

**COSEWIC**  
**Assessment and Status Report**

on the

**Flammulated Owl**  
*Otus flammeolus*

in Canada



**SPECIAL CONCERN**  
**2010**

**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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Van Woudenberg, A.M. and D.A. Kirk. 1999. COSEWIC assessment and UPDATE status report on the Flammulated Owl *Otus flammeolus* in. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 1-24 pp.

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## COSEWIC Assessment Summary

### Assessment Summary – April 2010

**Common name**

Flammulated Owl

**Scientific name**

*Otus flammeolus*

**Status**

Special Concern

**Reason for designation**

In Canada, this small owl is restricted to older Douglas-fir and Ponderosa Pine forests of the southern interior of British Columbia. The species requires mature coniferous forests with a mosaic of large-diameter, old trees, clumps of dense regenerating younger trees and small patches of shrubby grassland for breeding. The extent and quality of this habitat was significantly reduced through the early to mid-1900s by forest harvest. Ongoing threats include forestry practices that remove large trees and snags, epidemics of insect pests such as the Mountain Pine Beetle and catastrophic fires combined with the species' small population, limited distribution, small clutch size and delayed breeding of males.

**Occurrence**

British Columbia

**Status history**

Designated Special Concern in April 1988. Status re-examined and confirmed Special Concern in April 1999, November 2001, and April 2010.



**COSEWIC**  
**Executive Summary**

**Flammulated Owl**  
*Otus flammeolus*

**Species information**

The Flammulated Owl is the only member of the genus *Otus* in the Americas. It is 15 to 17 centimetres long and weighs 45 to 63 grams in the nonbreeding season. Unlike other small Canadian owls it has dark brown eyes. The scapular feathers are always orange-tipped, hence the name “flammulated”, meaning marked with little flames. The Flammulated Owl territorial call is a distinctive, soft “*boo-boo*”. Genetic studies suggest that there is considerable genetic interchange between populations in different mountain ranges, perhaps not surprising considering their long-distance migration habits and low natal site fidelity. There is only one subspecies recognized in Canada and it occurs within a single biogeographic zone.

**Distribution**

The Flammulated Owl breeds from the southern interior of British Columbia, south through the mountains of western North America to Veracruz and Guerrero in southern Mexico; in winter it is found from central Mexico south and east to El Salvador. In Canada it occurs as a summer resident and breeder west to Lillooet and Riske Creek, north to Soda Creek, Barriere and Radium Hot Springs, and east to the Cranbrook area.

**Habitat**

The Flammulated Owl requires mature coniferous forests with a mosaic of large-diameter veteran trees, clumps of dense regenerating younger trees, and small patches of shrubby grassland. Forests used by the species in Canada are dominated by Douglas-fir, usually with a significant component of large Ponderosa Pines. Flammulated Owls nest in cavities, usually those excavated by Northern Flickers or Pileated Woodpeckers; most nests are in large Ponderosa Pine snags. Most of these older forests have been selectively logged over the past century throughout the species' range. Habitat loss over the past century has likely been dramatic, but the rate of loss has decreased in the last 20 years. Significant recent losses of older forests through beetle epidemics and catastrophic forest fires have resulted in a landscape of younger, denser forests that are much less suitable for both foraging and nesting.

## **Biology**

Most male Flammulated Owls do not breed until three to six years of age, but females likely breed at one year of age. They are relatively long-lived for a small bird; up to 14 years in the wild. Clutch sizes are small (2-4 eggs, mean 3.25). Males maintain territories about 15 ha in size during the breeding season. Flammulated Owls are insectivorous, eating a variety of adult moths, crickets and beetles. They are highly migratory, arriving on the breeding grounds in May, then leaving in September and October for wintering grounds in southern Mexico and northern Central America. Circumstantial evidence suggests that they are preyed upon by larger species such as Barred Owls, and are also killed occasionally by squirrels during competition for nest sites.

## **Population sizes and trends**

Population sizes are difficult to estimate, but the world population is thought to be about 40,000 individuals. In Canada the population estimate is likely somewhere between 1,200 and 2,000 breeding birds. Nothing is known directly about population trends, but it is assumed that the population has declined significantly over the past century throughout the range due to the conversion of older forests to less suitable younger forests. This decline has likely slowed in the past few decades as logging impacts have lessened.

## **Limiting factors and threats**

The Flammulated Owl is a relatively long-lived, slow-breeding species that shows a distinct need for older forests. The main limiting factor is its preference for structurally complex forests that have a mosaic of large, old trees, dead snags with cavities suitable for nesting, and small patches of densely growing younger trees for roosting cover. This forest type has been radically altered across North America in the last century through selective logging practices. The simpler, denser, younger forests that are now common are not suitable for the species, especially for foraging and nesting. Habitat loss through deforestation and degradation is also an issue on the wintering grounds.

## **Special significance of the species**

This is one of Canada's smallest owls and is unusual in being both exclusively insectivorous and highly migratory.

## Existing protection

COSEWIC designated the Flammulated Owl as Special Concern in November 2001, and it is currently listed as Special Concern on Schedule 1 of the federal *Species at Risk Act* and is also protected from direct persecution by the British Columbia *Wildlife Act*. In 1991, British Columbia placed the Flammulated Owl on the provincial Blue List as a vulnerable species. It is included in the Identified Wildlife Management Strategy (BC Ministry of Water Land and Air Protection 2004), allowing Wildlife Habitat Areas to be designated for it. The Flammulated Owl is considered a State Candidate species in Washington and has relatively high management concern in most other U.S. states within its range. It is ranked as G4 (apparently secure) by NatureServe (2008) and S3 (vulnerable) in all states adjacent to British Columbia, where it is ranked S3S4.

