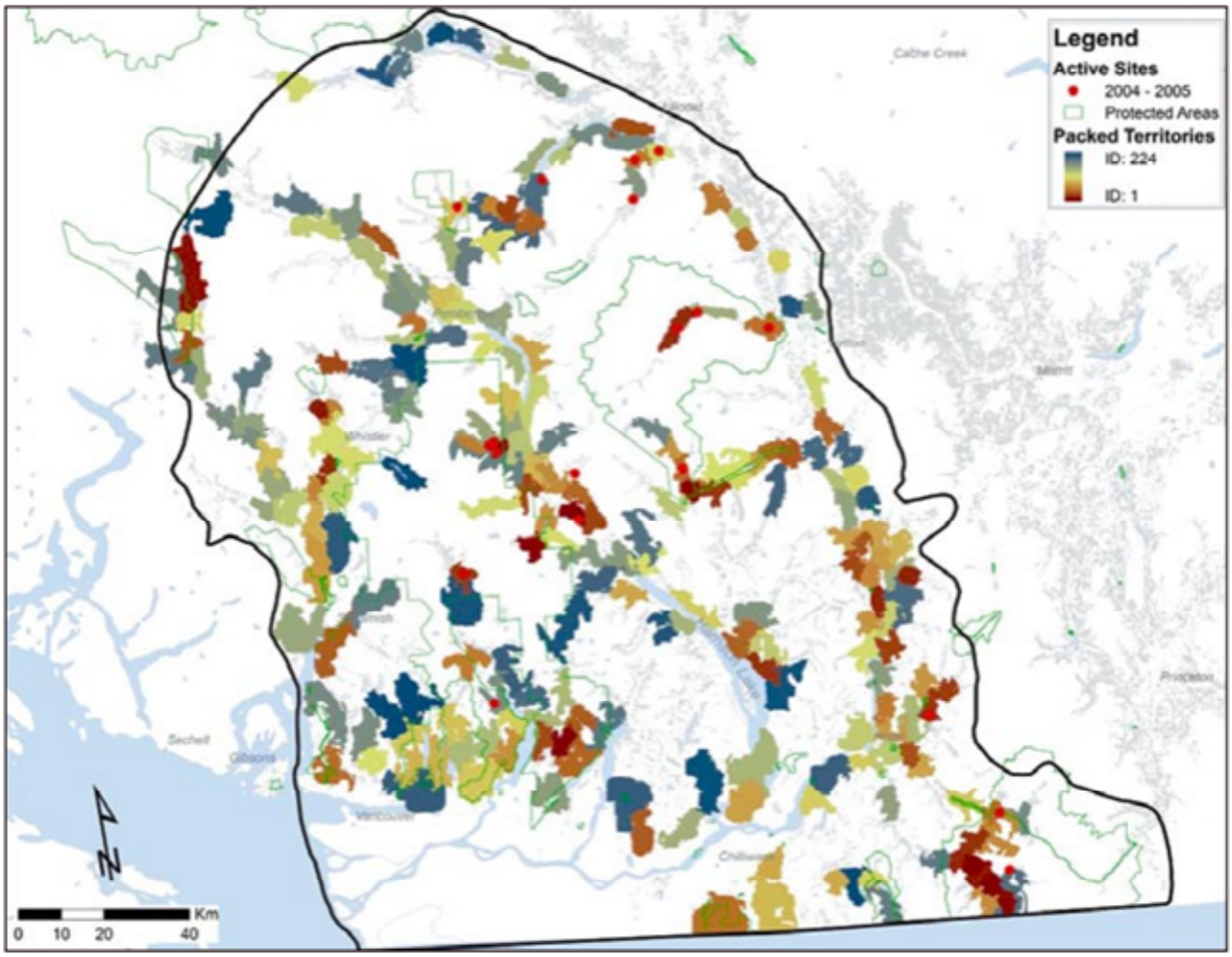


Figure AB7: Distribution of potential breeding territories across the Spotted Owl range as found by one iteration of the maximum territories model. Shown are all the territories located in year 50 (Sutherland et al. 2007).

4. An integrated habitat quality model

These maps are built using a Bayesian belief network (Figure AB3) that weighs selected habitat attributes measured at the site, territory, and population scales using outputs from some of the previous models. The BBN enabled CSORT to refine rules, some

which are difficult to parameterize, for assessing relative habitat quality between locations for Spotted Owls. It integrates uncertainties in habitat relations and enables a relative weighting for different structural and spatial habitat attributes at each location. The result is an integrated measure of biological habitat quality for each spatial location that can be used to facilitate selection of Critical Habitat locations (Figures AB8&9).

