

COSEWIC
Assessment and Update Status Report

on the
Spotted Owl
Strix occidentalis caurina

Caurina subspecies

in Canada



ENDANGERED
2008

COSEWIC
Committee on the Status
of Endangered Wildlife
in Canada



COSEPAC
Comité sur la situation
des espèces en péril
au Canada

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The Spotted Owl *Strix occidentalis caurina* was previously known as the Northern Spotted Owl *Strix occidentalis caurina*.

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COSEWIC Assessment Summary

Assessment Summary – April 2008

Common name

Spotted Owl – *Caurina* subspecies

Scientific name

Strix occidentalis caurina

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.

Occurrence

British Columbia

Status history

Designated Endangered in April 1986. Status re-examined and confirmed in April 1999, May 2000, and April 2008.



COSEWIC
Executive Summary

Spotted Owl
Strix occidentalis caurina

Caurina subspecies

Species information

The Northern Spotted Owl (*Strix occidentalis caurina*) is the subspecies of Spotted Owl that occurs in Canada. It is a medium-sized owl averaging 45 cm long and 90 cm wingspan. It is a dark-plumaged owl with dark eyes, lighter facial discs and no ear tufts. It is genetically distinct from other subspecies and from its co-existing congener the Barred Owl, even though hybridization occurs occasionally.

Distribution

The Spotted Owl occurs in western North America from southwestern British Columbia to Mexico. The Northern Spotted Owl subspecies occurs from the southwest mainland of British Columbia through western Washington, western Oregon and the coast ranges of northern California. The entire Canadian population of the Northern Spotted Owl occurs in about 32,800 km² in the southwest mainland of British Columbia.

Habitat

The Northern Spotted Owl occurs in coniferous forests with an uneven-aged, multi-layered canopy that includes numerous large trees with broken tops, deformed limbs and large cavities, and numerous large snags and accumulations of logs and downed woody debris. Wildlife trees such as broken large diameter trunks, cavities in large trees, or old stick nests of other birds are used for nests. A wider range of habitat is used for foraging compared to nesting. It has a narrow thermal neutral zone (e.g., has a low temperature-range tolerance). Habitat has declined since European settlement, continues to decline today and is forecast to decline for another 20 years. Most currently active sites are within protected areas or are protected by special government orders, but government-approved logging continues within some active sites.

Biology

The Northern Spotted Owl is a long-lived bird with low reproductive potential. It is normally monogamous, resident, lays one or two eggs and fledges one or two young when it breeds. Pairs do not typically nest every year. Young leave the nest in British Columbia from 9-26 June. Fledged young remain near the nest through August and to late September before dispersing. Mortality of juveniles during dispersal is very high. Main foods in British Columbia are northern flying squirrel and Bushy-tailed woodrat. Home ranges in British Columbia are about 2000 to 3000 ha.

Population sizes and trends

Survey effort was almost non-existent before 1985. Inventory began in 1992 and trends were monitored between 1992 and 2001. Intensive survey effort continued from 2002 through 2006. Total Canadian population was estimated to be about 500 pairs prior to European settlement, < 100 pairs by 1991, and < 30 pairs by 2002. Recent surveys found 17 active sites with 25 birds in 2004, 17 sites with 24 birds in 2005, 14 sites with 17 birds in 2006, and 14 sites with 19 birds in 2007. Without increased habitat protection and direct population augmentation, extirpation is now seemingly inevitable and appears likely to occur by 2012 if present trends continue.

Limiting factors and threats

Limiting factors include low annual productivity, high juvenile mortality, lack of recruitment in recent years, very low densities and large distances between active sites, loss and degradation of habitat, presumed reduced emigration from the USA, and competition from Barred Owls. Threats include continued degradation of habitat by logging and human development, degradation of habitat by wildfires and insect outbreaks, hybridization with Barred Owls, and increasing predation from raptors that favour more fragmented forests.

Special significance of the species

The Northern Spotted Owl is among the most studied owl species in the world and is an environmental icon in Canada and the USA. The Northern Spotted Owl is a high-level predator with specialized habitat requirements. It is at the top of the food chain in some late-successional coniferous forest ecosystems on the west coast of North America.

Existing protection or other status designations

Most active sites are protected within Provincial Parks or other protected areas. The Spotted Owl Management Plan covers 363,000 ha of land (about half of which is protected in parks) in 19 Special Resource Management Zones (SRMZs) specifically managed as habitat for Spotted Owls. Additional areas are protected as temporary Matrix areas (8 areas) which will be phased out over 50 years, or by Wildlife Habitat Areas recently created to conserve nine sites, eight of which were already SRMZs. A newly announced 5-year Spotted Owl Management Plan hopes to maintain this species in Canada. A national Recovery Strategy has been prepared and has now been posted on the SARA public registry.

The Northern Spotted Owl is on the British Columbia Red List and is protected in British Columbia under the BC Wildlife Act. Habitat may also be protected by Identified Wildlife Management Strategy provisions under the Forest and Range Practices Act, and Old-Growth Management Areas. In Canada, it is listed on Schedule 1 of SARA and COSEWIC has assessed it as Endangered in 2000.



COSEWIC HISTORY

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) was created in 1977 as a result of a recommendation at the Federal-Provincial Wildlife Conference held in 1976. It arose from the need for a single, official, scientifically sound, national listing of wildlife species at risk. In 1978, COSEWIC designated its first species and produced its first list of Canadian species at risk. Species designated at meetings of the full committee are added to the list. On June 5, 2003, the *Species at Risk Act* (SARA) was proclaimed. SARA establishes COSEWIC as an advisory body ensuring that species will continue to be assessed under a rigorous and independent scientific process.

COSEWIC MANDATE

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assesses the national status of wild species, subspecies, varieties, or other designatable units that are considered to be at risk in Canada. Designations are made on native species for the following taxonomic groups: mammals, birds, reptiles, amphibians, fishes, arthropods, molluscs, vascular plants, mosses, and lichens.

COSEWIC MEMBERSHIP

COSEWIC comprises members from each provincial and territorial government wildlife agency, four federal entities (Canadian Wildlife Service, Parks Canada Agency, Department of Fisheries and Oceans, and the Federal Biodiversity Information Partnership, chaired by the Canadian Museum of Nature), three non-government science members and the co-chairs of the species specialist subcommittees and the Aboriginal Traditional Knowledge subcommittee. The Committee meets to consider status reports on candidate species.

DEFINITIONS (2008)

Wildlife Species	A species, subspecies, variety, or geographically or genetically distinct population of animal, plant or other organism, other than a bacterium or virus, that is wild by nature and is either native to Canada or has extended its range into Canada without human intervention and has been present in Canada for at least 50 years.
Extinct (X)	A wildlife species that no longer exists.
Extirpated (XT)	A wildlife species no longer existing in the wild in Canada, but occurring elsewhere.
Endangered (E)	A wildlife species facing imminent extirpation or extinction.
Threatened (T)	A wildlife species likely to become endangered if limiting factors are not reversed.
Special Concern (SC)*	A wildlife species that may become a threatened or an endangered species because of a combination of biological characteristics and identified threats.
Not at Risk (NAR)**	A wildlife species that has been evaluated and found to be not at risk of extinction given the current circumstances.
Data Deficient (DD)***	A category that applies when the available information is insufficient (a) to resolve a species' eligibility for assessment or (b) to permit an assessment of the species' risk of extinction.

* Formerly described as "Vulnerable" from 1990 to 1999, or "Rare" prior to 1990.

** Formerly described as "Not In Any Category", or "No Designation Required."

*** Formerly described as "Indeterminate" from 1994 to 1999 or "ISIBD" (insufficient scientific information on which to base a designation) prior to 1994. Definition of the (DD) category revised in 2006.



Environment Canada
Canadian Wildlife Service

Environnement Canada
Service canadien de la faune

Canada

The Canadian Wildlife Service, Environment Canada, provides full administrative and financial support to the COSEWIC Secretariat.

**Update
COSEWIC Status Report**

on the

Spotted Owl
Strix occidentalis caurina

Caurina subspecies

in Canada

2008

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SPECIES INFORMATION

Name and classification

Scientific name: *Strix occidentalis caurina* Xántus 1859

English name: Spotted Owl

French name: Chouette tachetée

Classification: Class – Aves
Order – Strigiformes
Family – Strigidae
Genus – *Strix*
Species – *occidentalis*
Subspecies – *caurina*

Classification follows the American Ornithologists' Union (AOU 2005). First described by Xántus (1859), there are now three widely recognized subspecies (Dawson *et al.* 1986), which are based mainly on range and morphological variations (slight differences in size and plumage colouration): the Mexican Spotted Owl (*Strix occidentalis lucida* Nelson 1903), the California Spotted Owl (*Strix occidentalis occidentalis* Xantus 1859) and the Northern Spotted Owl (*Strix occidentalis caurina* Merriam 1898). Recent genetic analyses have reconfirmed these subspecies (Haig *et al.* 2001; Courtney *et al.* 2004). Only the Northern Spotted Owl occurs in Canada.

The Spotted Owl is one of three *Strix* owl species in Canada; the other two are Great Gray Owl (*Strix nebulosa*) and Barred Owl (*Strix varia*).

Vernacular names: n/a

Morphological description

The Northern Spotted Owl is a medium-sized owl averaging 45 cm long and 90 cm wingspan. Plumage is dark overall with dark brown feathers patterned by small roundish pale spots over most of the body. The tail has 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 classes can be identified by differences in plumage characteristics. Juveniles < 5 months old are identified by visible down feathers (Forsman 1981). After 5 months, juveniles moult downy feather and look similar to adults. Sub-adult (1 - 2 years old) and adult (older than 2 years) owls may be identified by differences in tail feathers. Juveniles and sub-adults (1-2 years) have pointed tail feathers with white tips whereas adult tail feathers are rounded and usually mottled in colour (Forsman 1981). Male and females have similar plumage but females are about 15% larger (female mean weight = 663 g, male mean weight = 579 g, Blakesley *et al.* 1990).

Genetic description

Genetic structure analyses in the three geographically defined subspecies of Spotted Owl have been conducted on USA populations. Sequences (522 bp) from domains I and II of the mitochondrial control region were analyzed for 213 individuals from 30 local USA breeding areas. Results confirmed significant differences between Northern Spotted Owls and the other two subspecies but did not provide support for subspecific level differences between California and Mexican Spotted Owls. Divergence times for Northern and California/Mexican Spotted Owls were calculated to be 115,000–125,000 years ago. The genetic analysis showed a zone of contact between Northern and California Spotted Owls in California but the zone is stable with distinct subspecific haplotypes elsewhere in their respective ranges (Haig *et al.* 2004), presumably also including Canadian Northern Spotted Owls. These findings were different from a study that combined nuclear and mitochondrial analyses and concluded that Mexican Spotted Owls were genetically distinct from a genetically overlapping Northern/California Spotted Owl group (Barrowclough and Gutierrez 1990; Haig *et al.* 2001).

Mitochondrial DNA sequences indicated large divergence between the closely related Barred Owl (which is now hybridizing with Northern Spotted Owls) and Spotted Owls. Diagnostic AFLP bands indicated extensive genetic divergence between the species, including markers differentiating them. Hybrids have unique genetic combinations, including AFLP markers from both parental species. Most hybrids genetically sampled resulted from crosses between female Barred Owls and male Spotted Owls (Haig *et al.* 2004).

Designatable units

Not applicable.

DISTRIBUTION

Global range

The Spotted Owl occurs in western North America from southwestern British Columbia to Mexico. The Northern Spotted Owl subspecies occurs from the southwest mainland of British Columbia through western Washington, western Oregon and the coast ranges of California to San Francisco Bay (Figure 1). The species occurs from the Pacific Ocean east to the eastern slopes of the Cascade Mountain Range, and can be found from sea level up to 2,250 m in elevation in southern portions (USDI 1992) and up to 1,370 m in northern portions of its range. Although the current range is similar to the historic range, the distribution and abundance of Northern Spotted Owls within this range has been significantly altered (USDI 1992; USFWS 2007).

