
Inventory Methods for Owl Surveys*

Standards for Components of British Columbia's Biodiversity No. 42

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* Nocturnal owls that respond to call-playback of recorded calls
(Barred, *Strix varia*, Boreal, *Aegolius funereus*, Flammulated, *Otus
flammeolus*, Great Horned, *Bubo virginianus*, Northern Saw-whet,
Aegolius acadicus, Northern Spotted, *Strix occidentalis caurina*, and
Western Screech-owl, *Megascops kennicottii*)

Preface

This manual is 1 of the Standards for Components of British Columbia's Biodiversity (CBCB) series. The series includes an introductory manual (*Species Inventory Fundamentals No. 1*) which describes the history and objectives of the Resources Information Standards Committee (RISC), and outlines the general process of conducting a species inventory according to RISC standards. RISC standards are also available for vertebrate taxonomy (No. 2), animal capture and handling (No. 3), and radio-telemetry (No. 5). Consultants must be thoroughly familiar with these standards before beginning a RISC wildlife inventory.

Occupancy and breeding status surveys are described for 7 species of owls responsive to call-playback surveys in British Columbia; Northern Spotted Owl, *Strix occidentalis caurina*, Barred Owl, *Strix varia*, Western Screech-owl, *Megascops kennicottii*, Northern Saw-whet Owl, *Aegolius acadicus*, Flammulated Owl, *Otus flammeolus*, Great Horned Owl, *Bubo virginianus*, and Boreal Owl, *Aegolius funereus*.

The template for data collection may be downloaded from (<http://ilmbwww.gov.bc.ca/risc/pubs/tebiodiv/index.htm>). Custom data forms can be made for the specific needs of a project using the Wildlife Species Inventory Data capture template available from (http://srmwww.gov.bc.ca/wildlife/wsi/wsi_xt/index.htm). Additional guidance is available at the Wildlife Species Inventory Homepage at: <http://srmwww.gov.bc.ca/wildlife/wsi/index.htm>.



Photo: Jolene Patrick

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Introduction

Owl survey methods vary with species' behaviour, breeding season and nesting habits. This manual describes call-playback protocols to determine occupancy and breeding status for the following British Columbia owls (Table 1):

Table 1. Owl species that respond to call-playback methods.

Species / Subspecies	Code
<i>Otus flammeolus</i> (Kaup) Flammulated Owl ssp: <i>idahoensis</i> (Merriam)	B-FLOW-ID
<i>Megascops kennicottii</i> (Elliot) Western Screech-owl	B-WSOW
ssp: <i>kennicottii</i> (Elliot)	B-WSOW-KE
ssp: <i>macfarlanei</i> (Brewster)	B-WSOW-MA R
<i>Bubo virginianus</i> (Gmelin) Great Horned Owl	B-GHOW
ssp: <i>lagophonus</i> (Oberholser)	B-GHOW-LA
ssp: <i>saturatus</i> (Ridgway)	B-GHOW-SA
ssp: <i>subarcticus</i> (Hoy)	B-GHOW-SU
<i>Strix occidentalis</i> (Xántus de Vesey) Northern Spotted Owl ssp: <i>caurina</i> (Merriam)	B-SPOW-CA
<i>Strix varia</i> (Barton) Barred Owl ssp: <i>varia</i> (Barton)	B-BDOW-VA
<i>Aegolius funereus</i> (Linnaeus) Boreal Owl ssp: <i>richardsoni</i> (Bonaparte)	B-BOOW-RI
<i>Aegolius acadicus</i> (Gmelin) Northern Saw-whet Owl	B-NSWO
ssp: <i>acadicus</i> (Gmelin)	B-NSWO-AC
ssp: <i>brooksi</i> (Fleming)	B-NSWO-BR

Note: Vertebrate species codes in British Columbia use the 4-letter international code with a 1-letter prefix for Class (B for birds) and, optionally, a 2-letter code for the subspecies (RISC 2002).

Call-playback methods can be used to determine the presence or occupancy of a species (see presence/Not Detected surveys in Species Inventory Fundamentals) but they also can be expanded to determine the nature of the residency and details of breeding. An owl may be resident or a floater (a transient, unpaired owl without a territory or mate). The area may be occupied by single owls or by a breeding pair. If a breeding pair is in residence then nesting status, productivity (the number of offspring that have successfully fledged), and dispersal success (the number of offspring that survive to dispersal age) may be assessed.

Surveying for multiple owl species concurrently by broadcasting the calls of various owl species at 1 sample station within the same night may inhibit owl response from some of the species (Olson et al. 2005). Therefore, the use of multi-species call-playback techniques is no longer an acceptable method of surveying for owls.