## TECHNICAL SUMMARY

*Otus flammeolus*  
Flammulated Owl

Petit-duc nain

Range of Occurrence in Canada: British Columbia

### Demographic Information

Generation time (usually average age of parents in the population; indicate if another method of estimating generation time indicated in the IUCN guidelines (2008) is being used)	5 yrs
Is there an [observed, inferred, or projected] continuing decline in number of mature individuals?  Inferred from loss of habitat	Yes
Estimated percent of continuing decline in total number of mature individuals within [5 years or 2 generations]	Unknown
[Observed, estimated, inferred, or suspected] percent reduction in total number of mature individuals over the last [10 years, or 3 generations].	Unknown, but likely a decline with habitat loss
[Projected or suspected] percent [reduction or increase] in total number of mature individuals over the next [10 years, or 3 generations].	Unknown, but likely a decline with continuing loss of habitat
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over any [10 years, or 3 generations] period, over a time period including both the past and the future.	Unknown, but likely a decline
Are the causes of the decline clearly reversible and understood and ceased?	Reversible: Not likely. Possible to reverse impact of forestry on the very long term with changes in harvest rates and forestry practices. Fire and insect outbreaks, which are not easily reversible, also reduce habitat, however. Understood: Yes Ceased: No
Are there extreme fluctuations in number of mature individuals?	No

### Extent and Occupancy Information

Estimated extent of occurrence	113,000 km <sup>2</sup>
Convex polygon drawn around Canadian occurrences	
Index of area of occupancy (IAO)  The area of occupancy was measured as an Index of AO using, as the smallest area essential at any stage of the life cycle of the owl, the average size of the nesting territory (500 m diameter). Known owl sites were intersected with a 2x2 km <sup>2</sup> grid to generate the value of IAO.	1,620 km <sup>2</sup>
Is the total population severely fragmented?	Not applicable
Number of "locations"	Not applicable
Is there an inferred continuing decline in extent of occurrence?	No – likely stable

\* See definition of location.

Is there an inferred continuing decline in index of area of occupancy?	Yes
Is there an [observed, inferred, or projected] continuing decline in number of populations?	Not applicable
Is there an [observed, inferred, or projected] continuing decline in number of locations?	Not applicable
Is there an observed continuing decline in quality of habitat?	Yes
Are there extreme fluctuations in number of populations?	Not applicable
Are there extreme fluctuations in number of locations?	Not applicable
Are there extreme fluctuations in extent of occurrence?	No
Are there extreme fluctuations in index of area of occupancy?	No

#### Number of Mature Individuals (in each population)

Population	N Mature Individuals
Total	1,200 – 2,000 breeding adults

#### Quantitative Analysis

Probability of extinction in the wild is at least [20% within 20 years or 5 generations, or 10% within 100 years].	None available
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#### Threats (actual or imminent, to populations or habitats)

<ul style="list-style-type: none"> <li>• Forest harvest that removes large trees and dead snags from habitat and subsequent regrowth that creates dense forest with few openings for foraging</li> <li>• Recent epidemics of forest pests, especially Mountain Pine Beetle, have destroyed significant areas of older trees, thus greatly reducing habitat quality</li> <li>• Climate change will likely result in more frequent catastrophic forest fires which destroy habitat</li> </ul>
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#### Rescue Effect (immigration from outside Canada)

Status of outside population(s)?	Likely declining
Is immigration known or possible?	Yes
Would immigrants be adapted to survive in Canada?	Yes
Is there sufficient habitat for immigrants in Canada?	Yes
Is rescue from outside populations likely?	Limited – neighbouring populations are likely declining

#### Current Status

COSEWIC: Special Concern (April 2010)
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#### Status and Reasons for Designation

<b>Status:</b> Special Concern	<b>Alpha-numeric code:</b> Not applicable
<p><b>Reasons for designation:</b> In Canada, this small owl is restricted to older Douglas-fir and Ponderosa Pine forests of the southern interior of British Columbia. The species requires mature coniferous forests with a mosaic of large-diameter, old trees, clumps of dense regenerating younger trees and small patches of shrubby grassland for breeding. The extent and quality of this habitat was significantly reduced through the early to mid-1900s by forest harvest. Ongoing threats include forestry practices that remove large trees and snags, epidemics of insect pests such as the Mountain Pine Beetle and catastrophic fires combined with the species' small population, limited distribution, small clutch size and delayed breeding of males.</p>	

#### Applicability of Criteria

<b>Criterion A</b> (Decline in Total Number of Mature Individuals): Does not meet criterion. No information on declines.
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<b>Criterion B</b> (Small Distribution Range and Decline or Fluctuation): Does not meet criterion. EO is > 20,000 km <sup>2</sup> . IAO is < 2,000 km <sup>2</sup> , but there is no evidence for severe fragmentation, extreme fluctuation in populations, habitat or range and no information on declines.
<b>Criterion C</b> (Small and Declining Number of Mature Individuals): Does not meet criterion. Population size is < 2,500 mature individuals but there is no evidence for extreme fluctuation in numbers and no information on declines.
<b>Criterion D</b> (Very Small or Restricted Total Population): Does not meet criterion. Population size is > 1,000 mature individuals and IAO is > 20 km <sup>2</sup> .
<b>Criterion E</b> (Quantitative Analysis): None available.



### 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 (2010)

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.



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

# **COSEWIC Status Report**

on the

## **Flammulated Owl**

*Otus flammeolus*

**in Canada**

2010

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## SPECIES INFORMATION

### Name and classification

The Flammulated Owl, *Otus flammeolus* (Kaup), is one of the smallest owls in Canada (Order Strigiformes, Family Strigidae). It is the only member of the genus *Otus* in the Americas; the screech-owls were formerly placed in that genus, but are now in the genus *Megascops*. The Flammulated Owl was retained in the genus *Otus* because of a perceived close relationship with the scops owls of Eurasia and Africa. It is known as Petit-duc nain in French and either Tecolote flameado or Tecolote ojo oscuro in Spanish.