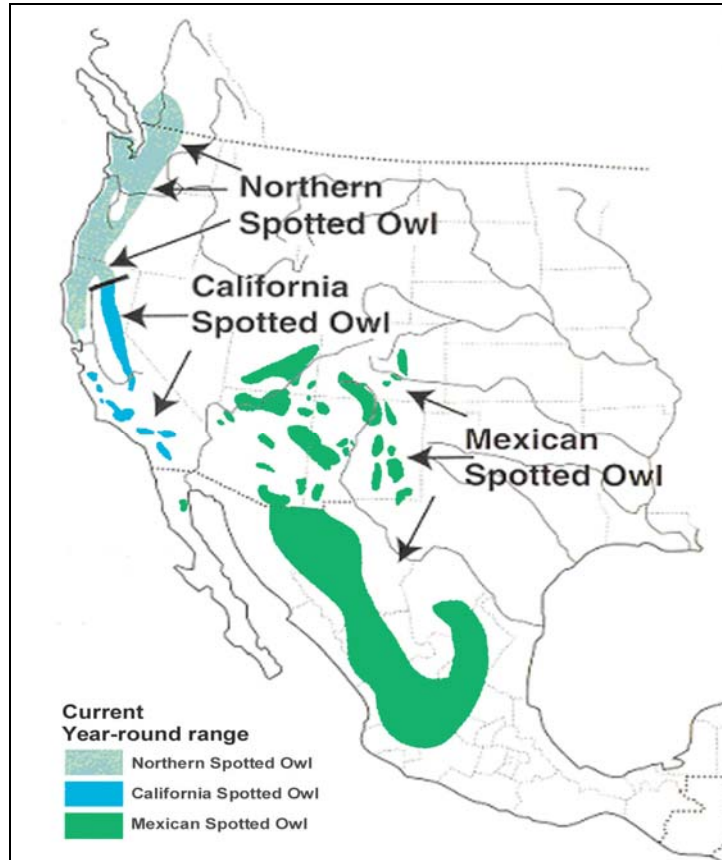


Figure 1. Distribution of the Spotted Owl in North America. (Chutter *et al.* 2004; adapted from Gutiérrez *et al.* 1995).

Canadian range

In Canada, the range of the Northern Spotted Owl is restricted to British Columbia (Godfrey 1986; Campbell *et al.* 1990). The entire Canadian population of the Northern Spotted Owl occurs in about 32,800 km² in the southwest mainland of British Columbia (Harestad *et al.* 2004), from the international border north 200 km to Carpenter Lake, west to Howe Sound, and east to near Lillooet and eastern Manning Park, just beyond the height of land of the Cascade Mountain Range.

Two historic records (Laing 1942) of Northern Spotted Owls as far northwest as Bute Inlet, on the mainland coast, were discounted because specimens were not collected and the observations were only audible detections (Dunbar and Blackburn 1994). Between 1985 and 2005, Northern Spotted Owls had been observed at 72 different locations in British Columbia (Chutter *et al.* 2007).

Canadian Northern Spotted Owl populations are continuous with populations in Washington; however, this linkage has been severely reduced by forestry, urban, and agricultural uses that has limited the connectivity to the foothills of the Cascade Mountain range. Large gaps in distribution occur within the Canadian range (Harestad *et al.* 2004). Northern Spotted Owls formerly occurred in much of the lower Fraser River valley but no longer do so because suitable habitat has been largely replaced by human development. It is likely that this owl formerly nested in the Greater Vancouver Regional District watersheds but is apparently absent now. Northern Spotted Owls are also absent from much of the Squamish River/Whistler area (Blackburn and Godwin 2003). Other portions of its range have concentrations of records: Pemberton to Lillooet area and Chilliwack Lake north through the Fraser Canyon area (Harestad *et al.* 2004).

HABITAT

Most previous habitat suitability descriptions have been extrapolated from research in Washington (Hanson *et al.* 1993, SOMIT 1997a). There are two general ecosystems used by Northern Spotted Owls in Washington and British Columbia: wetter ecosystems on the west slope of the Cascade Range and drier ecosystems on the eastern slopes of the Cascade Range. In British Columbia, Northern Spotted Owls occupy habitats found largely within 3 broad ecosystems: maritime Coastal Western Hemlock (CWH), sub-maritime CWH, and Interior Douglas fir (IDF) biogeoclimatic zones (Meidinger and Pojar 1991, SOMIT 1997a).

Very recently, considerable effort has been expended on developing a habitat model for British Columbia. The Canadian Spotted Owl Recovery Team (CSORT; Chutter *et al.* 2007) has grouped habitat types into three ecologically based subregions: maritime, sub-maritime or continental. In British Columbia, high-quality habitat tends to be in forests >200 years old, at elevations below 1200 m and with large amounts of large diameter and tall trees (Chutter *et al.* 2007). The most recent habitat model and supply analysis for British Columbia is provided by Sutherland *et al.* (2007).

Throughout its range, the Northern Spotted Owl occurs in mixed coniferous forests with an uneven-aged, multi-layered canopy that includes numerous large trees with broken tops, deformed limbs and large cavities, and numerous large snags and accumulations of logs and downed woody debris (Thomas *et al.* 1990; USDI 1992). In moister parts of the range, these habitat characteristics are found naturally in late seral and old-growth forests. In drier parts of their range, including British Columbia, owls have been observed in some younger forest stands where structural components typical of old-growth forests have been created by disturbances such as fire, wind or selective logging (Dunbar and Blackburn 1994; Buchanan *et al.* 1995).

Forest structure is more important than actual forest age when defining suitable Northern Spotted Owl habitat. In the southern part of its global range (northern California), Northern Spotted Owls can be found in younger-aged stands (< 100 years old) than further north in Washington and British Columbia. Longer growing seasons, different tree species and good site conditions in southern parts of the owl's range can provide old-growth-like structural components of owl habitat (e.g., large diameter trees and snags, multilayered canopies, and large woody debris) sooner than similar aged forests further north (Forsman 2003).

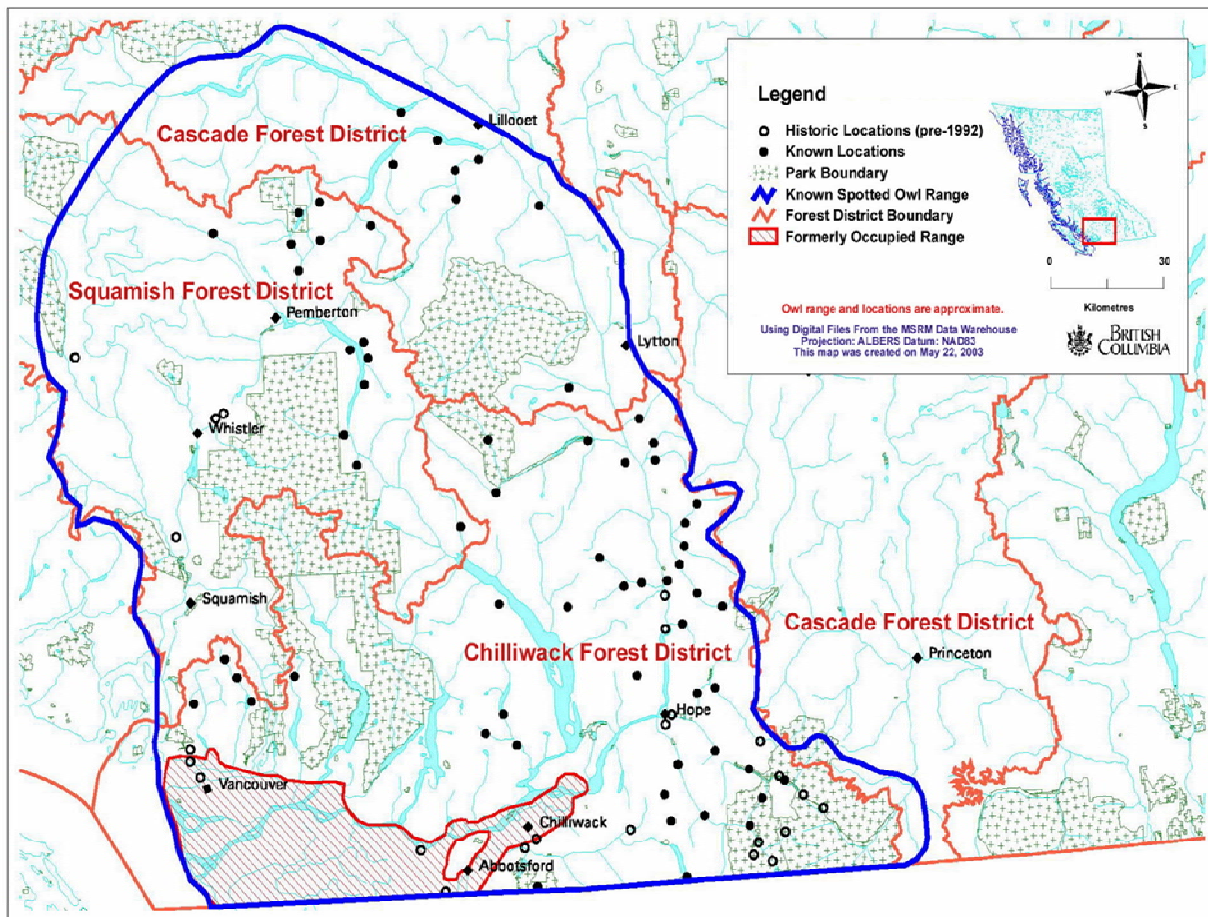


Figure 2. Former distribution of the Northern Spotted Owl in British Columbia (Chutter *et al.* 2007).

Breeding habitat

Northern Spotted Owls primarily use old-growth trees for nesting, either in old-growth stands or in remnant old-growth patches (Thomas *et al.* 1990; Forsman and Giese 1997; Ripple *et al.* 1997). Nest sites are typically located in dense, multi-layered, older forests with 85-90% canopy closure (Gutiérrez *et al.* 1995). Occasionally some of these characteristics are lacking, particularly in the drier, eastern parts of their range (Buchanan *et al.* 1995).

Northern Spotted Owls do not build their own nest, but depend on naturally occurring nest sites. Nest sites include broken treetops, tree cavities resulting from heart rot, abandoned raptor nests, mistletoe brooms, squirrel nests, and debris accumulations (Forsman *et al.* 1984; Dawson *et al.* 1986; Fenger *et al.* 2006). In Oregon, most nests were in tree cavities (64%) with the remainder on platforms, and average height above ground for nests was 27 m (range 10-55 m) (Forsman *et al.* 1984). A variety of different trees are used for nesting, suggesting the presence of structures (i.e., cavities or platforms) is more important than tree species in nest site selection (Forsman and Giese 1997). Pairs may reuse the same nest each year or use alternate nest sites (Gutiérrez *et al.* 1995; Hobbs 2004, 2005). In Washington, cavities tend to be used for nests on the coast and platforms tend to be used in the drier interior (Forsman and Geise 1997).

In British Columbia, Northern Spotted Owl nests have been found in the cavities of living western red cedar (*Thuja plicata*), western hemlock (*Tsuga heterophylla*) and Douglas-fir (*Pseudotsuga menziesii*) as well as in the top of Douglas-fir snags and on platforms in Douglas-fir trees. Most nests (n=12) were in hollows on top of broken tree stems (n=6), cavities at broken branches (n=3), in mistletoe (n=1) and in an old Northern Goshawk nest (n=2) (Manley *et al.* 2004; Hobbs 2004, 2005). The first nest ever reported for North America in a black cottonwood (*Populus balsamifera trichocarpa*) was found in British Columbia in 2004 (Hobbs 2005). Nests ranged from 5.1 to 38 m in height above ground. Nest trees in BC ranged from 50-131 cm dbh in live (n=6) or dead trees (n=5) (Manley *et al.* 2004).

In British Columbia, nests sites were found in four Biogeoclimatic variants: Southern Dry Submaritime Coastal Western Hemlock, submontane very wet maritime CWH, Wet Warm Interior Douglas-fir, and Cascade Dry Cool Interior Douglas-fir. Nests were at elevations ranging from 368-1130 m, were on steep or moderately steep slopes (mean 53% slope). In Interior Douglas-fir zones nest slopes had southeast to southwest aspects. In Coastal Western Hemlock zones aspects were north to east. Nine nests were in older forest structural stages, and two nests in the IDF were in mature age classes. Crown closure ranged from 15-70% with a mean of 48%. Decaying wood and rock were dominant substrates at nest patches (Manley *et al.* 2004).

Foraging habitat

Northern Spotted Owl foraging habitat is characterized by high canopy closure and complex structure (Gutierrez *et al.* 1995). Owls tend to concentrate their foraging in old-growth or mixed-aged stands of mature and old-growth trees, but use a wider variety of habitat for foraging than for nesting or roosting (Thomas *et al.* 1990). Telemetry studies in Oregon and Washington suggest that old-growth forests are superior habitat for Northern Spotted Owl foraging. Mature stands were found to be less suitable habitat than old-growth, young stands provided marginal habitat and clear-cuts were unsuitable habitat (Thomas *et al.* 1990; Forsman *et al.* 1984; Carey *et al.* 1990; Carey *et al.* 1992).