Call-playback methods can be used for 6 levels of detail regarding owl occupancy and breeding status (Figure 1, adapted from Hobbs et al. 2005). Information gathered using this method may be used in management planning, recovery planning, habitat conservation, and impact assessment and mitigation.

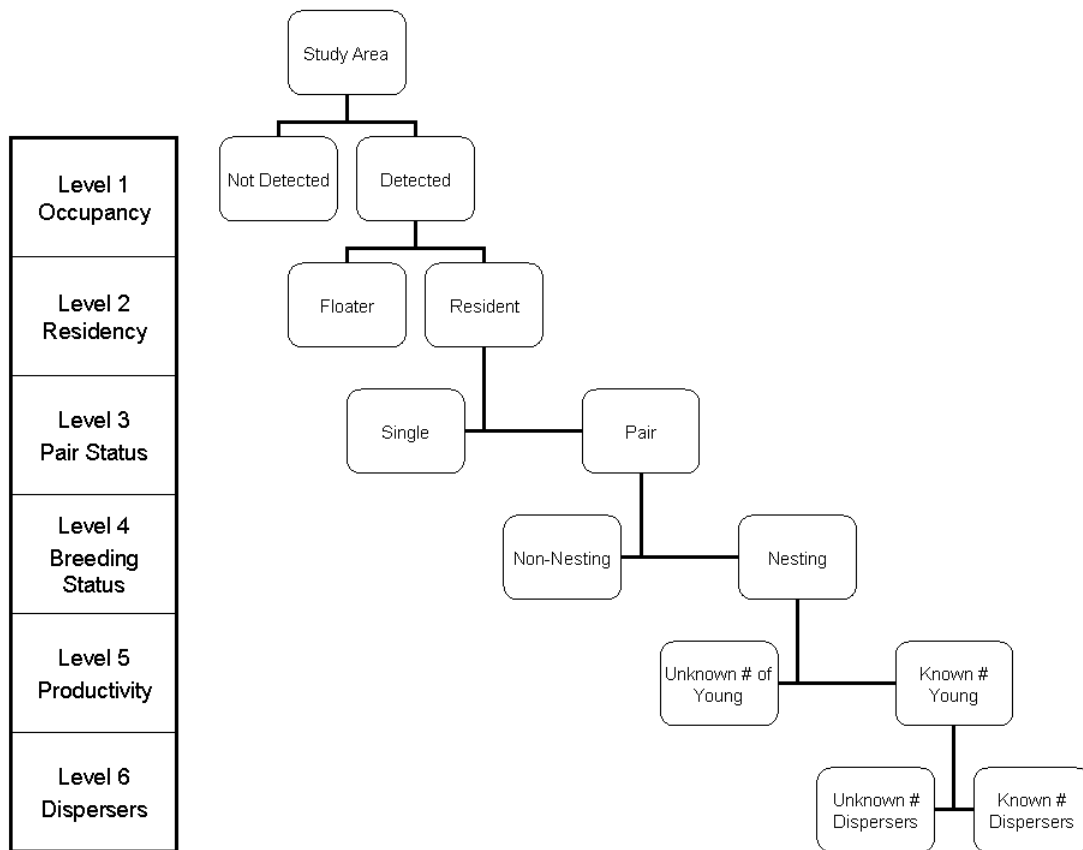


Figure 1. Levels of information in owl surveys.

Preliminaries

Definitions

“Occupied” means demonstrated to be occupied by positive results in a survey. Furthermore, it means at least 1 owl has either established a territory and is living in it, or has not established a territory and was merely passing through it at the time of the survey. The former is “resident” and the latter is a “floater”. These and other status designations are discussed in Appendix 2.

“Not Detected” does not mean absent; it means that, in a full and complete survey that met these protocols, investigators failed to detect it, even though it may have been present. “Not detected” implies that the target species is probably absent and that this uncertainty is measurable and within accepted limits. This term is used in owl call-playback surveys because, in contrast to other types of presence/absence surveys, owls cannot be proved to be absent. The lack of detection, after following all required procedures, is recorded as negative or null data. This is in contrast to the situation in which the observation was incomplete or compromised in some way, in which case no data were obtained. Investigators must be aware; however, that “Not Detected” has this specific meaning, and not the ordinary meaning of the phrase. For surveys that did not meet all requirements of the protocol and did not detect any owls, another status designation must be assigned, such as “survey incomplete”. Although it is not a proper noun, because of the

possible confusion of this technical term with the ordinary meaning, it is capitalized in this document.