Only one subspecies occurs in Canada. The name of this taxon is somewhat controversial as is the state of subspecific taxonomy within the entire species (McCallum 1994), but the latest published review considered *O. f. idahoensis* (Merriam) to be the form found at the northern end of the range, including Canada (Marshall 1978).

### Morphological description

The Flammulated Owl is a tiny owl, only 15 to 17 centimetres long and weighing 45 to 63 grams in the nonbreeding season (McCallum 1994; Figure 1). It has dark brown eyes, unlike all other small Canadian owls, which have yellow eyes. Its plumage is patterned cryptically in grey, dark brown and reddish brown. The scapular feathers are always orange-tipped, hence the name “flammulated”, meaning marked with little flames. It has small, inconspicuous “ear” tufts on the corners of its head. The toes are weak and unfeathered; other Canadian owls have feathered toes. The Western Screech-Owl (*Megascops kennicottii*) looks superficially similar but is about four times the mass; the Northern Saw-whet Owl (*Aegolius acadicus*) is more evenly brown and white (without grey), and lacks the feather tufts on the head. The Northern Pygmy-Owl (*Glaucidium gnoma*) has a proportionately smaller head and longer tail. The Flammulated Owl’s territorial call is a distinctive, soft “*boo-boot*” that is low-pitched for a small owl and very different from the trills typical of its closest Canadian relatives, the screech-owls.



Figure 1. Flammulated Owls: juvenile (above) and adult female (below) (R. J. Cannings photos).

## **Genetic description**

Arsenault *et al.* (2005) extracted DNA samples from 62 Flammulated Owls from four mountain ranges in New Mexico and one in Utah. These samples were cut with the Hae III restriction enzyme and analyzed using DNA fingerprinting methods. Heterozygosity estimates were between 0.74 and 0.81 for New Mexico and Utah mountain ranges. Population subdivision ( $F_{ST}$ ) was higher (0.03 to 0.04) when comparing distant ranges (e.g. those in New Mexico and the Wasatch Mountains in Utah) as compared with  $F_{ST}$  values between adjacent ranges (e.g. the Magdalenas and both the San Mateos ( $F_{ST} = 0.01$ ) and Black Range ( $F_{ST} = 0.00$ )). None of these populations were, however, highly differentiated. This is not surprising considering the long-distance migration habits and low natal site fidelity of this species.

## **Designatable units**

There is only one subspecies recognized in Canada and it occurs within a single biogeographic zone. There are no isolated populations, so a single designatable unit is considered here.

## **DISTRIBUTION**

### **Global range**

The Flammulated Owl breeds from the southern interior of British Columbia, south through the mountains of western North America to Veracruz and Guerrero in southern Mexico; in winter it is found from central Mexico south and east to El Salvador (Figure 2; McCallum 1994).



Figure 2. Distribution of the Flammulated Owl (modified from McCallum 1994).

### Canadian range

About 10% of the global range of the Flammulated Owl occurs in Canada, where it is a summer resident (May to October) in the southern interior of British Columbia (Godfrey 1986). It breeds west to Lillooet and Riske Creek, north to Soda Creek, Barriere and Radium Hot Springs, and east to the Cranbrook area (Figure 3).