Northern Spotted Owls forage mainly in older stands (Carey *et al.* 2002). Prey may or may not be more abundant in old-growth stands versus second growth as studies have shown contradictory or no data for primary prey species (Ransome and Sullivan 2003; J. Hobbs pers. comm.). However, the structural characteristics of old growth stands, such as multi-storied canopy which provide thermoregulation opportunities and stand openness likely makes prey more available in these situations.

Roost habitat

Spotted Owls have a narrow thermal neutral zone (Ganey *et al.* 1993; Weathers *et al.* 2001) and appear to select sheltered roosts to avoid poor weather, summer heat, predation and harassment by corvids and passerines (Barrows and Barrows 1981; Barrows 1981; Forsman 1980; Forsman *et al.* 1984, Herter *et al.* 2002; Courtney *et al.* 2004). During warm weather, Spotted Owls seek roosts in shady recesses of understory trees and occasionally will even roost on the ground (Barrows and Barrows 1981; Forsman *et al.* 1984; Gutiérrez *et al.* 1995). In winter, they roost relatively high in large trees near the trunk with overhanging branches to shelter themselves from precipitation.

Roost sites in Washington and Oregon were mostly in old-growth forest stands (88%) but some were in mid-seral forests (11%) (Carey *et al.* 1992). Roosts were typically in areas of relatively dense vegetation with high canopy closure. During summer, roosts are usually in cool, shady areas on the lower third of slopes (Blakesley *et al.* 1992). Owls respond to variation in temperature by moving within the canopy to find favourable microclimates and multi-storied stands facilitate this movement (Barrows 1981). Roost site selection varies seasonally, with cooler aspects (north, northeast and east) favoured in the summer, and warmer aspects (south and southwest) favoured in the spring and fall (Carey *et al.* 1992).

In British Columbia, Northern Spotted Owls tend to roost during the breeding season in larger conifers near nests within stands of older age classes but may occasionally use thickets of younger conifers (Hobbs 2002). Multi-year roost site fidelity has been confirmed in British Columbia (J. Hobbs pers. comm.)

Dispersal habitat

Juvenile owls are obligate dispersers that leave their parent's territory in the fall. To be successful, dispersing juveniles must find habitats that provide protection against predators and inclement weather, and provide available prey to sustain dispersing individuals. Old and mature forests are thought to provide ideal conditions for dispersal (Hanson *et al.* 1993). However, dispersing owls use a fragmented mosaic (unlike habitat used for other functions) of various-aged forests, clearcuts, roads, and non-forested areas (Forsman *et al.* 2002a).

Dispersal of juveniles tends to occur in random directions and juveniles travel variable distances (91% < 50 km; range 0.6-111 km) before settling on territories (Forsman *et al.* 2002a). Breeding-age owls also occasionally disperse, especially young females who have lost their mate. These movements may be to new territories or back and forth movements between alternate territories (Forsman *et al.* 2002a).

The quality (stand structure, degree of fragmentation, topography) of dispersal habitat is likely an important factor in survival of dispersing birds (Lamberson *et al.* 1992; Miller *et al.* 1997). Large non-forested valleys (e.g., such as the Lower Mainland of British Columbia in its current state) are known to act as barriers to dispersal (Forsman *et al.* 2002a).

In British Columbia, radio-telemetry data from 7 dispersing juveniles confirmed their use of old forest habitats during that life stage (Hobbs 2004, 2005). This study also showed that dispersing juveniles were able to negotiate their way through some sub-optimal habitats such as early seral forest, severely burned areas, and across large waterbodies (Hobbs 2005), although US research showed decreased survival with increased use of fragmented forest for dispersal (Lamberson *et al.*, 1992).

Habitat trends

Historical trends

Before European settlement, the amount of suitable habitat in southwestern British Columbia likely remained relatively stable notwithstanding habitat manipulations by First Nations peoples and by natural disturbances. Blackburn and Godwin (2003) estimated that about 67% (881,000 ha) of the 1,320,000 ha historic forested areas was suitable habitat (forests older than 100 years) in the Chilliwack and Squamish Forest Districts. Since the mid-1800s, timber harvesting for urbanization, agriculture and resource extraction has occurred in this area. Almost all of the forest in the lower Fraser River Valley has been converted to non-forest uses. It is estimated that about 639,000 ha (48% of total historic capable forested area) of suitable habitat currently exists within the two forest districts. This represents a 242,000 ha (28%) reduction in the amount of suitable habitat thought to occur historically, of which about 1/3 is permanently lost from the lower Fraser River Valley (I. Blackburn pers. comm.). Very recently, CSORT has stated there is 534,442 ha of suitable habitat (282,427 ha of nesting habitat and 251,995 ha of foraging habitat (Chutter *et al.* 2007); however, only 395,000 ha are in large enough patches to be suitable habitat for Northern Spotted Owls.

Changes to the distribution and quality of habitat in the landscape have a greater impact than the mere % loss of habitat. Although some impact of habitat loss has been offset by the recruitment of suitable habitat from maturing young forests much of this recruitment has occurred in constrained forests (e.g., protected areas, inoperable or inaccessible areas, high elevation forests), while most of the habitat loss has occurred at lower elevation along valley bottoms (I. Blackburn pers. comm.). The current distribution of suitable habitat includes small habitat patches, fragmented and isolated habitats, and landscapes with low densities of habitat; factors that may make these habitats unsuitable for Northern Spotted Owls. The general loss of lower elevation habitat has limited Northern Spotted Owls, in some areas, to using mid- to high-elevation habitats or excluded them entirely (I. Blackburn pers. comm.).

Future habitat trends

The amount of suitable habitat in British Columbia continues to decline through harvesting of old forest, mostly through industrial logging operations but also from urban and infrastructure expansions. In the future, the amount of suitable habitat is predicted to stabilize at about 565,000 ha, a further 12% decline in suitable habitat (Figure 3). In comparison to historic levels, the future level of suitable habitat represents a 314,000 ha (36%) decline in the total amount of habitat once thought to be available to the Spotted Owl (I. Blackburn pers. comm.). The CSORT expects a >20 year long lag time before area of habitat available begins to increase and is more suitably distributed for Northern Spotted Owls (Chutter *et al.* 2007).

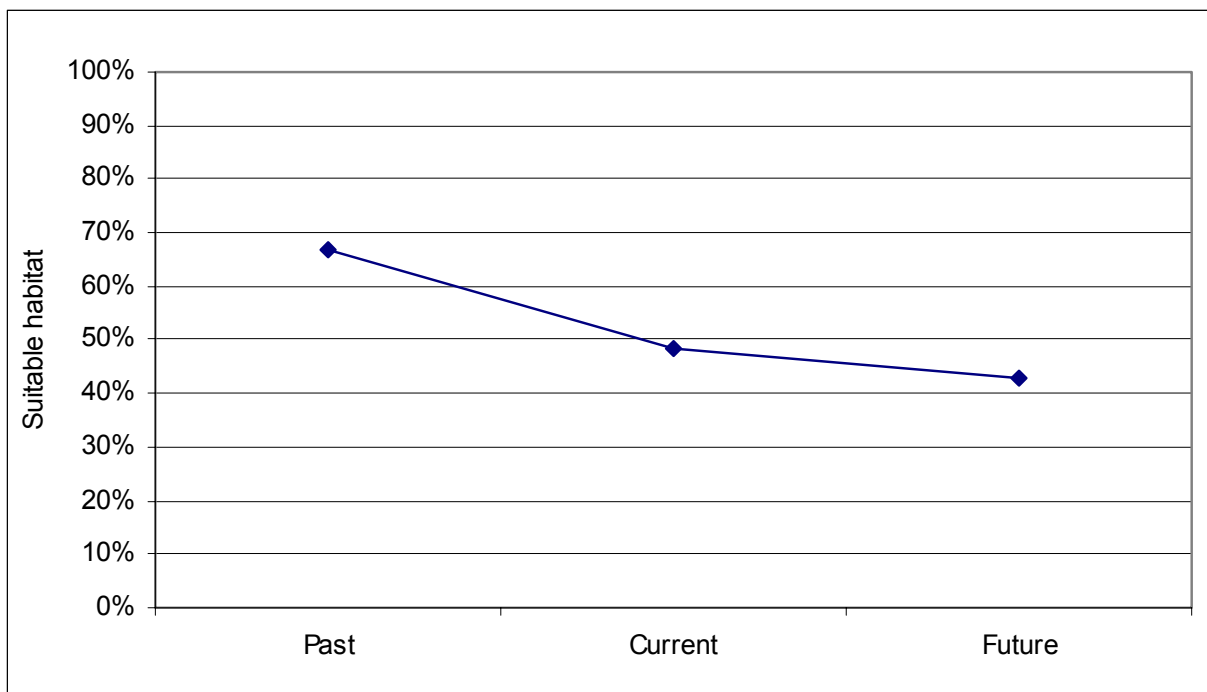


Figure 3. Estimated trend in Northern Spotted Owl habitat in the Squamish and Chilliwack Forest Districts (Figure from Blackburn and Godwin 2003).

Habitats within some Spotted Owl Management Zones (Special Resource Management Zones: SRMZs) and some protected areas will increase and provide better habitat conditions for Spotted Owls than currently available if current protection is maintained or improved. Due to logging history, 44 of 101 Long Term Activity Centres (LTACs) are <67% suitable for Northern Spotted Owls and require habitat recruitment to meet government policy requirements (Chutter 2004). As well, current forest practices (small and dispersed cutblocks) may provide for greater quantities of low elevation habitats for over-wintering and dispersal in the future (I. Blackburn pers. comm.). However, in some SRMZs and other Northern Spotted Owl “protected areas” with >67% suitable habitat logging continues (as of November 2006).

Habitat continues to decline in the USA as well and the current draft recovery plan for Spotted Owls includes allowances for logging of suitable habitat (USFWS 2007; Wildlife Society 2007).

Habitat protection/ownership

Protection of habitat is widely recognized as essential to preventing species extirpation and extinction (see *Accord for the Protection of Species at Risk*) (Chutter *et al.* 2007). Loss and fragmentation of habitat is recognized as a primary threat to the Northern Spotted Owl throughout the Pacific Northwest (USDI 1992; Dunbar and Blackburn 1994; Gutiérrez *et al.* 1995), and has been identified similarly in the Canadian Spotted Owl Recovery Strategy (Chutter *et al.* 2004); therefore, habitat protection is essential.

In British Columbia, the majority of Northern Spotted Owl habitat is located on Crown lands within provincial forests and protected areas. In 1997, the Spotted Owl Management Plan (SOMP) was released as government policy. Under SOMP (SOMIT 1997a,b) 363,000 ha were identified for the management of Northern Spotted Owls. Approximately 159,000 ha (44%) of this is located within parks and other protected areas including Provincial Parks (E.C. Manning, Golden Ears, Garibaldi, Cypress, Skagit Valley, Stein, Mehatl and Birkenhead Lake), Cascade Provincial Recreation Area, the Greater Vancouver Water District, and Ecological Reserves (Chilliwack River and Skagit River Cottonwoods). The remainder (204,000 ha) of habitat occurs within the Provincial Forest in the Chilliwack and Squamish Forest Districts.

Recent work (with different habitat model variables) has determined that only 99,675 ha in protected areas is actually suitable for Northern Spotted Owls. About 340,000 ha of unprotected suitable and restorable (within 20 years) habitat is available to breeding owls (Chutter *et al.* 2007).

Areas managed for Northern Spotted Owls include 19 Special Resource Management Areas (SRMZs) (Figure 4) which are further subdivided into 101 LTACs. Each LTAC represents the approximate home range of one pair of owls (~3,200 ha): targets are set to maintain 67% of this area as suitable habitat. Harvest is allowed within LTACs with greater than 67% suitable habitat and some silvicultural activities are allowed in LTACs for enhancement purposes (Chutter 2004); although in 2003 CSORT recommended no harvest in LTACs that have been occupied since 1997 (Chutter *et al.* 2004).

SOMP addresses some Northern Spotted Owls that occur outside of protected areas and SRMZs through management of eight 3,200-hectare Matrix Activity Centres (MACs). These eight MACs are designed to be phased out as protected areas for owls over the next 50 years as additional habitat (older forests) in LTACs is recruited and offsets predicted timber supply and forestry employment impacts. Nineteen sites within SOMP boundaries discovered after 1995 (11 in the Squamish and Chilliwack Forest Districts and all eight sites in the Cascades Forest District) are not offered any protection under the SOMP. However, three sites in the Cascades Forest District are receiving interim SOMP LTAC-equivalent protection as WHAs (J. Hobbs pers. comm.).