Minimum Qualifications for Field Personnel

All personnel must possess:

- knowledge of the calls and ecology of the targeted species,
- the ability to identify the territorial calls of British Columbia owls,
- normal to excellent hearing ability,
- occupational first aid training with transportation endorsement, and
- knowledge of backcountry travel and orienteering.

For Committee on Status of Endangered Wildlife in Canada (COSEWIC) as well as Provincial Red and Blue-listed species:

- one season of documented field experience surveying the targeted species, or
- specific training in the field identification of the targeted owl species.

Office Preparation

Organize paper maps for both office and field use at suitable scales for each survey, and for the project. For topographic maps more than a few years old, you must obtain current magnetic north declinations. If a GIS will be used to manage and display data, set the coordinate system to the provincial standard (RIC 1996). Since paper maps are critical components of field records, an adequate, long term archive facility must be available. If a GPS will be used in the field, ensure that its navigation settings use the provincial standard coordinate system (RISC 2001). Review safety procedures for night time orienteering in the backcountry and ensure that field crews have the necessary safety and other field equipment including spare batteries, notebooks, field survey forms, and pencils. Surveyors must consult with provincial biologists for recommendations on compact disc (CD), MP3 player, or audio tape recordings to ensure that the quality and repertoire of calls is consistent with Ministry standards. This is especially critical for Northern Spotted Owl surveys.

Field Equipment

Field survey equipment for each survey crew is listed below. Additional field safety equipment may be required, as determined by the crew or project supervisor, to ensure compliance with Workers' Compensation Board (WCB) requirements, or to meet project-specific objectives.

Required Equipment

Required equipment includes:

- water-resistant, portable CD player with a repeat function, a memory function, and no audible operating tones,
- recordings of owl calls:
 - Use only single male owl calls for the target species for call-playback.
 - Carry territorial calls of all owls that may be encountered in the study area for reference if an unknown owl calls are heard.
 - Recordings must be of very high quality with a minimum of background noise.
- megaphones that meet or exceed 10 watts and are able to broadcast owl calls without distortion greater than 600 m away under ideal conditions (Fanon™ or Radio-shack™)

- megaphones meet these requirements but must be modified to play calls from CD players),
- at least 2 GPS units plus extra batteries in case of malfunction and/or if crews separate to search different areas,
 - compass,
 - binoculars ,
 - hand-held 2-way radios for each crew member (during daytime breeding surveys),
 - maps that depict habitat suitable for nesting and breeding (i.e., BEC zone, elevation, tree class) reconciled against TRIM topography,
 - clipboard with data forms or a waterproof notebook for data recording, and
 - flashlights, headlamps and extra batteries.

Recommended Equipment

- rechargeable spotlight to confirm species identification or read color bands on some owl species,
- cellular telephone,
- satellite telephone for remote surveys (> 500m from roads),
- emergency contact numbers,
- project biologist contact number,
- digital camera with zoom,
- flash memory recorder (this small device can record and instantly play back an owl's own calls, often inducing it to respond when it is hesitant to respond to a pre-recorded call), and
- laser pointer (a pointer minimizes conversation, and hence disturbance to the owl, by obviating the need for investigators to try to tell each other where to look in a dark forest where all trees look alike; but investigators must take care not to shine them in any animals' eyes. The stronger ones designed for large auditoriums and powered by 2 AAAA batteries are recommended.).

Project Design

Survey Objectives

Occupancy surveys can be designed to determine all the owl species in an area or a single species. The project may be limited to occupancy (presence/Not Detected) or may also investigate breeding status and productivity. When determining species occupancy alone, use a systematic design and follow the procedure for initial detections only. If the objective of the survey is to determine breeding status and productivity as well, then you must perform visual searches for owls in addition to initial detections. If the goal of the survey is to re-examine known habitat or to target specific locations on a limited budget, use a strategic design to target those areas.

Systematic Surveys

Study area size depends on the home range of the species of interest. Design the survey to completely sample all suitable habitat. Wherever possible, use habitat maps in the survey design. Begin by stratifying the study area by habitat type and quality and then systematically place

transects within the strata. You may also omit areas where noise or other factors influence acoustics. In practice, transects typically follow ridges or valleys.

Place the sample stations at roughly equal intervals along transects. Choose transect length and inter-station distances appropriate to the species' vocal and auditory range and typical distribution patterns (Table 2).

In extremely steep or difficult terrain, add sample stations off the transect lines for more complete sampling. Additional sample stations may also be added to target previously identified nest or roost sites (see Spot Checks below).