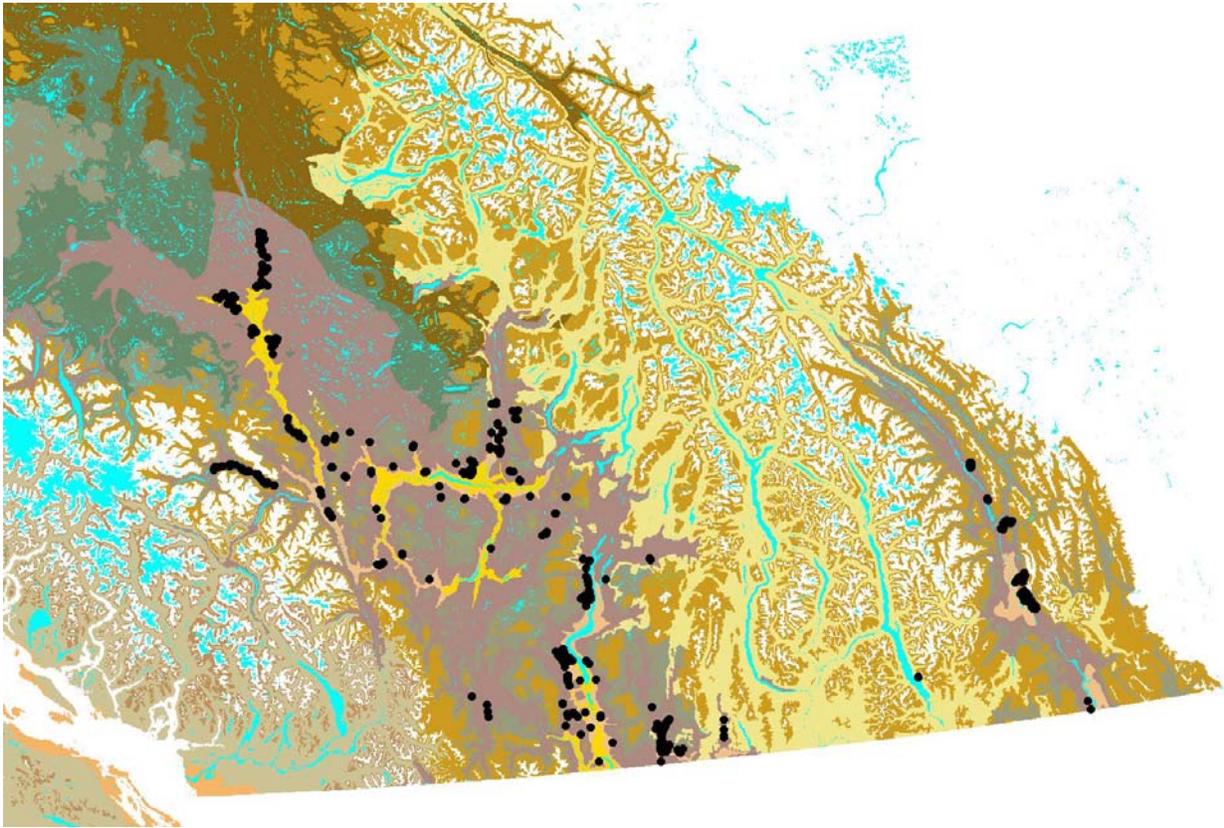


Figure 3. Distribution of the Flammulated Owl in British Columbia. Black dots indicate known sites; background colours indicate different biogeoclimatic zones. The Flammulated Owl is largely restricted to the Interior Douglas-fir zone (purple), where it is found on the ecotone between that zone and the Ponderosa Pine (pink) and Bunchgrass zones (yellow). It is absent from the extensive colder, wetter subzones of the Douglas-fir zone.

A minimum area convex polygon around the known locations in Canada results in an extent of occurrence of 113,000 km<sup>2</sup>. The index of area of occupancy (IAO) is approximately 1620 km<sup>2</sup>, using the average size of the nesting territory (500 m diameter) as the smallest area essential at any stage of the life cycle of the owl. Known owl sites were intersected with a 2x2 km<sup>2</sup> grid to generate the value of IAO.

## HABITAT

### Habitat requirements

In general, the Flammulated Owl requires mature forests with a diverse structural mix of large, veteran trees and snags, denser stands of younger regenerating forest and small grassy openings (Reynolds and Linkhart 1987, 1992, Bull *et al.* 1990, van Woudenberg 1992, Groves *et al.* 1997). Throughout most of its range it prefers older forests of mixed Douglas-fir (*Pseudotsuga menziesii*) and Ponderosa Pine (*Pinus ponderosa*) (Reynolds and Linkhart 1992, Groves *et al.* 1997, Wright *et al.* 1997), and this is certainly the case in Canada (Howie and Ritcey 1987, van Woudenberg 1992, Hausleitner *et al.* 2007). This habitat type occurs at the ecotone between the xeric pine forests and more mesic Douglas-fir forests. Linkhart and Reynolds (1997) found that older, more successful pairs had higher amounts of old forest in their territories as compared to those of younger birds. Wright *et al.* (1997) found that Flammulated Owls did not occupy all apparently suitable habitat, and were more likely to be found in landscapes with large contiguous areas of older Ponderosa Pine-Douglas-fir forest.

Flammulated Owls can be found in rather high densities in pure stands of mature Douglas-fir (Christie and van Woudenberg 1997, Waterhouse *et al.* 1997) but rarely occur in pure Ponderosa Pine stands. In the Cariboo-Chilcotin region, Flammulated Owls were found on steep upper slopes of mature Douglas-fir forests associated with the terrain break between the river valley below and plateau above (Waterhouse *et al.* 1997). Hausleitner *et al.* (2007) found that Flammulated Owl sites in the Carpenter Lake area were in forests dominated by Douglas-firs more than 120 years old.

Flammulated Owls prefer forests with an open character. Christie and van Woudenberg (1997) found that a crown closure of 40 to 50 percent was a good predictor of Flammulated Owl presence on their Kamloops, BC study site, and Manley (2004) reported canopy closures of 15 to 28 percent at nest sites in the East Kootenay region of British Columbia. Groves *et al.* (1997) reported mean crown closures of 52 to 64 percent on owl sites in Idaho. van Woudenberg (1992) found that Flammulated Owls also used denser forests near Kamloops, especially during outbreaks of Western Spruce Budworm (*Choristoneura occidentalis*), which apparently attracted the owls to more mesic Douglas-fir forests in the area.

Flammulated Owls nest in tree cavities, usually those excavated by Northern Flickers (*Colaptes auratus*) in dead pine snags (McCallum 1994). They will readily use nest boxes when available (Cannings and Cannings 1982). In Oregon, Flammulated Owls preferentially select Ponderosa Pine snags with Pileated Woodpecker (*Dryocopus pileatus*) cavities when available (Bull *et al.* 1990) and three nests found in the East Kootenay region of British Columbia were all in Pileated Woodpecker cavities (Manley 2004). Flammulated Owls prefer Ponderosa Pine to Douglas-fir as a species for nesting in British Columbia (Christie 1996, van Woudenberg 1992). In Oregon, 91% of the nests found were in dead trees (Bull *et al.* 1990); 75% of the nests found by van Woudenberg (1992) on Wheeler Mountain, BC were in dead trees and 25% were found in live trees with dead tops.

### Foraging habitat features

Flammulated Owls preferentially forage in open stands of older Douglas-fir and Ponderosa Pine, avoiding stands of younger Douglas-fir (Linkhart *et al.* 1998), although during budworm outbreaks they will glean caterpillars from the canopies of Douglas-fir thickets (van Woudenberg 1992).

The understory characteristics of Ponderosa Pine-Douglas-fir forests are particularly important for insect prey (Reynolds and Linkhart 1987). If insect abundance increases with shrub complexity, and sloped terrain enhances the amount of shrubs within a given horizontal distance, slopes may be selected by foraging owls (6-30%, Christie and van Woudenberg 1998). Steeper terrain may also facilitate escape from predators and accessibility to shrub and ground insects by shortening horizontal distances between habitat structures.