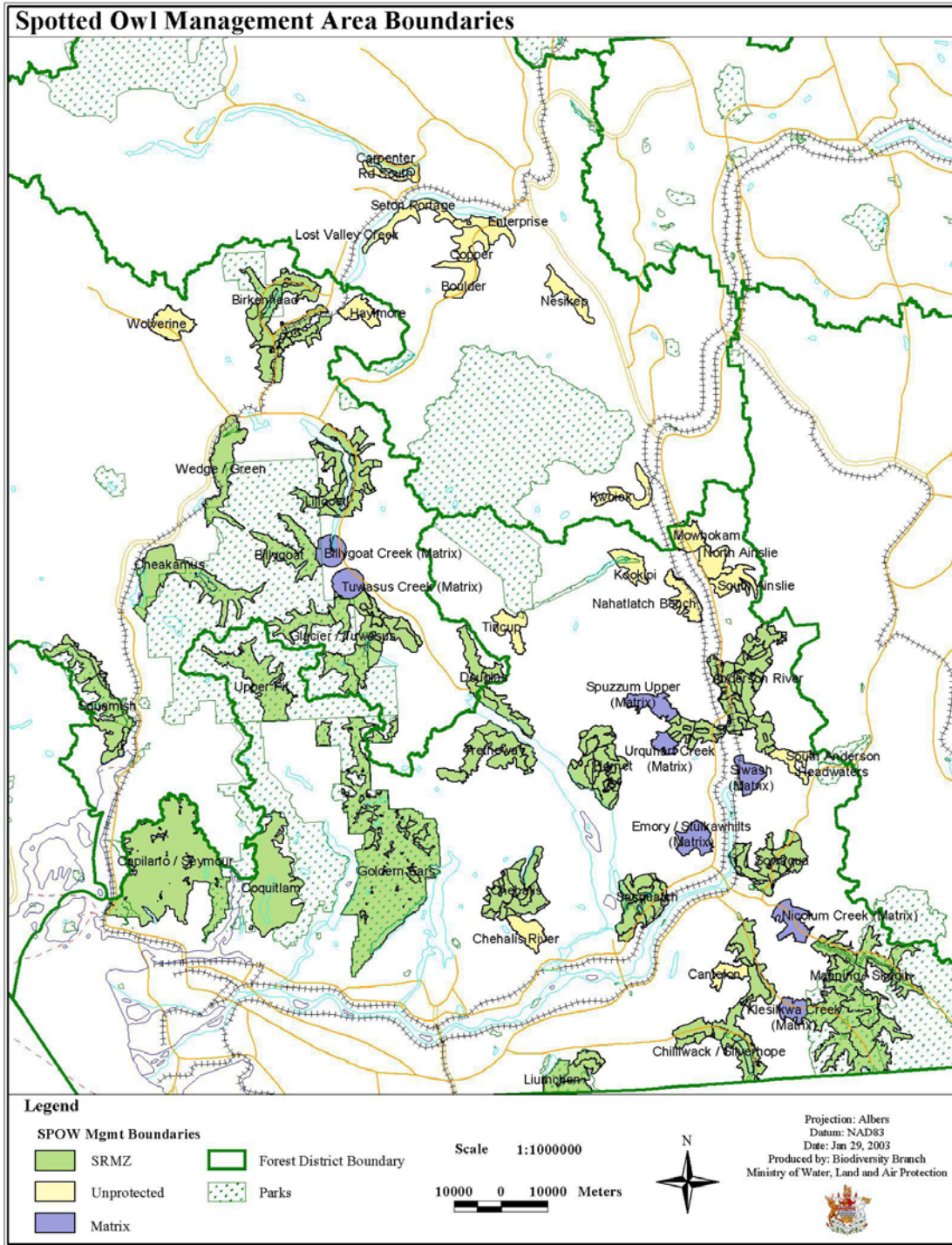


Figure 4. Spotted Owl Management Areas: Special Resource Management Zones, Provincial Parks, Matrix Areas and unprotected areas, 2003. Map source: Biodiversity Branch, BC Ministry of Environment, Victoria, BC.

Of the 72 sites reported as active at least from 1992 to 2005, 43 receive some form of long-term habitat protection within the boundaries of SOMP as they occur in parks/protected areas (11), the GVRD watersheds (5), or existing SOMP LTACs (27) which fall outside parks and the GVRD (Chutter *et al.* 2007). Of the 13 active sites detected in 2005, eight are located within parks/protected areas (Chutter *et al.* 2007; Hobbs 2005). More significantly, from an owl habitat management perspective, eight of the 11 sites known to exist in parks/protected areas since 1992 remained active in 2005, compared to just one of 32 in LTACs outside of parks (Chutter *et al.* 2007).

Two forest companies holding Crown forest tenures within the range of the Spotted Owl have voluntarily deferred logging in Spotted Owl SRMZs in response to concerns for Northern Spotted Owls. These deferrals remain indeterminate as both companies are awaiting further action/direction from government (Chutter *et al.* 2004). Two additional proposed LTACs were being protected as the involved forest companies had deferred logging (Chutter *et al.* 2007). BC Timber Sales, however, has taken control of some of the deferred areas and continues to allow logging within some SRMZs and other known Spotted Owl sites (J. Hobbs pers. comm.).

BIOLOGY

The Northern Spotted Owl is one of the most intensely studied birds in North America. It is a high-level predator with specialized habitat requirements, and is at the top of the food chain in some late-successional coniferous forest ecosystems on the west coast of North America. Northern Spotted Owls in British Columbia have adapted to harsher climatic conditions than populations further south; therefore, they may have more genetic capacity to adapt to changing conditions and may play an important role in maintaining the species if large-scale environmental changes occur (SOMIT 1997a). Most details of Northern Spotted Owl biology are known from studies of populations in the United States. All information presented below is from USA sources, except where noted as from British Columbia.

Life cycle and reproduction

Spotted Owls are typically monogamous, although evidence suggests a low occurrence of separation between pairs, possibly due to displacement by another Spotted Owl or as a result of poor past reproductive success (Forsman *et al.* 2002b). Owls usually first breed at two to three years of age, but some breed when one year old. In late winter and early spring, Spotted Owls begin roosting together near the nest 4 to 6 weeks prior to egg-laying, with copulation generally occurring 2 to 3 weeks before nesting (Forsman *et al.* 1984). The average clutch size is 2 eggs but 1 egg is also common for the Northern Spotted Owl. The incubation period is estimated to be approximately 30 +/-2 days (Forsman *et al.* 1984). Females incubate and brood the juveniles while the males provide food for both females and juveniles (Forsman *et al.* 1984). Most juveniles leave the nest when they are 34-36 days old.

In British Columbia, there are no data on clutch sizes but most nests (2002-2005) with nestlings observed have contained 2 young (2y-6 nests, 1y-3 nests, unknown-2 nests) (Hobbs 2002, 2004, 2005). Young leave the nest in British Columbia from 9-26 June (Hobbs 2005). Of 14 nests monitored for fledging success in British Columbia in 2002-2006, nine fledged at least one young, two were predated, one nest blew down and success was unknown for two nests (Hobbs 2002, 2004, 2005; Table 1). Fledged young then remain near the nest through August and to late September before dispersing. Dispersal in British Columbia has been documented to occur from 10-21 September (Hobbs 2005) and as late as 30 September (I. Blackburn pers. comm. in Hobbs 2005).

Annual reproductive output of a population is largely influenced by the number of pairs that breed each year, with few owls breeding in “poor” years and most owls breeding in “good” years, rather than the productivity of pairs that do breed (Franklin *et al.* 2002). The majority of Northern Spotted Owls do not breed every year (Gutierrez *et al.* 1995). In one study area in Oregon, the percentage of breeding females each year averaged 56% (range:18-82%), over 18 years from 1985-2002 (Forsman *et al.* 2002b). In the USA, mean annual number of young fledged per territorial adult female from 1985-2003 was 0.372 (Anthony *et al.* 2006). In British Columbia, most nests (57%; n=14) monitored from 2002-2005 fledged young (Table 1). Of nests that fledged young most (56%; n=9) fledged two young (Table 1).

Table 1. Number of young fledged from nests monitored in British Columbia 2002-2006. Data from Hobbs (2002, 2004, 2005) and J. Hobbs pers. comm.

Year	Nest No.	No. of fledglings
2002	1	2
2002	2	2
2003	1	1
2003	2	2
2003	3	2
2003	4	failed
2004	1	2
2004	2	predated
2004	3	1
2004	4	1 (+1 still in nest)
2005	1	1
2005	2	predated
2006	1	0
2006	2	?
Total	14	14

Only a small percentage of one- (1.5-8.4%) and two-year- old Northern Spotted Owls (2.6-33.3%) breed. Higher percentages are paired (20-83% for yearlings and 57-74% for 2-year olds) than breed (Forsman *et al.* 2002a), and it seems that breeding is delayed for a year or more after initial pair formation. In Oregon, the average age of pair formation was 2.4 years for males and 1.9 years for females, and the average age of first breeding was 3.9 years for males and 3.4 years for females (Forsman *et al.* 2002b).

Physiology, foraging and nutrition

Spotted Owls have three adaptations for nocturnal predation; acute eyesight, acute hearing and modified feathers for silent flight (USDI 1992). Northern Spotted Owls feed primarily on arboreal and semi-arboreal rodents at night, typically by perching and waiting to detect prey by sight or sound (Gutiérrez *et al.* 1995). In the northern portion of their range, analysis of regurgitated pellets on a percent frequency basis indicated the main food items are northern flying squirrels (*Glaucomys sabrinus* –32%), red tree voles (*Phenacomys longicaudus* –12%), deer mice (*Peromyscus* spp. –10%), red-backed voles and field voles (*Clethrionomys/Microtus* spp. –10%), and bushy-tailed woodrats (*Neotoma cinerea* – 7%)(Gutiérrez *et al.* 1995).

A recent study of three areas in western Washington confirmed that northern flying squirrels were the most frequently taken prey (29-54% numbers of prey) and comprised the highest percentage of diet by weight (45-59% biomass) in wet habitats. Other primary prey were snowshoe hare (*Lepus americanus*), bushy-tailed woodrat, red-backed vole, and mice (Forsman *et al.* 2001). Observed differences between years and areas were thought to be mainly related to variation in abundances of prey species (Forsman *et al.* 2001).

In British Columbia, northern flying squirrels, bushy-tailed woodrats, and deer mice are the most common prey of Northern Spotted Owls (Horoupian *et al.* 2000), which is similar to diets in Washington. Squirrels comprise 64.6% of the biomass consumed. Of this biomass, northern flying squirrels contribute 41.2%, other tree squirrels (*Tamiasciurus* sp.) contribute 0.8% and unidentified squirrel-sized prey a further 22.6%. Deer mice contribute little energetically, due to their small size. Horoupian *et al.* (2000) found that the percentages of prey species based on numbers of prey consumed do not differ between wet coastal forests and dry interior forests of British Columbia, but woodrats comprise 99% of diet in at least some interior British Columbia (drier sites) nests (J. Hobbs pers. comm.). Birds are rare in Northern Spotted Owl diets but Hobbs (2005) reports one case of predation on a Dark-eyed Junco (*Junco hyemalis*).

Home range

Home ranges are relatively large for a forest bird. Northern Spotted Owls are non-migratory, and adults typically occupy the same home range year-round (Gutiérrez *et al.* 1995). Home ranges tend to increase from south to north latitude, from drier to wetter ecosystems, and with increasing fragmentation of old forest (Forsman *et al.* 1984, 2005; Thomas *et al.* 1990; Carey *et al.* 1990; Glenn *et al.* 2004). Home range size may also

be larger in areas where the main Spotted Owl prey species is the northern flying squirrel (Forsman *et al.* 2005). Home range sizes are smaller in the breeding season than in the non-breeding season as owls concentrate activities closer to their nest (Carey *et al.* 1990; Forsman *et al.* 2005).

Home range of adjacent pairs usually overlaps to some degree (Thomas *et al.* 1990). In Oregon, neighbouring owls occupying adjacent territories shared an average of 12% of their home range. These overlapping areas tended to occur on the periphery of home ranges, in areas where owls spend a small portion of their time (Forsman *et al.* 1984). On Washington's Olympic Peninsula, individual home ranges are known to overlap about 70% (Forsman *et al.* 2005). Other studies in Washington found home ranges from 2100-4000 ha (reviewed by Gutierrez *et al.* 1995).