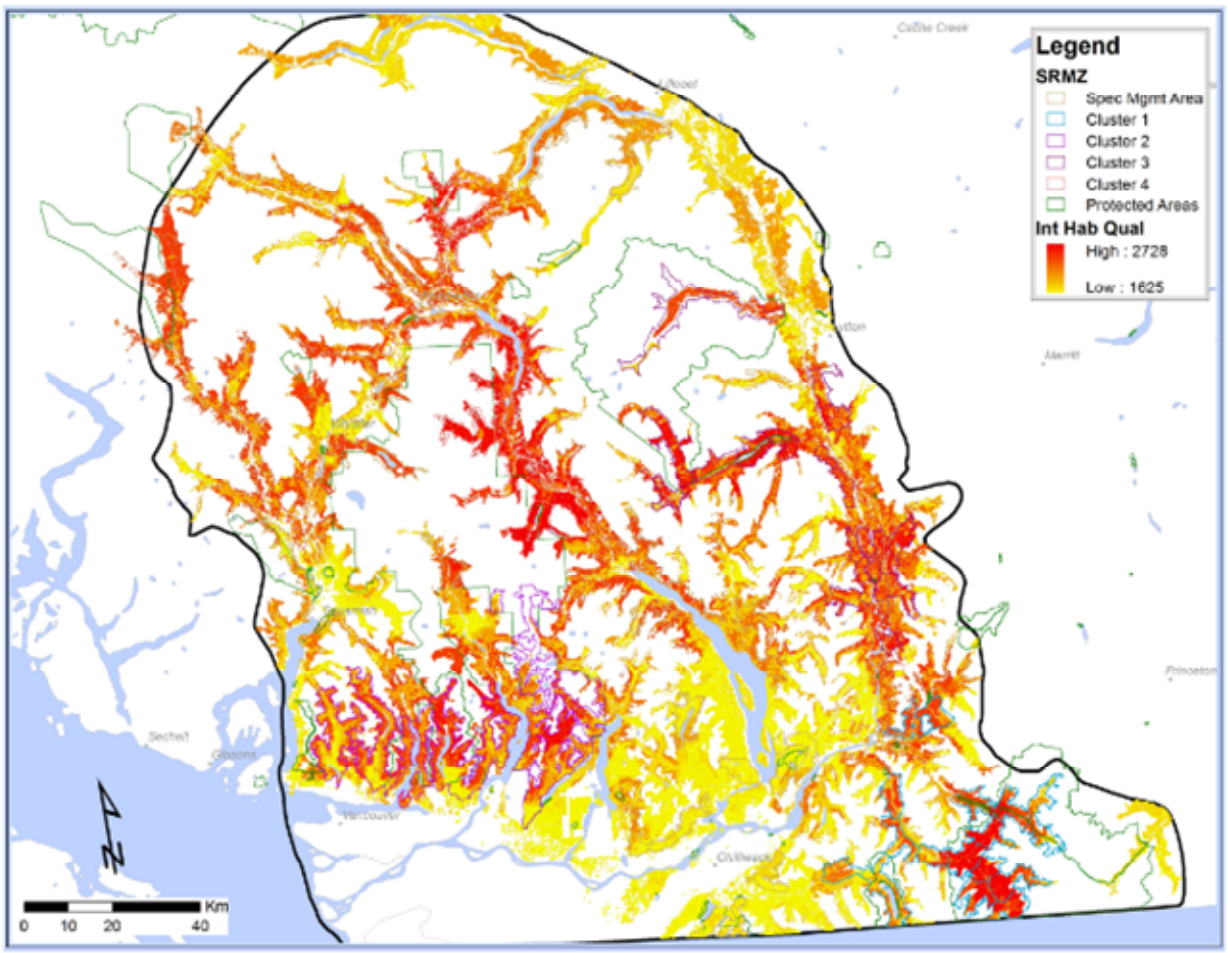


Figure AB8: Integrated Habitat Quality: the integrated Habitat Quality map at year 0 depicting the location of high-quality habitat (in red) that can be used to identify Critical Habitat (Sutherland et al. 2007).