Spot Checks

Spot checks are not systematic surveys of entire study areas, but are instead examinations of points or small areas within a study area. They are used to ascertain the status of previously documented residency or nesting or to check small forest patches in fragmented landscapes. They are used in the following types of situations:

- a single call station where surveyors call all night,
- a single call station to confirm the continued presence of an owl or pair previously detected,
- small forested patches with little or no suitable owl habitat between them and where continuous transects would be impractical, and
- call stations accessible only by helicopter, where multiple stations along a transect would be impractical.

Survey Timing

Owls are less vocal and more difficult to locate outside the breeding season (Forsman 1983, Hayward and Hayward 1993, Mazur and James 2000, Cannings and Angell 2001), or they may migrate from the region (McCallum 1994). Furthermore, detections outside of the breeding season are often floaters (transient owls), dispersing juveniles, or migrating adults. Because of this, conduct surveys during the breeding season of the target species. Breeding seasons begin at the onset of courtship in spring until adults stop feeding the young, prior to juvenile dispersal in fall (Table 2).

While many owl species do respond to acoustic lures during the daytime, the likelihood of response is greatly diminished. For example, nocturnal owl species only respond to call-playback during the daytime when the call is broadcast within a few hundred metres of the owl's daytime roost location (Forsman 1983, Mazur and James 2000). Peak activity and responsiveness for nocturnal owls begins within about 30 minutes after sunset and ends before sunrise. Conduct initial occupancy surveys during this time.

The number of repetitions required varies according to the species. Separate sampling repetitions equally over the breeding season and ensure that the sessions are at least 5 days apart. Reverse the order that you visit sampling stations between repetitions of the survey to vary the time of night that sampling occurs at each station. For some owls, response rates decline as the time from sunset increases.

Adverse weather, dense vegetation, social status, breeding condition, or presence of other owl species may confound owl responses on any given day (Wintle et al. 2005). Because of this,

increase the number of sampling sessions rather than the duration of individual sessions to improve survey effectiveness.

When estimating productivity, if the time interval between the actual fledging date and the date of the survey is long, the number of fledglings may be underestimated. This is because fledglings may die or disperse prior to the survey. To guide survey planning, the estimated dispersal dates are provided for each species (Table 2).

Table 2. Seasonal timing, inter-station distances, and duration of owl call-playback surveys.

<i>Owl Species</i>	<i>Occupancy</i>	<i>Pair Status</i>	<i>Nesting Status</i>	<i>Productivity Status</i>	<i>Dispersal Status</i>	<i>Maximum Inter-station Distances (m)</i>	<i>Duration of Call-playback (min)</i>
Barred Owl	15 Mar –15 Sept	15 Mar –15 Sept	1 Apr –1 June	1 June –1 July	1 Aug –15 Sept	500	15
Boreal Owl	1 Feb–15 Aug	1 Feb–1 Aug	15 Apr –1 Aug	15 June–1 Aug	Not available	700	15
Flammulated Owl	15 May–15 Aug	15 May –1 Sept	15 June–1 Aug	1 July –15 Aug	15 Jun –1 Sept	500	15
Great Horned Owl	1 Feb–1 Sept	1 Feb –30 June	1 Mar–15 July	15 Mar –15 Aug	1 Sept –1 Nov	600	15
Northern Saw-whet Owl	15 Feb –15 Sept	15 Feb –15 July	15 Mar–30 June	15 May –15 July	15 Aug–1 Sept	500	15
Northern Spotted Owl	1 Apr –30 Sept ^a	1 Apr –30 Sept	15 Apr–15 June	15 June –15 July	15 Aug–15 Sept	500	15
Western Screech-owl	1 Feb–1 Sept	1 Feb–1 Sept	1 Apr –15 June	15 April –15 Aug	30 June–1 Sept	300–500	15

^a 1 April was chosen as the commencement date to increase the probability that Northern Spotted Owls are defending territories and/or nesting. Protocols for Oregon and California suggest a 1 March to 15 March commencement date.

Strategic Sampling

You may use strategically placed sample stations — a type of spot check — in core habitat areas as an alternative to a transect layout. This design option emphasizes optimum habitat and may be suitable when returning to a known location or when logistics or the budget prevent a more systematic approach. When using this option, position the stations close together and sample all stations on 1, or at most 2, consecutive nights. Even though this survey design is intended to focus on a core area of interest such as a large forest stand of suitable habitat, include all areas that might be within the home range of the resident owls in the study area.

When using strategically placed sampling sessions, the maximum cumulative time spent must be 4 hours. Add 15 minutes of sample time for every additional 250 m increase in distance between stations. For example, stations spaced 500 m apart receive 30 minutes of sample time. The maximum sample station interval is 1,000 m with a sampling time of 60 minutes. If the sampling intervals are greater than 15 minutes, the pauses between call-playbacks must be increased.