In Washington State, median annual home ranges of Spotted Owl pairs were larger in the moister western forests (3300 ha, 67% suitable habitat) than the drier eastern forests (2700 ha, 71% suitable habitat) (Hanson *et al.* 1993). This pattern likely also occurs in British Columbia. In British Columbia, home range estimates for 3 pairs of owls in dryer ecosystems ranged from about 1,400 ha to 4,600 ha, with suitable habitat compositions ranging from 60% to 66% (Blackburn and Godwin 2003). In British Columbia, one radio-tagged male was observed roosting with the female and juvenile 1.5 km away from the nest suggesting a minimum natal rearing area of 700 ha (Blackburn and Godwin 2003).

CSORT has determined that home range area requirements (minimum area of suitable habitat required per territory and maximum feasible territory size) are reduced as habitat changes from coastal (Maritime) to interior (Continental) subregions. The mean amount of suitable habitat required for a territory is now thought to be: Maritime subregion, 3055 ha, Submaritime, 2211 ha; Continental, 1,912 ha (Chutter *et al.* 2007).

Behaviour

The Northern Spotted Owl is an easily approached owl and appears relatively "tame" for such a rare and reclusive species. However, the Spotted Owl may actively defend its nest and young from predators and biologists that approach too close (Forsman 1976; Gutiérrez *et al.* 1995).

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

Radio-telemetry data from three dispersing juveniles in British Columbia showed that owls reacted to snow > few inches depth by moving long distances in short periods of time (Hobbs 2004), presumably related to either thermal stress or lower availability of food. This behaviour was not observed in two radio-tagged owls tracked in 2004/05 as snow accumulations didn't persist or reach any depth greater than a few inches (Hobbs 2005). Hobbs (2005) observed a remarkable reaction to a large wildfire near Lillooet when a male, female and two fledged young remained roosting calmly approximately 50 m from a burning forest with intense smoke, even when the site was water-bombed by helicopters.

Survival and recruitment

Survival of adults is relatively high (0.750-0.886 annually) and adults are long-lived; some wild individuals are more than 17 years old (Gutierrez *et al.* 1995). Adults have greater survival rates than one (0.415-0.860) or 2 year olds (0.626-0.886) (Anthony *et al.* 2006). Survival of juveniles is low and it is typically considered a major limiting factor in population recruitment (Gutiérrez *et al.* 1995). About 50% (Forsman *et al.* 2002a) to 70% (Blakesley *et al.* 2001) of fledglings die before or during dispersal and only about 25% survive their first winter (Gutiérrez *et al.* 1995).

In British Columbia, 6 of 7 fledglings fitted with radio tags between 2002-2005 have died: four starved, 1 was depredated and 1 died of unknown causes (Hobbs 2005; Hausleitner 2006). The fate of the seventh birds is unknown as the radio transmitter failed (Hobbs 2005).

Recruitment into the British Columbia population has essentially been zero since monitoring began in the 1990s; only one juvenile fledged in 2005 and none fledged in 2006 (Hausleitner 2006).

Predation and competition

Northern Goshawks (*Accipiter gentilis*), Cooper's Hawks (*Accipiter cooperi*), Red-tailed Hawks, Great Horned Owls (*Bubo virginianus*) (Johnson 1992; Forsman *et al.* 2002a) and Barred Owls (Leskiw and Gutiérrez 1998) have been implicated as avian predators. Great Horned Owls inhabit forest edge habitats and are suspected to be the primary predator of the Northern Spotted Owl (Forsman *et al.* 1984; Carey *et al.* 1992). Predation accounts for a majority of mortality (68.0%) of juveniles, mainly due to avian predators (81%), with Great Horned Owls suspected to be the major cause (Forsman *et al.* 2002a). Some mammals (e.g., fisher (*Martes pennanti*) may eat Spotted Owl eggs and young (Gutiérrez *et al.* 1995) and there is a case of suspected predations of a juvenile Spotted Owl by a black bear (*Ursus americanus*) (J. Hobbs pers. comm.).

In British Columbia, one of only two active nests in 2005 was destroyed by an unknown predator which killed the adult female and nestling(s) at the nest (Hobbs 2005). In 2004, one nestling Northern Spotted Owl was thought to have been killed by a Northern Goshawk and one was killed by a Great Horned Owl (Hobbs 2005).

It seems logical that predation by Great Horned Owls, Barred Owls, and Red-tailed Hawks will likely occur more frequently as fragmentation increases because these species occur more frequently in more fragmented forests. These relationships, however, remain unproven (Courtney *et al.* 2004).

Barred Owls (*Strix varia*) and Great Horned Owls (*Bubo virginianus*) are known to occur within the range of Northern Spotted Owls and these owls compete for food (Gutiérrez *et al.* 1995) and space (Kelly *et al.* 2003). Great Horned Owls and Barred Owls are habitat generalists and occur in a wider variety of forested habitats than the more habitat-specialized Northern Spotted Owl. Northern Spotted Owls within a fragmented habitat landscape have larger home ranges than those within more contiguous habitats (Forsman *et al.* 1984), resulting in more overlap with habitats used by Great Horned Owls and Barred Owls and consequently higher risk of competition.

Competition with Barred Owls is widely accepted as a threat to Northern Spotted Owls through increased competition for space and prey, increased predation and hybridization (Wilcove 1987; Carey *et al.* 1992; SOMIT 1997a). Other studies show a negative effect on Spotted Owl survival if Barred Owls are present (Anthony *et al.* 2006). Strong territorial defence has been observed between Barred Owls and Northern Spotted Owls, and Barred Owls are known to displace Northern Spotted Owls in the USA (Hamer 1988; Hamer *et al.* 2001; Kelly 2002; Kelly *et al.* 2003; Herter 2004). Kelly's study showed that Barred Owls sometimes displaced Northern Spotted Owls from their territories when Barred Owls occurred within 0.8 km of a Northern Spotted Owl territory centre. Those Northern Spotted Owls that were not displaced continued to maintain their normal reproductive output, but regional reproductive output was lower because there were fewer Northern Spotted Owls (Kelly 2002). Conversely, one other study in Oregon found that Barred Owls displaced some Northern Spotted Owls but the study population of Northern Spotted Owls has not declined (Forsman *et al.* 2002b).

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

Competition with Barred Owls is a relatively new phenomenon as previously the two species were geographically separated. In the 1960s, Barred Owls expanded their range westward and southward so that it overlapped that of the Northern Spotted Owl in British Columbia (Campbell *et al.* 1990; Dunbar *et al.* 1991) and the USA (Hamer 1988; Gutiérrez *et al.* 1995). The range expansion is thought to have been a response to fragmentation of coniferous forest habitat and climate change in the boreal forest.

The extent of the potential for competition in British Columbia is illustrated by the discovery in the early 1990s that within the range of Northern Spotted Owl, Barred Owls were four times more abundant than Northern Spotted Owls (Dunbar and Blackburn 1994). This fact was confirmed more recently (2004-2005) as surveys for Spotted Owls in suitable Spotted Owl habitat in British Columbia found responses by Barred Owls

were 3-6 times more frequent than responses by Northern Spotted Owls (Hobbs 2004, 2005; Keystone 2004). There is no doubt that Barred Owls are now relatively common throughout British Columbia Northern Spotted Owl habitat.

Dispersal/migration

The nature of dispersal has recently been well-documented in studies in Washington and Oregon. Fledged young disperse in random directions from natal areas in September and October, moving rapidly in a series of movements before settling into temporary home ranges in late October and November. The latest date for juveniles remaining with their parents in British Columbia is September 30 (I. Blackburn pers. comm.). Dispersal may be influenced by barriers such as high elevation terrain, large bodies of water and large open areas of unsuitable habitat (Thomas *et al.* 1990, Miller *et al.* 1997, Forsman *et al.* 2002a). A second dispersal then occurs in February through April with many juveniles moving considerable distances before settling into summer ranges. Thereafter, some one-year-old owls remained in their second-summer range whereas others moved and occupied one or more temporary home ranges until settling on permanent territories when 2-5 years of age.

Dispersal directions, after the first dispersal movement, continued to be random. Final dispersal distances (from natal area to permanent territory) ranged from 0.6 km to 111 km, median distances were about 14 km for males and 24 km for females, and only 8.7% dispersed >50 km (Forsman *et al.* 2002a). In western Oregon the average dispersal distance was 32 ± 14 km (Miller *et al.* 1997). A small percentage (~6%) of non-juveniles disperse as well. These birds tend to be females, younger owls, owls that did not have a mate the previous year or owls that have lost mates (Forsman *et al.* 2002a).

The quality of dispersal habitat is likely an important factor in survival of dispersing birds. Dispersing owls used both continuous older forest and a fragmented mosaic of various-aged forests, clearcuts, roads, and non-forested areas (Forsman *et al.* 2002a). Large non-forested valleys are known to act as barriers to dispersal in western Oregon between the Coastal and Cascade Mountains but dispersal did occur in some broad, forested foothills between the same ranges (Forsman *et al.* 2002a). Although dispersing juveniles selected equally between less fragmented forest and more fragmented forests, net dispersal distance decreased with the increased use of clearcuts, suggesting that clearcuts may represent a partial barrier to dispersal (Miller *et al.* 1997).

In British Columbia, dispersal and settlement of juvenile Northern Spotted Owls appears to be not occurring at present as no new owls are showing up in monitored sites, many single adult owls remain unmated, and no radio-tracked juveniles survive beyond their first winter (Hobbs 2002, 2004, 2005). Hobbs (2005) did track one juvenile to cross a large lake and move a substantial distance during the fall dispersal phase.

Diseases and parasites

Thomas *et al.* (2002) diagnosed acute septicemic spirochetosis in a dead adult male from Washington State. The organism was identified as a member of the *Borrelia* genus, the most closely related species being *B. hermsii*, an agent of relapsing fever in humans in the western United States. This was the first report of a relapsing fever-related *Borrelia* in a wild bird (Thomas *et al.* 2002). Avian cholera has been reported from one dead owl (Forsman *et al.* 2002a).

The West Nile virus is a disease of concern, given the small population of Canadian Northern Spotted Owls. Originally the West Nile virus was known only from Africa, West Asia, and the Middle East. This virus was first isolated in the Western Hemisphere in New York in 1999, and has since spread rapidly across North America (Canadian Cooperative Wildlife Health Centre 2003). Although birds infected with West Nile virus can become ill or die, most infected birds survive as carriers (Centers for Disease Control and Prevention 2003). West Nile Virus has not yet been documented in wild Northern Spotted Owls.

Various parasites are ubiquitous in populations of wildlife and their effects on survivorship are likely related to the extent of the infestation. Threats from parasites are much less than those from diseases such as West Nile Virus. Known parasites of Northern Spotted Owls include blood parasites (hematozoans), helminthes (nematodes, cestodes, and acanthocephalans) and louse flies (Hippoboscidae) (Gutiérrez *et al.* 1995). Of 105 owls sampled from all three subspecies, all were infected with hematozoan parasites and multi-species infections were common (Gutiérrez *et al.* 1995). A majority of dead owls examined by Forsman *et al.* (2002a) were infested with blood or intestinal parasites.

Adaptability

The Northern Spotted Owl is adapted for very specific ecological conditions. It seems unable to cope with significant amounts of habitat fragmentation and increased levels of predation and competition from species that are better adapted to fragmented landscapes.

Northern Spotted Owls in British Columbia have adapted to harsher climatic conditions than populations further south; therefore, they may have more genetic capacity to adapt to changing conditions and may play an important role in maintaining the species if large-scale environmental changes occur (SOMIT 1997a).

POPULATION SIZES AND TRENDS

Search effort

Prior to 1985, the Northern Spotted Owl in Canada was largely known from museum specimens. By 1985, only 28 records of the subspecies were known, suggesting that it was a very rare and local resident within its range in Canada (Campbell and Campbell 1984, Dunbar *et al.* 1991, Dunbar and Blackburn 1994; Fraser *et al.* 1999). Due to the initial COSEWIC report by Campbell and Campbell (1984), surveys for Spotted Owls were begun in 1985. Between 1992 and 2002, more intensive and standardized surveys were conducted in 147 areas in the Chilliwack and Squamish forest districts. Forty of these 147 survey areas were then chosen and used to assess population trends. Only survey areas that were occupied at least once by a territorial Spotted Owl during the study were chosen. Search effort varied among years so some areas were not surveyed annually. Surveys were conducted at night using Spotted Owl call playbacks at stations along transects within each survey area (Blackburn *et al.* 2002; Harestad *et al.* 2004).

A cumulative frequency distribution was derived for the search effort required to detect the first Spotted Owl each year in each of 40 survey areas between 1992 and 2002. This distribution was used to determine a criterion for estimating the likelihood that Spotted Owls were absent from other individual survey areas. A minimum 13 hours of unsuccessful nocturnal survey effort was used to indicate a 90% chance that a surveyed area was vacant (Blackburn *et al.* 2002; Harestad *et al.* 2004). The methods used to calculate an adequate level of survey effort should give all readers confidence that the survey data reported for the period 1992-2002, and then thereafter, is reasonably accurate.