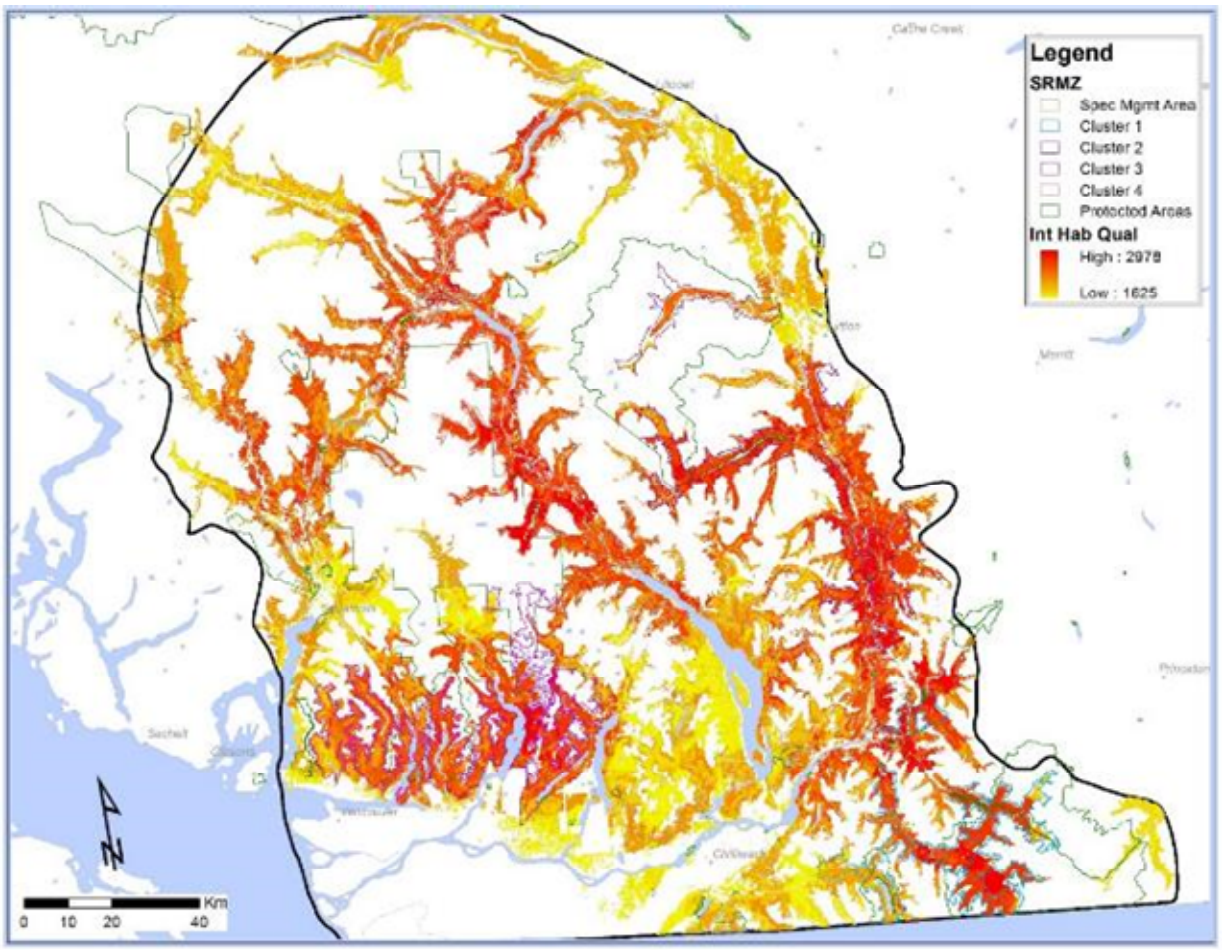


Figure AB9: Integrated Habitat Quality - the integrated Habitat Quality map at year 50 depicting the location of high-quality habitat (in red) that can be used to identify Critical Habitat (Sutherland et al. 2007).

5. Resource location model.

   This model is similar to the packed territory model, but modified to track additional attributes such as information from the integrated habitat quality map (Figure AB9). Territories were termed Resource Units (RU) to capture broader potential management application of the model. The model is iteratively applied at years 0, 20 and 50 to locate all possible territories (Figure AB10). At time 0 years, 50 territories are initiated using active nest sites and/or randomly selected potential nest sites. Once the packed territory layer at this time step is generated all territories are then ranked using a subset of biological criteria (i.e., proportion of suitable habitat; Table AB1) and the top ranked 50 RU are then used to seed the next time step. To determine the top 125 territories of the final time step year 50, the CSORT then used two sets of criteria for ranking towards understanding potential differences in landscapes: the top 125 territories based on Best Biological (no timber harvesting – Figure AB11) and the top 125 territories Best Biological with risk (exclude territories with high amount of timber harvesting land base – Figure AB12).

2212 **Table AB1.** Biological criteria used to rank locations from Sutherland et al. 2007
2213

EVALUATION CRITERIA	ATTRIBUTE	RATIONALE FOR SELECTION IN THE SPOTTED OWL CASE STUDY
BIOLOGICAL CRITERIA	Ecological subregion	To control the representation of RUs in different ecological subregions; linked to demographic dynamics
	Area (ha) of each RU	Area interacts with policy considerations and could be used for biological assessment in other weightings (e.g., % of area that is suitable)
	Area (ha) of suitable habitat in each RU	Linked to energetic requirements
	Area of nesting habitat in each RU	Linked to reproductive requirements
	Mean integrated habitat quality for the RU	Ranks quality of each unit by combining site-, territory- and population-scale attributes (see Section 8)
	Proportion of RU that is currently suitable habitat	Linked to demographic dynamics
	Ratio of nesting to foraging habitat in each RU	Linked to likelihood of finding suitable nest sites
	Least-cost distance to nearest occupied site	Linked to likelihood of receiving a dispersing owl
	Least-cost distance to nearest centroid	Linked to likelihood of being near future potential centres of population
	Mean age relative to minimum age of suitable habitat	Linked to amount of restorable habitat in the RU