### Security and roosting habitat features

Regenerating Douglas-fir thickets (Howie and Ritcey 1987, van Woudenberg 1992) and large old trees with heavy branching (Linkhart 1984) provide security cover for Flammulated Owls. Studies in both British Columbia and Colorado have shown that Flammulated Owls prefer Douglas-firs to Ponderosa Pines for roosting, undoubtedly because their denser foliage provides greater cover (Linkhart *et al.* 1998, van Woudenberg, unpubl. data).

Hiding cover is also a feature of song trees (Reynolds and Linkhart 1992). In Colorado, radio-telemetry showed that old Ponderosa Pine and Douglas-fir trees (> 289 years of age, on average) were selected for singing. In the Cariboo-Chilcotin region, calling Flammulated Owls used large diameter (mean = 67 cm dbh, range = 30-153.2, SD = 22.5), tall, old Douglas-fir trees (Waterhouse *et al.* 1997).

In summary, suitable breeding habitat for Flammulated Owls must contain specific critical features for foraging, security and nesting. Foraging habitat is generally more open and contains large trees; security habitat usually consists of denser stands of young Douglas-fir; nesting habitat requires large diameter snags with suitable nest cavities.

Wintering habitat is very poorly known, but occurs in pine-oak forests at higher elevations (McCallum 1994).

## Habitat trends

The extent and quality of Flammulated Owl habitat clearly decreased significantly early in the 1900s as larger Ponderosa Pines were harvested throughout the range of the owls (Marshall 1988, McCallum and Gehlbach 1988, Groves *et al.* 1997, Klenner *et al.* 2008). Most large Ponderosa Pines were harvested before 1950, at which time concern was expressed that the harvest in British Columbia was unsustainable (Klenner *et al.* 2008). Old-growth Ponderosa Pine is now considered one of the rarest forest types in western North America (Illg and Illg 1994).

After the large pines were taken, loggers turned to large Douglas-firs (Klenner *et al.* 2008). Dead snags were almost always removed before the felling of live trees began. Logging activity in Flammulated Owl habitat has declined steadily since the 1960s; in that decade alone about 7% of the habitat was harvested in British Columbia. That figure fell to about 5% in both the 1970s and 1980s, and about 1.5% in the 1990s (Klenner *et al.* 2008). Most of the good habitat remaining in Canada tends to be on steep slopes that are difficult to harvest (e.g. Manley 2004).

The combination of selective logging practices that remove large trees and aggressive fire suppression policies since 1950 have tended to create dense forests of young trees, habitat largely unsuitable for Flammulated Owls. While fire suppression is viewed as a problem in this sense, these dense forests have created ideal conditions for catastrophic fires. These fires destroy stands completely rather than burning in the understory to create open forests more amenable to the owls. Although the present rate of forest loss to fire is similar to that in previous drought periods (e.g. 1925-1935, Klenner *et al.* 2008), loss of forests to fire is expected to increase in the region if climate change models predicting longer, hotter summers are accurate (Flannigan and van Wagner 1990).

A second factor that negatively affects Flammulated Owl habitat is the periodic outbreak of insect populations, particularly those of the Mountain Pine Beetle (*Dendroctonus ponderosae*) and the Western Pine Beetle (*Dendroctonus occidentalis*). There are reports cited in Klenner *et al.* (2008) of extensive loss of mature Ponderosa Pines throughout southern British Columbia in the 1930s, including areas where more than half of the large pines had been killed. This cycle is being repeated now in the present epidemic of Mountain Pine Beetle through the province. Essentially all the mature Ponderosa Pines in the Thompson Valley were killed in August 2006 when a

massive flight of these insects blanketed the valley forests. Westfall and Ebata (2008) report that 83,420 ha of Ponderosa Pine in British Columbia were affected by pine beetle in 2007, almost double the figure recorded in 2006. High mortality of Ponderosa Pine is now occurring farther south in the Nicola and Similkameen valleys, and over half of the pines in the Okanagan Valley are predicted to be affected by 2014. This epidemic will produce little in the way of new long-term nesting sites for woodpeckers and owls, since the beetle-killed snags have a half-life of only six years (Landram *et al.* 2002).

Douglas-fir is also subject to periodic massive losses from insects, especially defoliating caterpillars. Both the Douglas-fir Tussock Moth (*Orgyia pseudotsugata*) and the Western Spruce Budworm can kill trees over a large area during outbreaks, but attack trees of all sizes, not only large trees. Flammulated Owls may temporarily benefit during these defoliation outbreaks since they can forage on the moths and even glean caterpillars from the needles (van Woudenberg 2001), but if large tracts of mature trees are killed the long-term effect is clearly negative. These outbreaks increased from the 1960s through the 1990s; in the latter decade alone more than 15% of the Douglas-fir forests in the southern interior of British Columbia was affected (Klenner *et al.* 2008). Westfall and Ebata (2008) report that 847,344 ha of Douglas-fir forests across southern British Columbia were damaged by budworm in 2007.

Although the exact area affected has not been quantified, these factors have certainly changed the majority—in fact, almost all—of the older Ponderosa Pine and Douglas-fir forests in British Columbia into younger, denser forests over the past century. This translates directly into a significant drop in the quantity and quality of Flammulated Owl habitat. Most of this drop occurred from 1930 to 1970, based on forest harvest rates; the rate of this habitat loss has decreased in recent years as forest harvest has declined. Loss of habitat to Mountain Pine Beetle has been high in the past five years, at least in the core of the Canadian range in the Thompson and Nicola valleys, and will continue at a slower pace for the next five years. Habitat loss from catastrophic wildfires is expected to increase according to climate models (Flannigan and van Wagner 1990).