Beginning in 2002, intensive surveys of other areas thought to have suitable habitat for Northern Spotted Owls were initiated (Table 2), resulting in seven new sites being found by 2004 (Hobbs 2005, Keystone 2004). Four of these sites extended the range of the Northern Spotted Owl further north than previously known (Hobbs 2004). Survey effort by the BC Government in 2005 was about 50% greater than in 2004 (Table 2) and resulted in another five new sites. Survey effort by the Ministry of Environment in 2006 declined by 80% (860 hrs) compared to 2005, and five sites known to be active in 2005 were not surveyed to standard. In 2006, only 14 active sites were found (Hausleitner 2006).

Table 2. Survey effort for Northern Spotted Owls in British Columbia 2002-2006. Data from Beauchesne (2003), Hobbs (2004, 2005), Keystone (2004), Hausleitner 2006).

Year	2002	2003	2004	2005	2006
Survey areas	>17	41 ¹	149 ³	149	33
Transects	>17	?	285 ⁴	249	?
Call playback stations	?	>85 ²	3139 ⁵	3342	577
Hours spent surveying	?	?	754 ⁶	835	158

¹32 by BC Government, 9 by MCA. ²85 by MCA. ³91 by BC Government, 58 by Keystone.

⁴155 by BC Government, 130 by Keystone. ⁵2112 by BC Government, 1027 by Keystone.

⁶452 by BC Government, 302 by Keystone.

Even so, one of the key recommendations of the CSORT (Chutter *et al.* 2004) is to ensure that all Northern Spotted Owls in British Columbia are found and great effort has been expended over the years to ensure this. Surveys in recent years have focused on areas with the highest probability of finding “new” owls. Although it is possible that some owls remain undiscovered, there is no doubt that virtually all of the most likely areas have been surveyed.

Abundance

Prior to European contact, the size of the original Spotted Owl population in Canada was estimated at 500 breeding pairs (Blackburn *et al.* 2002). This estimate was based on the amount of suitable habitat estimated to have occurred at the time and using densities of Northern Spotted Owls found in relatively unfragmented landscapes. The Canadian population was estimated at fewer than 100 pairs in 1991, based on low response rates (0.03 pairs/km) during field inventories conducted from 1985 to 1988 (Dunbar *et al.* 1991; Dunbar and Blackburn 1994). By 2002, the Canadian population was estimated to be less than 50 pairs (Blackburn *et al.* 2002), but was more likely less than 30 pairs (I. Blackburn pers. comm. 2003; Cooper 2006) or 33 pairs (Harestad *et al.* 2004). Currently, the Ministry of Environment estimates the provincial population to be 16-60 individuals (CDC 2007), but the actual population is likely much closer to the lower number (19 owls are known in 2007).

From 1985 to 2002, 71 sites had been documented in British Columbia (Hobbs 2005); there were 79 by 2006 (J. Hobbs pers. comm.). In 2002 and 2003, 15 and 10 active Northern Spotted Owl sites, respectively, were confirmed (Hobbs 2004); but not all sites were surveyed. In 2004, 17 active sites and 25 adult owls (9 single owls and 8 pairs) were confirmed (Table 3). Only 4 of the 8 pairs were confirmed to breed (Hobbs 2005). Of these 17 sites, only 10 were from the 71 known sites prior to 2002, and 7 sites were new since 2002 (Hobbs 2005). In 2005, the total known number of Northern Spotted Owls in British Columbia was 23, 6 pairs and 11 single adults (Hobbs 2005; Table 3) but numbers had dwindled to 21 by year’s end as one adult female was killed by a predator at the nest and a lone adult was found dead in December (Hobbs 2005).

In 2006, numbers declined to 17 owls > 1 year old at 14 active sites (three pairs and 11 single birds) (Hausleitner 2006). Five sites with 6 birds documented in 2005 were not surveyed in 2006; presumably, some of these birds would be alive in 2006. An adult Northern Spotted Owl was found injured (and later died; Vancouver Sun report) on Highway 3 east of Hope in October, 2006. This bird was about 13 km from a known Northern Spotted Owl site with a pair of birds in 2005, and occupied by a male (unknown if he attracted a mate) in 2006: it is unknown if the dead owl was from that site J. Hobbs (pers. comm.). In 2007, there were 14 active sites with five pairs and nine single owls (J. Hobbs pers. comm.).

Table 3. Numbers of known active sites, pairs, single adults and breeding attempts by Spotted Owls in British Columbia 2002-2007. Data from Hobbs (2004, 2005) and J. Hobbs pers. comm. Uneven survey efforts between 2002 and 2003, and less intensive survey efforts in 2002-2003 compared to 2004-2005 explain some variations in the numbers of owls, pairs and nests found.

Year	2002	2003	2004	2005	2006	2007
Active sites	15	10	17	17	14 ⁴	14
Pairs	2	4	8	7 ¹	3	5
Single adults	13	6	9	10 ²	11	9
Pairs that attempted to breed	2	4	4	2	2	
Total known adult owls	17	14	25	23 ³	17	19

¹reduced to 6 pairs after death of an adult female at the nest. ²reduced to 9 after a lone adult was found dead in December 2005. ³Reduced to 22 by December 2005. ⁴Five active sites in 2005 were not surveyed in 2006.

The global population of Northern Spotted Owls was estimated at 3778 pairs in the early 1990s (Gutiérrez *et al.* 1995). A more recent estimate, based on more reliable inventory data, is about 6,000 pairs (2300-northern California, 2900-Oregon, 860-Washington, 30-British Columbia) (Forsman 2003). The Canadian population may have once been about 10% of the global population but now accounts for <0.02% of the global population.

Fluctuations and trends

Pre-European settlement, the Spotted Owl likely inhabited most mature and old forests found throughout the Pacific Northwest (USDI 1992). Populations of the Northern Spotted Owl are now declining throughout its range in Canada and the USA. In the United States, Northern Spotted Owls were the subject of the largest population dynamics analysis on any raptor. Between 1985 and 1998, demographic studies indicated a 3.9% annual decline in the population of territorial females within 15 study areas in Washington, Oregon and California (Franklin *et al.* 1999). A more recent meta-analysis of 14 study areas in the same three states found a -3.7% annual decline from 1985-2003 (Anthony *et al.* 2006). There is considerable variation between study areas, however. One study area in central Washington reported a 7% annual decline from 1992-2002 (Forsman *et al.* 2002b), whereas populations in one Oregon study area remained relatively stable from 1985-2002 (Forsman *et al.* 2002b).

In British Columbia, inventory in 40 of 147 survey areas between 1992 and 2002 indicate the Canadian population declined by approximately 67% during that time period, suggesting an average annual rate of -10.4% (Figure 6; Blackburn *et al.* 2002; Harestad *et al.* 2004). A similar total decline (-70%) over a similar time period (1990-2003) was reported for one population in adjacent Washington state in the central Cascade Range (Herter 2004). At the low population levels of 2002, extirpation of the Northern Spotted Owl from Canada was estimated to likely occur within 5-10 years (i.e., 2007-2012; Blackburn *et al.* 2002), or 2009 (Cooper 2006) if the rate of population decline continued (Figure 5). Without habitat protection and direct population augmentation, extirpation is now seemingly inevitable and will likely occur by 2012.

Rescue effect

There is potential for natural rescue from Washington State as Spotted Owl habitat and populations are contiguous between British Columbia and Washington. However, rescue potential is reduced because the lower Fraser River valley is now heavily urbanized or farmed and is likely a significant barrier to emigration as Spotted Owls do not normally cross such large open areas. At present there seems to be only a narrow corridor through the Cascade Range from which natural emigration to Canada could occur. The potential for rescue from Washington is further compromised as Spotted Owl populations there are also declining; slower than in Canada but faster than in Oregon and California (Anthony *et al.* 2006).

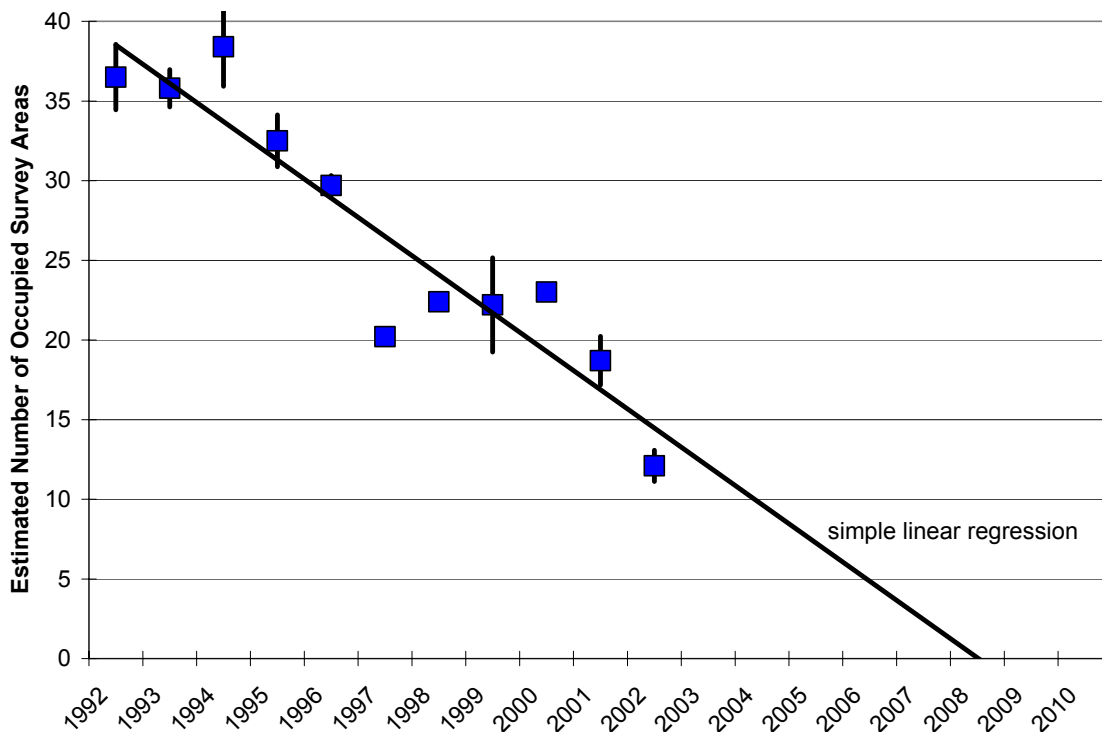


Figure 5. Estimated number of occupied survey areas among the 40 survey areas from 1992 to 2002 (with 90% C.I.). Figure from Cooper (2006), adapted from Blackburn and Godwin (2003).

LIMITING FACTORS AND THREATS

Northern Spotted Owls in British Columbia are very vulnerable to extirpation because of their small population size and low densities. Factors that threaten the species, from now onwards, can be divided into primary and secondary factors (Blackburn and Godwin 2003). Primary factors are those that cause long-term sustained effects that limit the carrying capacity, or total capable population size. The primary factor is habitat loss and fragmentation, while competition with Barred Owls is a primary factor resulting from habitat fragmentation. Secondary factors can cause short-term effects in population size, but populations would normally recover soon after the influence of the factor changes to a more favourable condition. Secondary factors include stochastic environmental and demographic events, genetic variability, predation, disease, parasites and viruses. Although primary factors generally limit population size and may cause extirpation, secondary factors are often the leading cause of extirpation of small populations (Blackburn and Godwin 2003).

Very small and declining population

Populations (<25 individuals and 6 breeding pairs as of 2005; 17 individuals and 3 pairs in 2006) and densities are very low in British Columbia. Although a few new territories have been discovered in recent years (e.g., Hobbs 2002, 2004, 2005; Keystone 2004), recruitment of young into the British Columbia population may have ceased as no new owls have been found in areas that have been intensely surveyed the last few years (Blackburn *et al.* 2002; Hobbs 2002, 2004, 2005). In addition, all recently radio-tagged juveniles have been found dead (n=6) or disappeared (n=1) (Hobbs 2004, 2005). If no natural recruitment is occurring, then the population is likely doomed to extirpation within 2-5 years unless populations are augmented.

Geographic isolation of existing pairs and lack of recruitment

Small, insular populations with high variance in reproductive success have a high likelihood of rapid extirpation unless populations are connected to create a larger meta-population (Shaffer 1985; Gilpin 1991; Lamberson *et al.* 1994). For resident species such as Spotted Owls, connectivity among the greater population is provided by dispersing juveniles which move through the landscape to find their own territory and mate. In 2006, the lack of recruitment of young owls from known active nests into the Canadian population, the large proportion of sites occupied by single owls and the distances between known breeding pairs suggests that existing sites and owls are too isolated for a biologically feasible level of natural connectivity.