2214

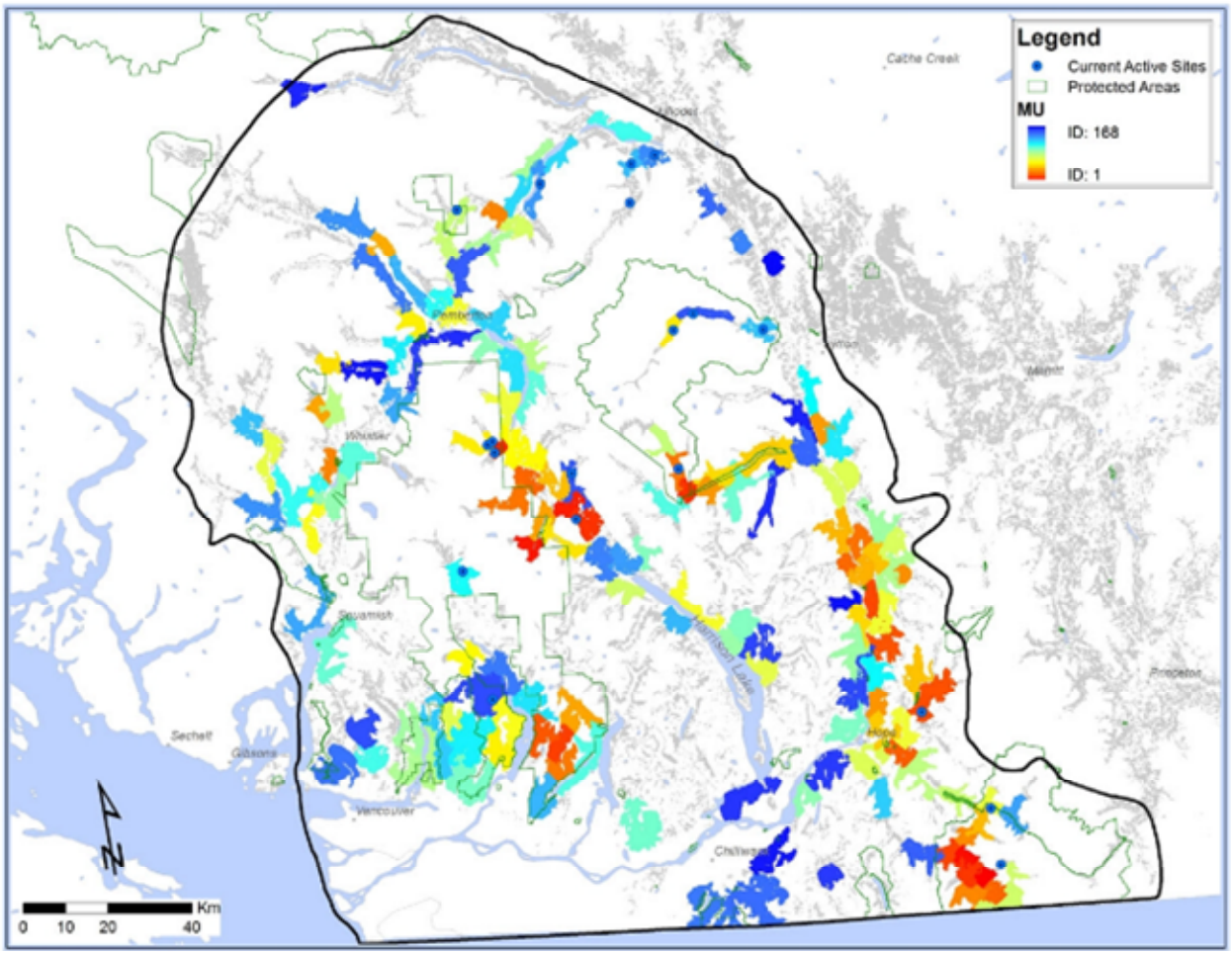


Figure AB10: Map of all possible candidate Resource Units (Sutherland et al 2007). The Packed-Territory Model output was applied against the Integrated Habitat Quality maps to rank candidate Resource Units (potential owl territories). The following example is projection of candidate territories at year 50. Modeled RUs are ranked by best (1) to worse (168). Filters could then be applied to the results of this map to identify 125 Spotted Owl Territories.

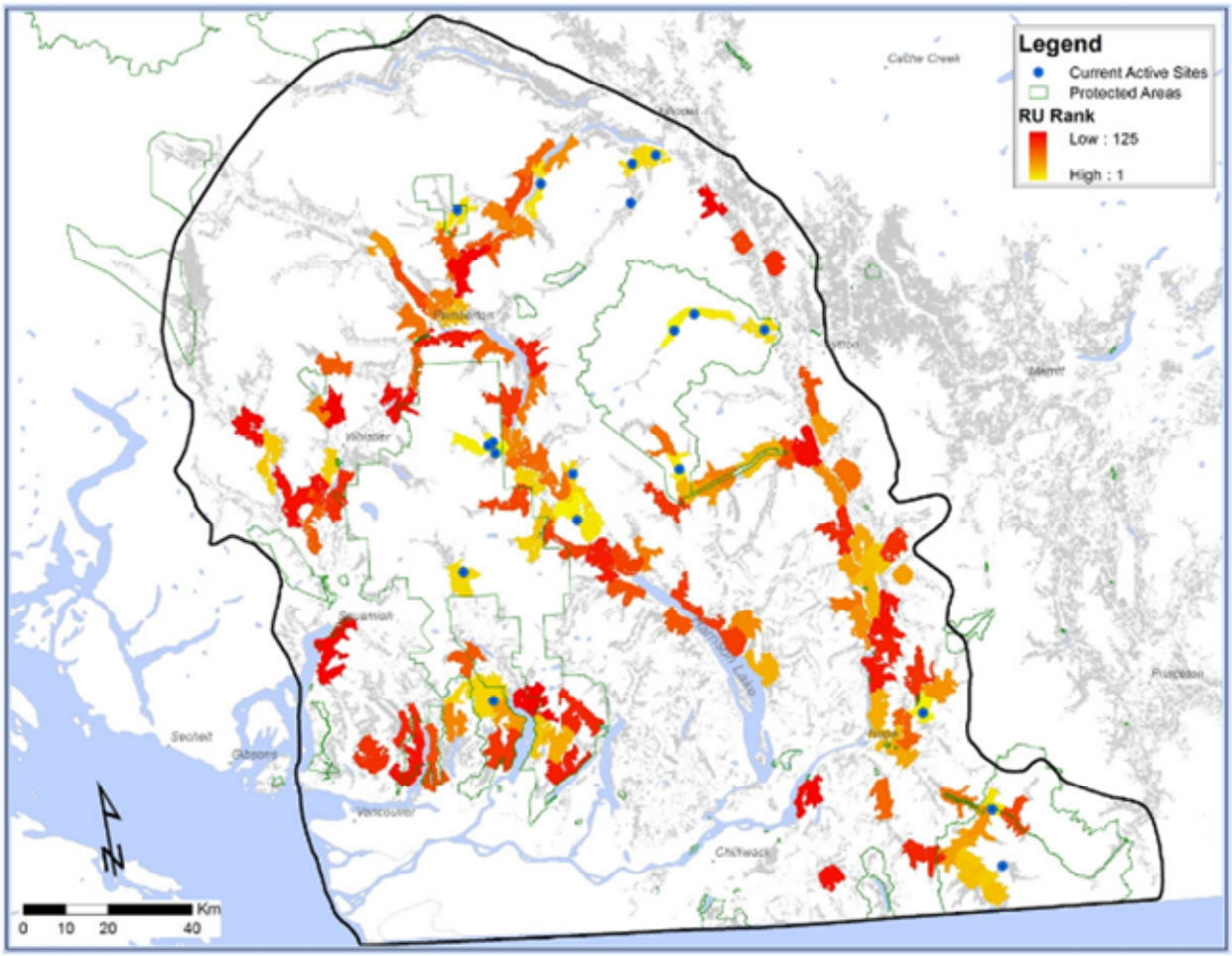


Figure AB11: Best biological scenario (Sutherland et al. 2007) Candidate Resource Units (RUs) for the case study selected according to RUs weighted by biological criteria only at year 50 (The highest weighted rank = 1, lowest = 125.)