Habitat loss over the past three generations (15 years) is difficult to quantify, but would likely be at least 100,000 ha based on Mountain Pine Beetle effects alone. How this relates to percent loss is difficult to calculate, but it would likely be less than 10% of occupied habitat.

Trends in wintering habitat are little known, but forest harvest is removing older pine forests in Mexico and Central America as well (McCallum 1994), and rates of deforestation through forest harvest and fire greatly exceed rates of reforestation in the pine forests of Mexico (Fisher *et al.* 1995).

## Habitat protection/ownership

About 89% of all known Flammulated Owl sites in British Columbia are located on Crown land with the remaining sites being on private lands. About 75% are on public lands managed for forest harvest and 7.3% are in protected areas (Ecological Reserves, Provincial Parks and Park Reserves, or other Crown Reserves). They have been recorded in three Provincial Parks (Junction Sheep Range, Okanagan Mountain, Columbia Lake), one Wildlife Management Area (Dewdrop-Rosseau Creek), as well as in Churn Creek Protected Area, South Okanagan Grasslands Protected Area, Vaseux Protected Area, Lac Du Bois Grasslands Protected Area, Soap Lake Ecological Reserve, Kettle River Recreation Area, and White Lake Grasslands Protected Area (Cooper *et al.* 2005). Two of the largest of these areas, Okanagan Mountain Provincial Park and Vaseux Protected Area, were almost completely burned in 2003 and most of the Flammulated Owl habitat within them destroyed. Flammulated Owl is listed as accidental in Glacier National Park on the basis of a single record (Parks Canada 2006).

Wildlife Habitat Areas (WHAs) can provide further protection for Flammulated Owl habitat in British Columbia (BC Ministry of Water Land and Air Protection 2004). These areas generally have a core area 7 to 12 ha in size and a 100-m buffer around that. Forest harvest activities are restricted within the core and regulated within the buffer. Twelve WHAs have been created in the East Kootenay region for Flammulated Owls, with a total core area of 184 ha and an additional 136 ha of buffer, although this is only 1% of the timber harvesting landbase (Myke Chutter pers. comm. 2009). WHAs for Flammulated Owls are being considered for other regions in southern British Columbia, but since there is a limit of 1% of the Crown forest landscape allowed for all WHAs combined, managers are giving priority to other species (Orville Dyer, pers. comm. 2009).

Ungulate winter range prescriptions can provide a measure of protection for Flammulated Owl habitat in British Columbia, and there is strong overlap between these areas and owl habitat (Waterhouse *et al.* 1997, Jared Hobbs, pers. comm. 2009). Manley (2004), however, expressed concern that habitat enhancement prescriptions for ungulate winter range in the Rocky Mountain Trench may actually turn suitable Flammulated Owl habitat into a woodland that is too thinly treed to be of use to the owls. Old Growth Management Areas are another Crown land status in British Columbia forests that could protect Flammulated Owl habitat. Analyses of the extent and overlap of these two tenure types with Flammulated Owl habitat are underway, but are as of yet incomplete (Jared Hobbs, pers. comm. 2009).

## BIOLOGY

Until the late 1970s, very little was known about the Flammulated Owl, but a series of detailed studies since then has filled in most important knowledge gaps in the biology of this species.

## Life cycle and reproduction

Flammulated Owls are likely capable of breeding at one year of age and most females likely do breed at that age, but most young males remain unmated for three to six years (Linkhart and Reynolds 2007, B. Linkhart, pers. comm. 2008). Flammulated Owls are relatively long-lived for such a small bird; one banded male was still alive at 14 years of age (Linkhart and Reynolds 2004). Mean generation time is estimated to be about five years.

Flammulated Owls have a small clutch size, normally laying 2-4 eggs (McCallum 1994). The mean clutch size of 10 Canadian nests was 3.3 (BC Nest Record Scheme, Cannings unpubl. data). The mean number of young fledged per nest ranges from 1.43 to 2.3 in various parts of North America; sample sizes from Canada are too low to make any meaningful calculations (McCallum 1994). Linkhart and Reynolds (2006) calculated lifetime reproductive success of Flammulated Owls in Colorado; males produced  $6.9 \pm 1.2$  fledglings over  $4.3 \pm 0.8$  years, while females produced  $4.0 \pm 0.6$  fledglings over  $2.0 \pm 0.3$  years. They also found that relatively few adults produced most of the offspring; 18 percent of females and 24 percent of males produced 50 percent of total young. They concluded that Flammulated Owls are similar to larger raptors in having a low annual reproductive rate and a long lifespan.

Flammulated Owl males had mean home ranges of about 14 ha in Colorado (Linkhart 1984) and about 16 ha in Oregon (Goggans 1986). Flammulated Owls are usually found in distinct aggregations, and areas of suitable habitat often remain unoccupied. Arsenault *et al.* (2002) found 44 territories in New Mexico clumped into groups of 1 to 10 territories; while individual territories may have been on the order of 15 ha in size, the mean area of habitat per territory on the study area was about 55 ha.

## Predation

van Woudenberg (1992) suggests that Flammulated Owls were subject to predation from Barred Owls (*Strix varia*) on her Kamloops study area since radio-tagged Flammulated Owls disappeared from territories when Barred Owls arrived, and were much more cautious in their movements when Barred Owls were around. This interaction might limit Flammulated Owls at the northern edge of their range, but these two species do not overlap throughout most of the Canadian range.