In ideal conditions about 50% of juvenile Northern Spotted Owls die before or during natal dispersal. During dispersal, Spotted Owl juveniles have an increased susceptibility to both starvation and predation (Forsman *et al.* 2002a). This high mortality rate, coupled with distance between unoccupied suitable habitat and territories with only single owls in British Columbia, and very low numbers, makes it unlikely that any individual dispersing owl can find a mate. Lahaye *et al.* (2001) suggested that settlement by juvenile Spotted

Owls might be postponed in declining owl populations due to a lack of mates, which has obvious implications for management of populations in British Columbia. However, Hobbs (2005) documented dispersing juveniles from different nests crossing paths near Anderson Lake, British Columbia, which suggests there is still potential for genetic exchange and establishment of “new” pairs, if juveniles could survive.

Managing for connectivity/dispersal habitat in British Columbia seems critical if Northern Spotted Owls are to be recovered and then maintained within their historic and current range in Canada.

Competition

Many biologists believe that Barred Owls may now pose a substantial impediment to recovery, although the severity of this threat is difficult to measure (Courtney *et al.* 2004; Herter 2004). Barred Owls are able to thrive in a variety of forest types and seral stages and can adapt to more varied food sources; therefore, they likely are at a competitive advantage over Northern Spotted Owls in fragmented old-growth forests. One study in the Washington Cascade Range showed that the presence of Barred Owls excluded Spotted Owls, even in Spotted Owl reserve areas (Pearson and Livezy 2003). Kelly *et al.* (2003) predict two scenarios if present trends continue: 1) Barred Owls displace Northern Spotted Owls or 2) an equilibrium is reached where either both occur within the same landscape or each occurs in different parts of the landscape.

Although the impact in British Columbia on Northern Spotted Owls from competition with Barred Owls is unknown, it likely is similar to that found in the USA (e.g., Kelly *et al.* 2003). Because of the very small population in British Columbia, any case of displacement of Northern Spotted Owls by Barred Owls will have serious consequences.

Great Horned Owls also occur in Northern Spotted Owl habitats and likely compete for food and space (Gutierrez *et al.* 1995).

Climate and climate change

The Spotted Owl is at the northern limit of its range in British Columbia. Colder and harsher climates in British Columbia suggest lower fecundity and survivorship than in the USA. Subsequent habitat changes from logging and other development may increase thermal and food intake stresses on Spotted Owls, further decreasing habitat suitability (Main and Harestad 2004).

Weather pattern is identified as one possible cause of widespread population declines (Anthony *et al.* 2006), so there seems a logical link to climate change as a threat. Effects of global warming may threaten Northern Spotted Owls if negative impacts occur on prey (e.g., declining abundance and availability), weather (e.g., more rain or snow or colder mean temperatures), vegetation (e.g., changing composition and structure), environmental stochasticity (e.g., increased fire rates and intensity if less rain, more insect outbreaks due to less severe winters), and disease (e.g., more exotic diseases such as West Nile Virus). For example, the Mountain Pine Beetle outbreak has reached catastrophic epidemic proportions with virtually all lodgepole pine forests in

British Columbia seemingly doomed. Insect outbreaks are also seriously damaging Ponderosa pine and Douglas-fir forests throughout south interior British Columbia, including in SRMZs near Lillooet and Carpenter Lakes. Increases in insect outbreaks have been linked with global warming (Dale *et al.* 2001).

On the other hand, global warming may improve habitat and other environmental conditions for Northern Spotted Owls if conditions mimic those now found in the USA. This threat, however, is unmanageable as it relates to Northern Spotted Owls in British Columbia.

Habitat loss and fragmentation due to logging

Loss and fragmentation of habitat to harvesting of old-growth forests and degradation of habitat as a result of even-aged management of forests are widely believed to be the primary long-term threats to viable populations of Northern Spotted Owl throughout the Pacific Northwest (Gutiérrez *et al.* 1995; Courtney *et al.* 2004) and in British Columbia (Chutter *et al.* 2007).

Historically, in British Columbia, forest harvesting by clearcut logging has reduced structural diversity in harvested areas. Today, about 31% of suitable Northern Spotted Owl habitat lies within the harvestable landbase (Chutter *et al.* 2007) and is, therefore, threatened. Over the next 25 years, the rate of habitat loss caused by timber harvest and natural disturbance is expected to exceed the recruitment of suitable habitat from young forests resulting in further fragmentation and isolation of habitats available to the owl. Even more sobering is the projection that habitat recruitment under reasonable scenarios is not expected to equal habitat loss until 50 years from now (Sutherland *et al.* 2007). Note that eight of the 11 sites known to exist in parks/protected areas since 1992 remained active in 2005. This compares to one of 32 in SOMP/GVRD LTACs outside of parks, suggesting that ecological conditions within parks and/or habitat protection measures under the *Parks Act*, are more conducive to continued Spotted Owl presence (Chutter *et al.* 2007).

Loss of habitat to logging may be less permanent than losses from urban and rural development if logged areas are managed for owl habitat in the future. Evidence from the USA shows that lands managed under the Northwest Forest Plan, which has provisions for maintaining habitat for Spotted Owls, can better maintain habitat and owl populations as population declines were lower (-2.8%) than in other lands (-5.8%) (Anthony *et al.* 2006).

Northern Spotted Owls tend to use lower elevation habitats during winter to possibly avoid extreme cold temperatures and deep snow packs that limit prey availability. The shift to higher elevations, due to loss of old forest at lower elevations to harvest or development may cause increased mortality caused by starvation and exposure during severe cold and wet winters (I. Blackburn pers. comm.).

Recent impacts from habitat loss may be more related to fragmentation effects such as increased predation pressure, increased competition for food and space from Barred Owls, distance between suitable habitat patches, and other factors rather than just amount of habitat lost.

Habitat loss and fragmentation due to wildfire and other natural disturbances

In the USA, wildfire has consumed more Spotted Owl habitat than logging since 1990 (Courtney *et al.* 2004), although the effects of fire may not be detrimental to Spotted Owls unless extensive areas are lost (Bond *et al.* 2002; Clark 2007). Clark (2007) has shown that Spotted Owls will use moderately and severely burned areas (> 70% over mature forest overstory removed by fire) in the USA.

In British Columbia, wildfires have also impacted significant amounts of Northern Spotted Owl habitat. For example, the 2002 Seton Fire consumed about 1,400 ha of mainly suitable Northern Spotted Owl habitat and a 2004 wildfire consumed 900 ha of good habitat near a known nest (Hobbs 2005). The adult female that resided around the 2004 burned area was radio-tagged and was not observed to use the burned habitat for the 6 months her transmitter was responding, although she was observed roosting in live trees within 10 m of the still smoldering fire edge in the late fall.

Losses of habitat from wildfire, insect infestations (mountain pine beetle, Douglas-fir beetle) and blowdown may reduce available habitat if losses are extensive (Chutter *et al.* 2007), and negatively impact survival of existing birds or recovery potential. Insect infestations have expanded rapidly over most of interior British Columbia, and are also very evident within the eastern and northern edges of the range of the Northern Spotted Owl in BC.

Habitat loss to other human development

In British Columbia, in addition to commercial forestry, there has been considerable loss and/or fragmentation of forest habitat from rural and urban development, especially in the Lower Mainland, the Squamish valley, and other valleys with transportation corridors. Habitat lost to urban and agricultural development is undoubtedly lost forever as habitat for Northern Spotted Owls. Development of roads, pipelines, and utility corridors, in general, contribute to habitat fragmentation. In British Columbia, losses associated with expanding water reservoirs, independent power projects, and electric transmission lines are considered significant future threats (Chutter *et al.* 2007). There are also potential threats from increased mine and backcountry tourism development (Pierce Lefebvre 2005).

Connectivity with populations in the USA has been compromised by human development of the lower Fraser River valley. Large unforested valleys are known to act as barriers to dispersal (Forsman *et al.* 2002a); therefore, dispersal of owls between the USA and Canada is unlikely in the lower Fraser River valley between Vancouver and Agassiz.

Productivity

The Northern Spotted Owl is long-lived but has very low reproductive potential due to its low clutch size, irregular breeding (does not breed every year), and high juvenile mortality. Recovery of populations is strongly limited by these reproductive limitations.

Predation

Predation has not been identified as a limiting factor for Northern Spotted Owl populations overall (Gutiérrez *et al.* 1995). At the time the Northern Spotted Owl was listed as Endangered in the USA, increased predation risk in increasingly fragmented habitats was thought to be a major threat; however, research has not borne this out (Courtney *et al.* 2004). However, the threat of predation is likely more important for small populations of Northern Spotted Owls, such as found in British Columbia, compared to larger populations as the loss of one individual may have a larger, if not significant, impact on populations. Predation accounts for a large portion (68.0%) of juvenile mortality (Forsman *et al.* 2002a).

Diseases and parasites

Little is known about diseases and parasites that affect Northern Spotted Owls (Gutiérrez *et al.* 1995), but it is thought that these factors may be involved in some cases of starvation or predation (Forsman *et al.* 2002a). A majority of dead owls examined by Forsman *et al.* (2002a) were infested with blood or intestinal parasites. West Nile Virus is identified as a potential threat but of uncertain effect (Courtney *et al.* 2004).

Hybridization

Northern Spotted Owls are closely related to Barred Owls (Gutiérrez *et al.* 1995). In Washington and Oregon, a total of 50 hybrids were observed between 1974 and 1999 (Kelly 2002). In British Columbia, there is one known case of a male Barred Owl breeding with a female Northern Spotted Owl (Hobbs 2004) and one case of a male Spotted Owl paired with a female Barred Owl (J. Hobbs pers. comm.). The frequency of interspecific matings is extremely low when compared to the total number of Northern Spotted Owl matings within the demographic study areas in Washington and Oregon (Kelly 2002) and the present extent of hybridization is assumed to be low (Gutiérrez *et al.* 1995). In general, segregation by habitat (Barred Owls use more open forest, Spotted Owls use more closed-canopied mature forest) serves to separate the two species (e.g., Herter and Hicks 2000), but these differences may be declining. Despite the extensive sympatry of these two species, genetic isolating mechanisms that separate Northern Spotted Owl and Barred Owl are thought to be effective enough to maintain hybridization at this very low incidence (Hamer *et al.* 1994).

Genetics

Courtney *et al.* (2004) did not identify any genetic issues that are significant threats to Northern Spotted Owls range-wide, but these authors did note there is concern that the small Canadian population may be at such low levels that inbreeding, hybridization, and other effects could occur (e.g., restricted gene flow in fragmented habitats and isolated populations, Barrowclough *et al.* 2006).

SPECIAL SIGNIFICANCE OF THE SPECIES

Importance to people

The Northern Spotted Owl is among the most studied owl species in the world because of its association with commercially valuable old-growth coniferous forests (Gutiérrez *et al.* 1995; Courtney *et al.* 2004; Anthony *et al.* 2006). It has become an environmental icon in Canada and the USA (e.g., Noon and Blakesley 2006), lauded by those concerned with environmental values as an indicator of the health of old-growth forests (e.g., Sierra Legal Defence Fund 2002, 2005), or those concerned about their fate (e.g., Pynn 2006) and dismissed by those who want unfettered economic development of those forests (e.g., Stout 2003). In December 2005, the Sierra Legal Defence Fund launched the first-ever lawsuit seeking an emergency order under the *Species at Risk Act* to protect Canadian Northern Spotted Owls.

Northern Spotted Owls are much sought after by bird watchers, but few attempt to observe them in British Columbia because of their extreme rarity and the remote locations in which they live.

Ecological role

The Northern Spotted Owl is a high-level predator with specialized habitat requirements. It is at the top of the food chain in some late-successional coniferous forest ecosystems on the west coast of North America, including southwestern mainland British Columbia. Specialized and rare forest species can be thought of as indicators of forest ecosystem diversity and function. If the Northern Spotted Owl persists, then that may indicate that forest ecosystems are functioning as well as previously. If the Northern Spotted Owl becomes extirpated, the full consequences for forest ecosystems might not be well understood. But if consequences for ecosystem function are minimal, biodiversity values would obviously be lessened.

ABORIGINAL TRADITIONAL KNOWLEDGE

The authors were unable to find any Aboriginal traditional knowledge specifically referring to the Northern Spotted Owl.