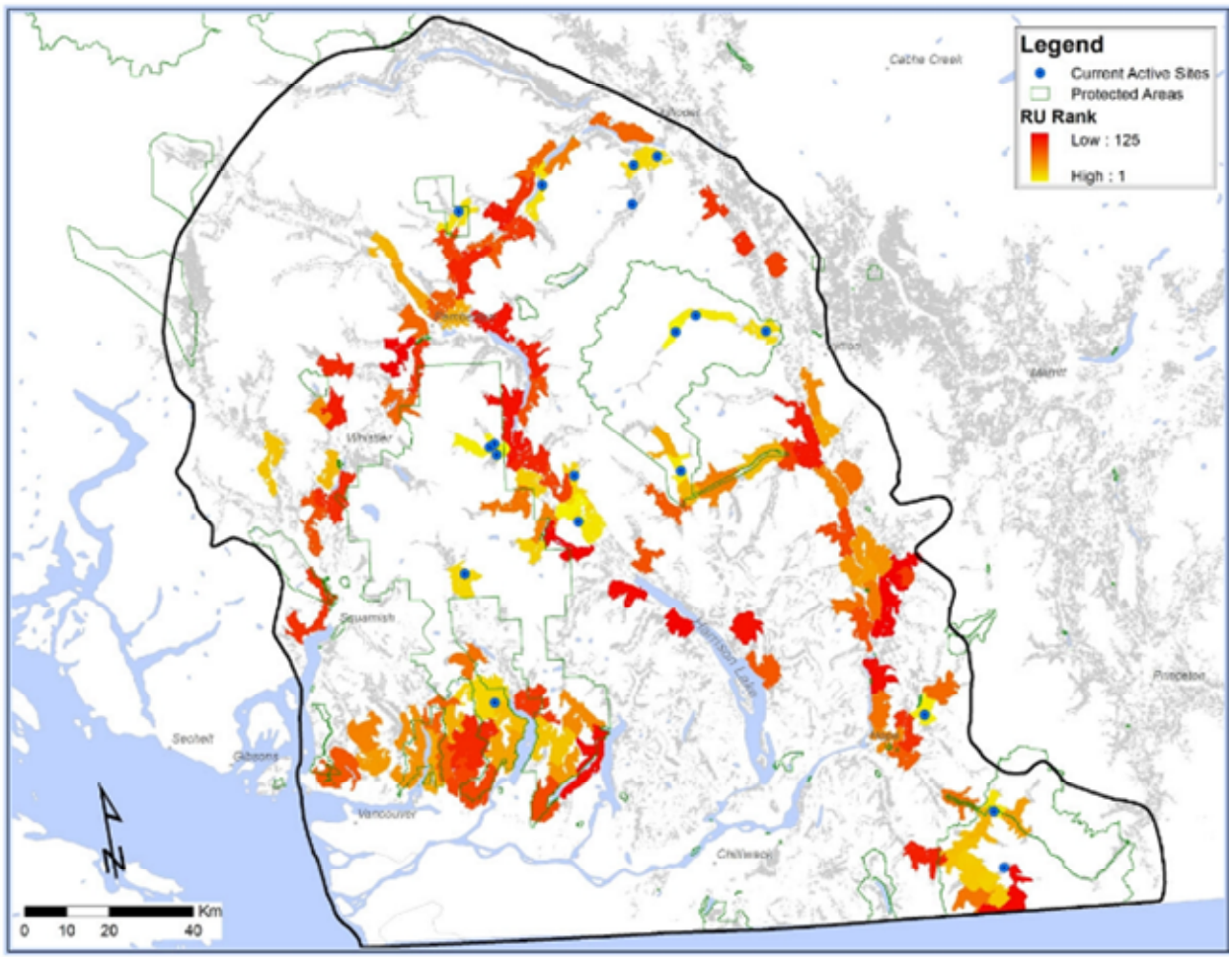


Figure AB12: Best biological scenario with human and natural disturbance (Sutherland et al. 2007): Candidate Resource Units (RUs) for the case study selected according to RUs weighted biological + risk criteria at year 50 (excludes RUs with the highest amount of Timber Harvest Land base and/or risk of fire). (The highest weighted rank = 1, lowest = 125.)

Sutherland et al. (2007) states that "*We are (and must be) fairly conservative in our interpretation of the findings obtained with the framework in our case study. From the outset, we did not expect spatial modelling results alone to provide a complete solution for recovery of either the British Columbia Spotted Owl population or indeed any species, because of uncertainties in biological parameters, in inventory data, and in describing and projecting all possible threats to populations. We argue that the structure of the framework is very amenable to further informing (and being informed by) long-term monitoring programs for recovering species designed to assess management strategies established to promote the chances of recovering an endangered species or population*."

3. CSORT Advice on Critical Habitat (Chutter et al. 2007)

Species Population and Habitat Recovery Targets

The CSORT clarified that the sustained survival of the Northern Spotted Owl in Canada requires a population of 100 owls whereas the recovery (down-listing) of the species would be achieved once the population reached 250 mature owls in BC. This was subsequently translated into a

habitat objective of providing enough habitat to sustain 125 Spotted Owl breeding territories. CSORT then modeled the amount of suitable habitat required to sustain 125 territories to be approximately 290,000 ha (recovery target), and 116,000 ha to achieve 50 territories (survival target).

CSORT determined that over 540,000 ha of suitable habitat occurred within the range of the Spotted Owl in BC. However, *"due to past land management decisions, sufficient suitable habitat does not appear to exist currently in the spatial distribution required to meet the long-term recovery goal for the Spotted Owl. Recruitment of new areas of suitable habitat through natural succession and active enhancement of capable habitat is needed for recovery."* Chutter et al. (2007).