A perhaps more serious interaction is that with both Red Squirrels (*Tamiasciurus hudsonicus*) and Northern Flying Squirrels (*Glaucomys sabrinus*). Both these species compete with Flammulated Owls for nest cavities throughout the Canadian range of the owl, and data strongly suggest they occasionally kill incubating owls in order to take over the cavity (Cannings and Cannings 1982).

## **Diet**

Photographs of nest sites near Kamloops showed that prey deliveries in dry habitat types included a variety of lepidoptera and orthoptera; at nests in mesic habitat types where there was little or no Ponderosa Pine, orthoptera were the most common prey item delivered (at least 50%) (van Woudenberg 2001). In Oregon, orthoptera were also the most common type of prey delivered to nests (Goggans 1986).

## **Dispersal/migration**

Flammulated Owls likely leave their Canadian breeding grounds in September and early October and migrate to southern Mexico and northern Central America (McCallum 1994). Arsenault *et al.* (2005) found high breeding-site philopatry, but low natal-site philopatry in Flammulated Owls nesting in the southern Rocky Mountains.

## **Interspecific interactions**

Flammulated Owls are secondary cavity nesters and depend on woodpeckers, particularly the Pileated Woodpecker and Northern Flicker, to excavate nesting cavities that the owls subsequently use. van Woudenberg (1992) found that Flammulated Owls tended to abandon territories after Barred Owls arrived in the area.

## **Adaptability**

The Flammulated Owl has a rather narrow habitat tolerance throughout its range, requiring mature forests, usually those dominated by Douglas-fir and Ponderosa Pine. It is a secondary cavity nester, requiring the presence of large woodpeckers to excavate these cavities. They will readily use nest boxes if other suitable nest sites are not available (Cannings and Cannings 1982).

# **POPULATION SIZES AND TRENDS**

## **Search effort**

Early inventory activities were nonrandom and centred on the south Okanagan valley and Kamloops area (Howie and Ritcey 1987). van Woudenberg (1992) carried out her Master's thesis research on Flammulated Owls in the Kamloops area. Since the mid-1990s all suitable habitat with roads has been searched, which amounts to more than half of the available habitat of the species in Canada (Table 1). These surveys involved 4117 survey points, although not all these points are unique since some surveys were repeated in following years. The limitations of these surveys are that they will tend to overestimate the number of detections because some survey sites are close enough to each other that some detections probably involve the same bird calling from a nearby site in the same year or the same bird being counted again in a subsequent year.

**Table 1. Flammulated Owl surveys in British Columbia, 1994 to 2007.**

Study	Year	Location	Sites Surveyed	Owls detected
van Woudenberg <i>et al.</i> 2008	1994	Thompson, Nicola, Fraser	723	76
Cannings & Booth 1997	1997	Kettle, Okanagan, Nicola	108	51
Gyug 1998	1998	Kettle, Okanagan, Nicola	507	64
van Woudenberg <i>et al.</i> 2000	2000	Rocky Mountain Trench	266	58
Addison & Christie 2002	2001	Rocky Mountain Trench	160	35
Manley 2004	2003	Rocky Mountain Trench	160	64
Manley 2004	2004	Rocky Mountain Trench	94	96
Hausleitner & Young 2005	2005	Carpenter Lake	224	42
Dyer <i>et al.</i> 2007	2005	Okanagan	273	31
Sawicz <i>et al.</i> 2006	2006	Okanagan, Thompson, Nicola	329	59
Hausleitner <i>et al.</i> 2007	2007	Carpenter & Seton Lakes	297	26
Iredale <i>et al.</i> 2007	2007	Heffley Creek, Kamloops	214	24
Jackett <i>et al.</i> 2007	2007	Kettle, Okanagan	523	157
BC Nocturnal Owl survey	2005	Southern Interior	239	25
<b>TOTAL</b>			<b>4117</b>	<b>808</b>

## Abundance

The world population is thought to be about 40,000 birds (Rich *et al.* 2004), but this is a crude estimate and the quality of the data is given the lowest possible status. Kirk and Hyslop (1988) estimated the Canadian population at about 1,200 breeding pairs (2,400 birds), but this was simply based on expert opinion of habitat availability and known breeding sites. van Woudenberg (2001) estimated a breeding population of 600 to 750 pairs (1,200 to 1,500 birds) in British Columbia. This estimate was based on more extensive surveys and in part on habitat models. Tallies of unique survey points have found a total of 694 sites with owl detections and a total of 808 owls in British Columbia (Table 1). Since there is likely a large nonbreeding population, the actual size of the spring population may be significantly larger. The current estimate of the Canadian population is a figure of > 3,000 individuals (Cooper *et al.* 2005).

In summary, the population of Flammulated Owls in Canada is likely about 1,500 breeding birds, with perhaps another 1,500 nonbreeding birds present as well. A reasonable range for the breeding population would be 1,200 to 2,000 birds (600 to 1,000 pairs).

## Fluctuations and trends

There are no data on population trends anywhere in the species' range because repeated surveys have not been made on a regular basis. The population is generally considered to have declined throughout most of the 1900s when low elevation logging took place throughout western North America, including British Columbia (Howie and Ritcey 1987, Marshall 1988). van Woudenberg (2001) suggests that the Canadian population will continue to decline over the next century as forest habitats become less suitable for Flammulated Owls through succession processes.

## Rescue effect

There is a substantial population of Flammulated Owls in Washington, Idaho and Montana in areas adjacent to the Canadian border. While there have been no population estimates made, the numbers of owl in those three states as a whole is probably roughly similar to the population in British Columbia, based on habitat availability and extent (McCallum 1994). This is a migratory species and long-distance dispersal can occur into Canada from American populations. However, both American and Canadian populations are threatened by the same process—the loss and degradation of breeding habitat—so rescue effect is limited unless habitat losses are reversed.