EXISTING PROTECTION OR OTHER STATUS DESIGNATIONS

International conventions and agreements

Migratory Birds Convention Act, 1994

Not protected by this act.

Convention on International Trade in Endangered Species (CITES).

All owl species are listed as Appendix 2 under CITES.

Federal and provincial legislation

Species at Risk Act

The Northern Spotted Owl is designated as Endangered and is on Schedule 1 of the Canadian *Species at Risk Act* (SARA). In 2001, the Northern Spotted Owl was assessed to be Canada's highest priority species for recovery by RENEW (Chutter 2004).

British Columbia Wildlife Act

The Northern Spotted Owl and its eggs, active nests, and young receive protection from killing, disturbance, and possession via Section 34 of the *British Columbia Wildlife Act*.

Spotted Owl Management Plan (SOMP)

The history of Northern Spotted Owl management in British Columbia began in 1985 when the first inventories were conducted. A Spotted Owl Recovery Team (SORT) was established in 1990 and an interim conservation strategy was prepared in 1993. SORT's option report was released in 1994 (Dunbar and Blackburn 1994) and a provincial socio-economic impact assessment report followed in 1995. In 1995, the British Columbia government chose one option from the 1994 report and created the Spotted Owl Management Inter-agency Team to develop a SOMP for the Squamish and Chilliwack Forest Districts. In 1997, the SOMP was released as Cabinet Policy (SOMIT 1997a,b).

The SOMP option chosen by the BC government (which was not endorsed by SORT) predicted a 50% chance of stabilizing Northern Spotted Owl populations in British Columbia after a continued short-term decline. It is obvious this plan has failed to meet its objectives as the Canadian population heads rapidly towards extirpation.

For comparison purposes, in the USA, development of the Northwest Forest Plan (NWFP) was motivated by concerns about the overharvest of late-seral forests and the

effects of intensive forest management on the long-term viability of the Northern Spotted Owl. Implemented in 1994, a decade later it remains unclear whether the enactment of the NWFP has improved the conservation status of Spotted Owls. The cause of the decline is difficult to determine because the research needed to establish cause and effect relations has not been done (Noon and Blakesley 2006).

BC Species At Risk Coordinating Office

In April 2006, the BC government announced a 5-year plan to initiate measures to rebuild populations. The plan includes captive breeding and release, moving Spotted Owls to new locations, increasing food sources for Spotted Owls, and managing competing species such as Barred Owls (Chutter *et al.* 2007). The plan also aims to evaluate and revise existing Spotted Owl management areas to ensure they better protect owls. This will be a collaborative effort between the ministries of Environment and Forests and Range, the federal government, First Nations and forest licensees. Options for protection will be very limited if the plan is constrained by a no-net-loss-to-timber-revenue. The province also commits to consultation with Environment Canada to provide an appropriate amount of habitat protection in areas where the 2005 survey reported Spotted Owls, ignoring areas where owls have been found in other years.

Northern Spotted Owl Recovery Strategy

A recovery strategy prepared by the CSORT (Chutter *et al.* 2004) is now posted on the SARA public registry. This strategy points out that conservation involves many challenges because of a complexity of biological, political, social, and economic factors.

Old Growth Management Areas

Through an *Old Growth Order*, British Columbia established provincial old growth objectives to maintain biodiversity values. Old growth retention targets are set for each biogeoclimatic zone and variant within a landscape unit. The primary intent of Old Growth Management Areas (OGMAs) is to represent different ecosystem types but provincial policy is to overlap OGMAs with habitat for species at risk, including Northern Spotted Owl, wherever possible (Chutter *et al.* 2007).

The Forest and Range Practices Act (FRPA)

The *FRPA* contains a number of provisions that contribute to managing Northern Spotted Owl habitat. These include Section 5 (which provides for wildlife biodiversity in forest stewardship plans) and Section 7 (which provides for Species At Risk). For example, recently, seven areas (22,480 ha) have been captured as LTACs through a Section 7 Notice under the *Forest and Range Practices Act* (Chutter *et al.* 2007). Section 7 notices are limited, however, because they are intended to conserve wildlife habitat without unduly reducing the supply of timber from British Columbia's forests. Management of all species at risk is limited to an impact cap of 1% of mature forest by forest district (Chutter *et al.* 2007).

Identified Wildlife Management Strategy

The Northern Spotted Owl is designated as an Identified Wildlife in British Columbia with special habitat protection measures under the BC *Forest and Range Practices Act* (Blackburn and Godwin 2004). Under the IWMS, nine Wildlife Habitat Areas have been established on provincial Crown forest and/or range land, most of them previously designated as LTACs. Wildlife Habitat Areas of sufficient size and quality have the potential to protect owl territories (Chutter *et al.* 2004). There is a no-net-loss provision in establishing WHAs, i.e. for every hectare designated as a WHA, a hectare is removed from elsewhere in the SOMP boundaries.

Other potential legislative tools (*Forests Act, Environment and Land Use Act*, and provisions for *Forest Certification*) (Chutter *et al.* 2007) have very limited utility for conserving Northern Spotted Owls.

Status designations

National and sub-national designations

The Northern Spotted Owl was designated as Threatened in the USA under the US *Endangered Species Act* in 1990. In Canada, COSEWIC assessed the Northern Spotted Owl as Endangered in 1986 based on the first status report on Northern Spotted Owl (Campbell and Campbell 1984). This status was reconfirmed in 1999 (Kirk 1999) and 2000.

The Northern Spotted Owl is Red-listed (since 1989) in British Columbia (CDC 2007).

TECHNICAL SUMMARY

Strix occidentalis caurina

Northern Spotted Owl

Range of Occurrence in Canada: BC

Chouette tachetée

Extent and Area Information

<ul style="list-style-type: none"> <i>Extent of occurrence (EO)(km²)</i> Estimated as occurring in 3.3% of the British Columbia land area (945,000 km²); based on analyses by Harestad <i>et al.</i> (2004) and Pierce Lefebvre (2005) 	32,000 km ²
<ul style="list-style-type: none"> <i>Specify trend in EO</i> 	Declining
<ul style="list-style-type: none"> <i>Are there extreme fluctuations in EO?</i> 	No
<ul style="list-style-type: none"> <i>Area of occupancy (AO) (km²)</i> Estimated by multiplying standard home range size of 3.2 km² x 17 (number of active sites) 	Approx 54.4 km ²
<ul style="list-style-type: none"> <i>Specify trend in AO</i> 	Declining
<ul style="list-style-type: none"> <i>Are there extreme fluctuations in AO?</i> 	No
<ul style="list-style-type: none"> <i>Number of known or inferred current locations</i> 79 known locations since 1985 but only 14 were known to be active in 2006 and 2007 (J. Hobbs pers. comm.) 	17 known locations with at least 1 adult owl in 2005; 14 sites in 2006 and 2007
<ul style="list-style-type: none"> <i>Specify trend in #</i> 	Declining
<ul style="list-style-type: none"> <i>Are there extreme fluctuations in number of locations?</i> 	No
<ul style="list-style-type: none"> <i>Specify trend in area, extent or quality of habitat</i> Habitat supply based on analysis by Chutter <i>et al.</i> (2007) 	Declining currently and forecast to decline for 20 years before stabilizing

Population Information

<ul style="list-style-type: none"> <i>Generation time (average age of parents in the population)</i> 	Ca. 8 years
<ul style="list-style-type: none"> <i>Number of mature individuals</i> 	19 known adults in 2007 based on an essentially complete count (J. Hobbs, pers. comm.).
<ul style="list-style-type: none"> <i>Total population trend:</i> Extirpation is forecast by this report to occur between 2009-2012; based on known ages of known owls and apparent lack of recent recruitment of young owls 	declining
<ul style="list-style-type: none"> <i>% decline over the last/next 10 years or 3 generations.</i> 	Declined at about 10.4% annually 1992-2002 (67% decline over 10 years, 93% over 3 generations)
<ul style="list-style-type: none"> <i>Are there extreme fluctuations in number of mature individuals?</i> 	No
<ul style="list-style-type: none"> <i>Is the total population severely fragmented?</i> 	Yes
<ul style="list-style-type: none"> <i>Specify trend in number of populations</i> 	Number of occupied locations declining; most of these contain a single owl
<ul style="list-style-type: none"> <i>Are there extreme fluctuations in number of populations?</i> 	No
<ul style="list-style-type: none"> List populations with number of mature individuals in each 	

Threats (actual or imminent threats to populations or habitats)

Very low population making it susceptible to stochastic events. High juvenile mortality and no or little current recruitment of young birds into the population. Habitat degradation and loss through logging and conversion of forests to urban/industrial uses. Habitat also susceptible to wildfires and insect outbreaks. Possibly at northern edge of range in BC and limited by climate. Low annual reproductive potential (pairs do not breed every year, fledge 1-2 young when do breed) but adults are long-lived.

Current low numbers, widely separated sites, fragmented habitat and lack of recruitment suggest extirpation in Canada by 2012.

Rescue Effect (immigration from an outside source)

<ul style="list-style-type: none"> • <i>Status of outside population(s)? About 6,000 Northern Spotted Owls estimated to occur in the USA but populations there are declining.</i> 	
<ul style="list-style-type: none"> • <i>Is immigration known or possible?</i> 	Yes
<ul style="list-style-type: none"> • <i>Would immigrants be adapted to survive in Canada?</i> 	Yes
<ul style="list-style-type: none"> • <i>Is there sufficient habitat for immigrants in Canada?</i> 	No
<ul style="list-style-type: none"> • <i>Is rescue from outside populations likely?</i> 	No

Quantitative Analysis

Extrapolation from current trends and population figures suggest extirpation by 2012.

Current Status

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

Status and Reasons for Designation

Status: Endangered	Alpha-numeric code: A2ac; B2ab(i,ii,iii,iv,v); C1+2a(i), D1, E
<p>Reasons 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.</p>	

Applicability of Criteria

Criterion A: (Declining Total Population): Meets Endangered A2ac.
Criterion B: (Small Distribution, and Decline or Fluctuation): Meets Endangered B2ab(i,ii,iii,iv,v)
Criterion C: (Small Total Population Size and Decline): Meets Endangered C1+2a(i)
Criterion D: (Very Small Population or Restricted Distribution): Meets Endangered D1
Criterion E: (Quantitative Analysis): Endangered E (extirpation predicted by 2012)

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Several biologists have spent an incredible amount of time developing various iterations of recovery plans and recovery strategies, and trying to determine the best way to maintain Northern Spotted Owls in Canada. These dedicated professionals include Myke Chutter, Alton Harestad, Louise Waterhouse, Ian Blackburn, Jared Hobbs, Liz Williams, Wayne Wall, John Surgenor, and David Cunnington. Again, the author offers his apologies for anyone missed.

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Authorities consulted

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BIOGRAPHICAL SUMMARY OF REPORT WRITER

John Cooper is a professional ornithologist in British Columbia and has authored over 150 books, academic papers, technical reports, and popular articles on birds and other wildlife. John is a founding partner of Manning, Cooper and Associates Ltd, a consulting company with three offices in British Columbia. MCA specializes in biodiversity studies, forest biodiversity management and policy development, and environmental impact assessments. John is regularly consulted on the status and conservation of birds in British Columbia by the provincial and federal governments, industry, and NGOs. He is co-author of the reference books *The Birds of British*

Columbia Vols. 1-4, Rare Birds of British Columbia and Wildlife and Trees in British Columbia. He has contributed to COSEWIC and conservation of species at risk as author or co-author of COSEWIC status reports for Peregrine Falcon, Northern (Queen Charlotte) Goshawk, Streaked Horned Lark, Spotted Owl and Black-footed Albatross. He has developed SARA Management Plans for Peale's Peregrine Falcon, Lewis's Woodpecker and Flammulated Owl. John has also been the lead or sole author of 12 BC provincial status reports on birds at risk. John is an active volunteer on the Garry Oak Ecosystem Recovery Team, which is leading recovery efforts for several extirpated or rare birds in southwestern British Columbia and on the Coastal Vesper Sparrow/Streaked Horned Lark Recovery Team. Also as a volunteer, John has conducted field surveys and helped NGO campaigns that eventually led to the establishment of Protected Areas in British Columbia including the spectacular Tatshenshini-Alsek Provincial Park and Kitlope Heritage Conservancy Protected Area, is an advisor to local conservation NGOs on Vancouver Island, and raised funds for Ducks Unlimited Canada for more than 20 years. John is also a hunter, fisher and wilderness wanderer whose passion for wildlife and wildlife management was kindled by the wisdom of past generations of outdoorsmen and outdoorswomen. In his spare time he operates a horse farm and consultancy business with his wife Suzanne.

COLLECTIONS EXAMINED

None.