CSORT's perspective on SOMP1 was *"The Spotted Owl Management Plan allocated 363,000 hectares of habitat for Spotted Owl management, which theoretically could be enough to maintain a sustainable population. However, current habitat conditions of these areas may be too fragmented to allow for effective connectivity of subpopulations, re-colonization of currently vacant habitat, and juvenile dispersal."* (Chutter et al. 2007)

CSORT recognized that there was a shortfall within SOMP1 to attain the 290,000 ha of suitable habitat. CSORT's perspective was that *"This deficit can be addressed through recruitment over the long-term, and in the shorter 20-year term, the restorable habitat could have a significant positive benefit if it is strategically placed on the landscape."* (Chutter et al. 2007).

Identifying Critical Habitat

Chutter et al. (2007) provided some important commentary on the limitations of the models used to define proposed Critical Habitat:

"*While detailed stand structure descriptions of Spotted Owl habitat exist (SOMIT 1997), all this information was not available in appropriate datasets for modeling habitat supply and identifying locations of critical habitat. The modeling supported by the CSORT thus only provides a strategic definition of Spotted Owl habitat, and it therefore needs to be recognized that any proposed amounts of critical habitat or spatial locations of critical habitat, based on model outputs, will be strategic and will require field verification prior to implementation (Sutherland et al. 2007). In addition, the assumptions and sensitivities of the parameters used to define suitable habitat, territories and habitat quality for the current modeling affect the results and may need further testing and evaluation (i.e., based on new information) if these results are to be implemented (Sutherland et al. 2007)."*

CSORT recommended the following approach to Critical Habitat planning for Spotted Owls in BC:

- *Take into account the current endangered status and imminent threat of extirpation of the species in Canada.*

  Recovery of Spotted Owls is a priority for British Columbia. Recovery Actions to date include an improved Spotted Owl Management Plan (SOMP2), a Captive Breeding and Release Program, and the removal of Barred Owls from priority habitats.

- *Consider recent history of occupancy for prioritizing protective measures.*

SOMP2 considered the current and historic (1995 to 2008) locations of Spotted Owls. Prioritizing protective measures was informed by connectivity analyses corridors and identification of broader ecological subregions influencing population distribution.

- *Consider representation across the species' range in the province.*

SOMP2 established Spotted Owl WHA's throughout the Canadian range to ensure full representation of ecosystems. For the most part this included adding the protection of Spotted Owls in the Continental eco-region which were previously unknown to occur in the eco-region.

- *Consider maximization strategies for connectivity and clustering of territories and groups of territories to enable successful dispersal and territory establishment at subregional, provincial and international scales, especially between the habitat areas that the modeling framework analyses indicate have become isolated.*

SOMP2 prioritized creating large clusters of potential breeding territories around high-quality habitats (as identified by the Integrated Habitat Quality maps) that were spaced less than 15.5 km apart to facilitate movement of owls between clusters.

- *Consider natural and human-caused disturbance impacts on habitat, and allow that more area may need to be set aside to mitigate the risk of stand replacing natural disturbance events (such as fire) in drier portions of the range.*

SOMP2 includes over 53,000 ha of WHAs as Managed Future Habitat Areas to act as ready replacements or recruitment areas in the event of catastrophic loss. Further, Under FRPA, WHAs can be modified or created to address catastrophic loss.

- *Consider minimizing fragmentation of Type A and Type B habitat areas within territories because this can both limit the success of a territory and can reduce the overall land area needed to manage in reserves (i.e., territories become more compact).*

SOMP2 was informed by the Integrated Habitat Quality map and RLM output using Biological only criteria to prioritize inclusion of contiguous landscapes with high quality habitats over fragmented landscapes and low quality habitats. SOMP2 eliminated the 67% rule to capture current and plan for in the future contiguous landscapes of suitable habitat (Type A and B).

- *Make consistent management decisions range-wide, while retaining opportunities for flexibility where appropriate (particularly to allow for replacement areas if critical habitat is lost to natural disturbances)*

SOMP2 applied the Conservation Principles presented in A Conservation Strategy for the Northern Spotted Owls (Thomas et al. 1990) throughout the species' range. SOMP2 also include over 53,000 ha of WHAs as Managed Future Habitat Areas to act as ready replacement or recruitment areas in the event of catastrophic loss.

- *Consider that habitat management decisions must be made now to provide desirable future habitat supply to meet the recovery goal.*

SOMP2 was informed by the Integrated Habitat Quality map and RLM output using biological only criteria to prioritize WHA establishment to meet current and future recovery habitat.

- *In the new range-wide habitat plan, consider how to balance the function of standard management units (e.g., LTACs) against the range of variability in territory sizes observed in naturally occurring populations where a minimum amount of habitat is needed for a breeding territory and the likely success of that territory increases as habitat becomes more concentrated/less fragmented.*

SOMP2 prioritized the protection of large contiguous landscapes of high-quality habitat capable of supporting multiple breeding territories. These large habitat areas can accommodate for fluctuations in owl home range sizes. Further, SOMP2 increase the amount of habitat protected within Long-term Owl habitat WHAs from 67% retention (SOMP1) to habitat 100% retention.

Accordingly, the Spotted Owl Recovery Team recommends the following prescriptions for planning for Spotted Owl critical habitat/protected areas:

1. *Priority for habitat protection should be based on an area's history of occupancy.*

SOMP2 considered the current and historic locations of Spotted Owls.

2. *Cluster territories and maintain/enhance connectivity.*

SOMP2 prioritized creating large clusters of potential breeding territories around high-quality habitats (as identified by the Integrated Habitat Quality maps) that were spaced less than 15.5 km apart to facilitate movement of owls between clusters.