## LIMITING FACTORS AND THREATS

The Flammulated Owl is a habitat specialist requiring older Douglas-fir and Ponderosa Pine forests with a mosaic structure that includes large-diameter trees, dead snags, openings and small patches of dense young trees. Forest harvest throughout the 1900s altered much of the suitable habitat in Canada, resulting in large areas with smaller trees, few snags and a denser forest structure. There are several studies that suggest that Flammulated Owls are rare or absent in selectively logged areas (e.g. Franzreb and Ohmart 1978, Marshall 1988).

There is a widespread belief among forest ecologists that the dry coniferous forests of western North America have evolved under a regime of frequent cool fires, creating an open understory and park-like structure to the habitat (reviewed in Allen *et al.* 2002). This process would maintain the forest openings that are an important component of Flammulated Owl habitat (McCallum 1994). Fires in low-elevation Ponderosa Pine forests would, however, likely eliminate the understory altogether which would reduce habitat suitability, but these forests are generally not used by the owls to any great extent. Thus, the quality of Flammulated Owl habitat has almost surely been degraded throughout its range since forest fire suppression began, particularly the cessation of prescribed burns set by Aboriginal people until the late 1800s. The extent to which this was the case in southern British Columbia has been downplayed by Klenner *et al.* (2008), who present evidence that these forests occurred in a mosaic of ages and stem densities before widespread logging began in the early 1900s.

The effects of hotter, more sporadic fires are a different matter. Catastrophic firestorms such as those common across southern British Columbia over the last decade (e.g. in 2003, 2009) have certainly destroyed large areas of suitable Flammulated Owl habitat. These events are likely to become more common if climate change scenarios involving longer, hotter summers become the norm in British Columbia (Flannigan and van Wagner 1990).

Recent forest pest epidemics, particularly that of the Mountain Pine Beetle, have removed older Ponderosa Pines throughout large parts of the species' range in Canada, and this process will likely continue for the next few years at least. Western Spruce Budworm infestations in British Columbia are treated by aerial spraying of *Bacillus thuringensis* (Btk). These applications would reduce lepidopteran prey availability for Flammulated Owls, but the effect this has on owl populations is unknown. In 2007, 57,000 ha of the southern interior of British Columbia—the majority of it in Flammulated Owl habitat—was treated with Btk (Westfall and Ebata 2008).

There is strong evidence that the Barred Owl, a recent arrival into the range of the Flammulated Owl, can be an important predator or at least prompt resident Flammulated Owls to leave established territories.

Habitat loss on the wintering grounds is also another threat. There has long been concern over the rate of the loss of temperate forests in Mexico (Fisher *et al.* 1995).

Finally, the Flammulated Owl has a life history strategy more typical of large predatory species—a small clutch size, delayed breeding (at least in males), and a relatively long life span. These factors make it more difficult for the species to recover from a population decline if conditions become more favourable in the future.

### **SPECIAL SIGNIFICANCE OF THE SPECIES**

This is one of our smallest owls, a species about which almost nothing was known 30 years ago. It is unusual as a Canadian owl in being both exclusively insectivorous and highly migratory and is the only species in the genus *Otus* found in the New World.

### **EXISTING PROTECTION OR OTHER STATUS DESIGNATIONS**

The Flammulated Owl was designated by COSEWIC as a species of Special Concern in Canada in April 1988; the status was re-examined and confirmed in April 1999 and in November 2001. The last assessment is based on an existing status report (van Woudenberg 2001). It is listed as Special Concern on Schedule 1 of the federal *Species at Risk Act*. A management plan has been prepared (Cooper *et al.* 2005), and the species is part of the recovery strategy for species at risk in the South Okanagan and Lower Similkameen valleys.

The Flammulated Owl, its nests, and its eggs are protected from direct persecution by the British Columbia *Wildlife Act*. In 1991, British Columbia placed the Flammulated Owl on the provincial Blue List as a vulnerable species (Fraser *et al.* 1999; CDC 2005). It is included in the Identified Wildlife Management Strategy (BC Ministry of Water Land and Air Protection 2004), allowing Wildlife Habitat Areas to be designated for it.

The Flammulated Owl is considered a State Candidate species in Washington (Washington Department of Fish and Wildlife 2003) and has relatively high management concern in most other U.S. states within its range.

It is ranked as G4 (apparently secure) by NatureServe (2008) and S3 (vulnerable) in all states adjacent to British Columbia, where it is ranked S3S4. In Canada it is ranked as N3 (vulnerable) and in the United States it is N4 (apparently secure).

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## BIOGRAPHICAL SUMMARY OF REPORT WRITER

Richard (Dick) Cannings was born and raised in the Okanagan Valley in a family keenly interested in natural history. This early involvement in birds, bugs and plants led him to a university education in zoology, including a BSc degree from the University of British Columbia and an MSc from Memorial University of Newfoundland. He worked for 15 years as the Curator of the Cowan Vertebrate Museum in the Department of Zoology at the University of British Columbia. He left UBC in 1995 to return to his Okanagan roots.

Dick now works half-time for Bird Studies Canada, coordinating Canadian Christmas Bird Counts, the eBird program and the British Columbia-Yukon Owl Survey. His consulting work is primarily centred on endangered species, in particular those in southern British Columbia. He was co-chair for birds on the Committee on the Status of Endangered Wildlife in Canada for eight years. He has served on both the BC Environmental Appeal Board and the BC Forest Appeals Commission. He has written a number of books, including *The Birds of the Okanagan Valley, British Columbia* with brothers Sydney and Robert Cannings; *British Columbia: A Natural History* with Sydney Cannings, *The BC Roadside Naturalist*, *The Rockies: a Natural History* and *An Enchantment of Birds*.

## COLLECTIONS EXAMINED

No collections were examined.