3. *Consider using the existing SOMP mean territory size of 3200 ha throughout the species range in British Columbia as a <u>minimum</u> default standard until a new range-wide habitat management plan has been developed.*

SOMP2 used the mean suitable habitat requirements for a breeding territory as modeled by CSORT.

4. *Consider continuing to protect 67% suitable habitat within territories as the <u>minimum</u> default standard throughout the species' range in British Columbia until a new range-wide habitat management plan has been developed.*

SOMP2 increased the amount of suitable habitat protection within each potential breeding territory from 67% retention (SOMP1) to 100% retention within Long-term Owl Habitat Area WHAs.

5. *Where practicable, do not allow any further habitat removal from prescribed territories, except to assist in recruiting/restoring suitable habitat.*

BC established GAR Orders that legally prohibit the destruction of suitable habitat within Long-Term Owl Habitat Area WHAs. The GAR Order enable recruiting and enhancing

forests to become suitable habitat. Long-Term Owl Habitat Area WHAs and other protected areas are the primary habitat areas to attain the habitat recovery target for 125 breeding territories.

6. *Where practicable maximize the amount of Type A habitat in territories.*

SOMP2 prioritized, where practicable, the protection of Type A (nesting) Habitat.

7. *Consider ongoing updating, enhancing and testing of the habitat model.*

SOMP2 is updated frequently with newer versions of the Vegetative Resource Inventory (VRI). Further, GPS monitoring of release captive born owls can be used to determine habitat requirements and test habitat models.

SOMP2: CRITICAL HABITAT

The following considerations were applied to identify Critical Habitat under SOMP2.

1. The mapped Integrated Habitat Quality:

   - The Integrated Habitat Quality maps and associated Resource Units were based on a closed population and did not consider connectivity to the owl populations in the United States. This assumption may have biased the distribution of habitat quality (i.e., the Chilliwack Valley is ranked low quality), as the model did not consider the importance of connectivity. As per CSORT's advice, connectivity to the USA should be considered in the identification of Critical Habitat.
   - The Integrated Habitat Quality maps and associated Resource Units were based on the location of Spotted Owl found in 2004 and 2005. This assumption may have biased the distribution of habitat quality (e.g., Rogers Creek is ranked one of the highest quality habitats as it was an initiation point in the model, yet no resident Spotted Owl was ever confirmed at this location). As per CSORT's advice, current and historic owl locations should be considered in the identification of Critical Habitat.
   - Based on habitat supply, the Integrated Habitat Quality model and associated Resource Units ranked the Squamish to Pemberton corridor as high for recovering Spotted Owls. Though this corridor is likely needed for long-term species recovery, no Spotted Owls have been detected within this corridor (despite a historic record of a Spotted Owl nest cut down in Whistler). As such, prioritizing this area for immediate Critical Habitat protection may not be warranted in the short-term.

   Despite these considerations above, it is clear, through the various modeling outputs, that the Spotted Owl population is divided into 3 isolated populations and that each contains an abundance of high-quality habitat.

2. Revisions to SOMP1 were to achieve a no-net loss of suitable habitat or timber supply. As stated previously, CSORT opinion was *"The Spotted Owl Management Plan allocated 363,000 hectares of habitat for Spotted Owl management, which theoretically could be enough to maintain a sustainable population. However, current habitat conditions of these areas may be too fragmented to allow for effective connectivity of subpopulations, re-colonization of currently vacant habitat, and juvenile dispersal."* (Chutter et al. 2007). As

such, revision to SOMP1 prioritized higher-quality habitats that are well distributed across the 3 isolated populations to maintain a sustainable population of 250 adult Spotted Owls.

Protected Critical Habitats

The following is a brief overview of the prioritization and protection of Critical habitat under SOMP2.

Coastal Population:

As the majority of high-quality habitats are already protected within the Metro Vancouver Watersheds, Provincial Parks and other protected areas, no further actions were taken.

Fraser Population:

The Integrated Habitat Quality Map at year 0 (Figure AB8) and 50 (Figure AB9) clearly demonstrated that high-quality habitat occurs from the Skagit Valley (Canada-USA border) to the Nahatlatch Lakes area. The maps also clearly demonstrated that habitats protected for Spotted Owls under SOMP1 in the Harrison Lake area remained low quality (coloured yellow) for the 50-year duration. As such, to meet immediate and short-term recovery objectives, habitat protection measures within low-quality habitat in the Harrison Lake area were removed and applied within high-quality habitats.

To protect Critical Habitat within high-quality habitat areas, management actions taken were to:

- Infill managed areas to increase habitat protection from 67% retention (SOMP1) up to 100% retention.
- Protect a large cluster of potential breeding territories in the Nahatlatch River and Lakes area
- Protect additional habitat to the Anderson managed area to include the known owl site at Siwash Creek.

In addition, to address connectivity to the USA along the foothills of the western Cascade Mountains, additional habitat protection was afforded to known Spotted Owl locations at Greendrop Lake, Chilliwack Lake and Liumchen Lake.

To support dispersal distances between large managed area, single breeding territories, capable of providing all life requisites to sustain a breeding territory, were established at Nahatlatch Bench, Mohowkum Creek and Elk Creek.

Lillooet Population

Most of the high-quality habitat occurs along the Lillooet River between Harrison Lake and Pemberton, and north of Pemberton along the Birkenhead and Gates Rivers. Due to the linear distribution of this habitat and the corresponding linear distribution of managed areas, the option to convert entire managed areas to either LTOHA or MFHA, as in Chilliwack, is not feasible without jeopardizing connectivity. As such, the emphasis was to establish 100% LTOHA over large portions of each managed area that contained higher proportions of high-quality habitat and/or had current or previously known resident Spotted Owls. In exchange, areas with lower proportions of habitat quality habitat were converted to MFHA.

Cascades Forest District

In the Cascades Forest District, known Spotted Owl breeding territories were fully protected prior to SOMP2. To facilitate better connectivity, additional breeding territories were established along Anderson Lake, Mohowkum Creek, and Nesikep.

Squamish to Pemberton Corridor

Despite an abundance of high-quality habitats within the Squamish to Pemberton corridor, SOMP2 prioritized the short-term protection of high-quality habitats in areas where current and historic occurrences (since 1985) of Spotted Owls were known. Since known Spotted Owl occurrences were pre-1985 within this corridor, no additional habitat were protected, except for the establishment of WHA-MFHA to enable the future recruitment of this area.

Amount and Distribution of Protected Critical Habitat

Under SOMP2, Critical Habitats are protected within legally established Wildlife Habitat Areas call Long-term Owl Habitat Areas, Provincial Parks, Metro Vancouver Watersheds and other protected areas. Combined, this represents an area of 310,490 of which 281,272 ha are identified by BC ‘s Suitable Habitat model as nesting, foraging and recruitment habitat.

Applying a 25% territory overlap between adjacent territories and using the median area of suitable habitat (nesting and foraging) needed for a Spotted Owl breeding territory, it is estimated that these protected habitats could currently support up to 93 breeding territories (Table AB2), greater than needed for the Survival Target of 50 breeding pairs. Over time, as habitat recruits into suitable habitat, these protected habitats may support up to 132 breeding territories. Both estimates do not include non-territorial owls, which are a significant portion of the population. At full recovery, these protected habitats, in theory, may satisfy CSORT’s minimum population target of 250 mature Spotted Owls.

In addition to these protected habitats, 49,257 ha of suitable and recruitment Spotted Owl habitat were established as Wildlife Habitat Areas - Managed Future Habitat Areas (WHA - MFHA) for future habitat recovery consideration (such as replacement areas for catastrophic loss due to fire). Though these areas provide for short-term timber harvesting opportunities, these areas contain 24,994 ha of nesting and foraging habitat. Applying the same territory calculation above, these WHAs can currently support up to an additional 14 breeding territories. As timber harvest is allowed within MFHA, it’s contribution to potential breeding territories was not considered in the future habitat conditions. However, it is expected that the MFHA will provide some additional habitat as not all of the areas within MFHA are harvestable (e.g., approximately 21% of MFHA is under highly restrictive forest constraints).

Table AB2. Estimated number of potential breeding territories within SOMP2.

Estimated number of potential territories* within the SOMP2	Current Conditions	Future Conditions
	Territory overlap 25%	Territory overlap 25%
Protected Habitats (Parks/WHA-LTOHA)	93	132
Managed Habitats (WHA-MFHA)	14	tbd
Total	**107**	**132**

***** Based on the mean amount of nesting and foraging habitat needed per breeding territory (3,010 ha, 2,224 ha, and 1,907 ha for Maritime, Sub-maritime and Continental Ecosystems, respectively).

Table AB3 represents the distribution of protected areas across the 3 populations. The number of potential breeding territories meets and exceeds the minimum 20 breeding territory recovery objectives to support each of the three isolated population. The true number of Spotted Owl that may occupy forests within the habitat plan is unknown. Many factors, such as predators, Barred Owls, and prey densities, as well as habitat quality and quantity, will influence the level of occupancy and density of territorial Spotted Owls.

Table AB3. Estimated numbers of current and future potential territories capable within protected areas for each Sub-population.

Sub-population	Total Forested Area	Suitable habitat	Percent Suitable	Current Potential Territories	Future Potential Territories
Coastal	98,819	57,889	59%	23	40
Fraser	127,762	95,314	75%	50	69
Lillooet	54,691	44,586	82%	20	27
Total	281,272	197,869	70%	93	136

Connectivity of Managed Areas:

The dispersal of owls between managed areas is essential to recover and sustain the population as dispersing individuals may re-occupy vacant habitats and/or rescue locally extirpated portions of the species range. As well, dispersing individuals may find mates that maintain genetic diversity among the population and may prevent genetic depression in localized portions of the species range. As such, a biological objective applied was to place population units that are located less than 15.5 km apart for an adjacent population unit.

To determine the inter-connectedness of the 31 population units, the distance, edge to edge, of the first, second and third closest neighboring population unit was calculated (Table AB4). In the analyses, 3 managed areas in the US were considered; two of which are connected with managed areas in BC. Of most significance, the 35,900 ha LTOHA in the Skagit Valley is connected to the 30,500 ha Managed Owl Conservation Area (MOCA) on the US side of the Skagit Valley to create a 66,600 ha habitat patch capable of supporting up to 39 breeding territories over time.

For the most part, both the first and second nearest neighboring managed area are well within the objective of 15.5 km inter-distance between adjacent managed area. Most “third neighbors”

are situated further than 15.5 km, in part due to the linear nature of the habitat plan. In some circumstances, to reach the “third neighbor” requires travelling through the managed area of a “first” or “second” closest neighbor. Despite this, the close proximity of managed areas to their closest neighbors suggests that successful movements between adjacent managed areas are likely to occur.

Table AB4. Mean, Median and range of distances between the 31 population units and their first, second and third nearest neighboring population units.

	First Neighbor	**Second Neighbor**	**Third Neighbor**
Mean	6.7 km	11.3 km	19.0 km
Median	6.3 km	10.0 km	17.5 km
S.D.	4.4 km	5.6 km	6.6 km
Range	0 - 18.0 km	3.0 - 25.5 km	5.0 - 32.0 km