Weather and Noise

Do not conduct surveys in high winds (> Beaufort 3), rain, snow, heavy fog, abnormal temperatures, or loud noise (turbulent streams, machinery, highway traffic). These factors influence owl behaviour and responsiveness and they may adversely influence owl detection (Palmer 1987. Table 3 summarizes acceptable and unacceptable weather conditions

Table 3. Acceptable and unacceptable weather conditions for raptor surveys.

Condition	Acceptable	Unacceptable
Wind	Beaufort 0 (< 2 km/hr). Smoke rises Beaufort 1 (2–5 km/hr). Some smoke drift Beaufort 2 (6–11 km/hr). Leaves rustle Beaufort 3 (12–19 km/hr). Leaves & twigs in motion	Beaufort 4 (20–29 km/hr) Raises dust, small branches move Beaufort 5 (30–39 km/hr). Small trees sway Beaufort 6 (> 40 km/hr)
Precipitation	None Light drizzle Light snow	Steady rain Heavy snow
Temperature	Ideally, temperatures should be close to the season average. Be aware that equipment malfunctions in cold conditions (< 10 °C). There is evidence that some owls may be less vocal in cold weather (Takats et al. 2001).	

From: Biodiversity Inventory for Raptors (RISC 2001)

Field Procedures

There are 2 parts to call-playback surveys. First, initial detection or occupancy surveys use call-playback to find the owls. After owls are detected, visual surveys confirm identification and provide additional information regarding breeding status and productivity. Figure 2 illustrates the call-playback procedure.

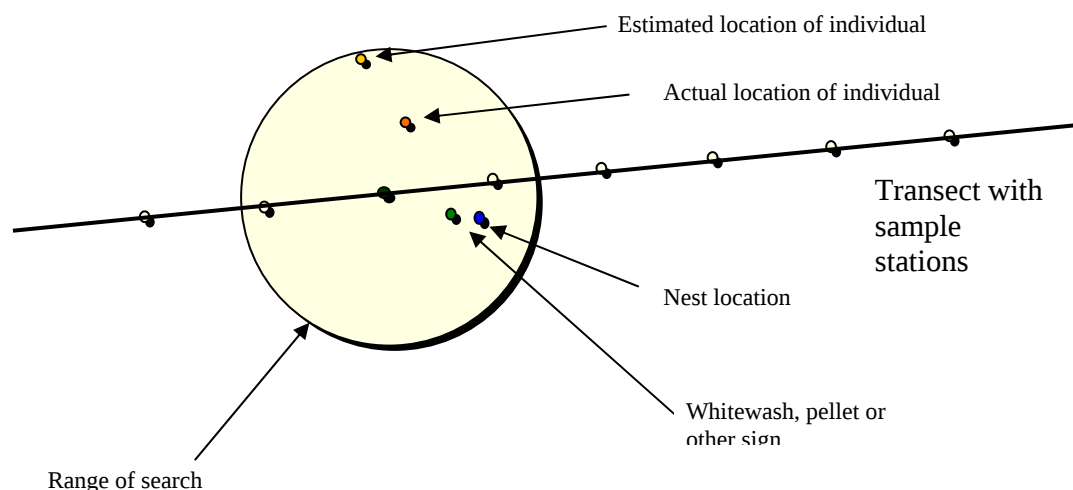


Figure 2. The components of call-playback owl surveys.

Before departing, ensure that field personnel have the required forms in sufficient quantity, maps, spare pencils, spare batteries, and other equipment. Check that the GPS navigation settings are set to the provincial standard coordinate system (RISC 2001) and ensure that field personnel know and follow these procedures. Check that the current magnetic declination is set on the compasses of all personnel.

Initial Detections (Call-Playback Occupancy Surveys)

After arriving at each sample station, begin timing the call-playback sample time immediately. Broadcast the call for approximately 1 minute then listen for a response for at least 4 minutes. Broadcast at least once and up to 3 times per sample station, totalling 15 minutes at each station when sample stations are greater than 250 metres apart. Add additional broadcasts if the audio range is compromised by ambient noise, or if you suspect that an owl is nearby.

Hold the megaphone at chest height or higher. Aim the call in various directions for each broadcast. Broadcasts must be without distortion and loud enough to be heard by the surveyors from 1 station to the next under normal sampling conditions. Record the total elapsed time (the sum of the broadcast times plus the pauses) as Total Sample Effort.

If no owl is detected, complete the required data fields on the survey form as a null observation and move to the next sample station. If an owl is detected, halt broadcasting immediately and continue listening. Listen for mates or juveniles as well. Determine the direction to the calling owls from at least 2 listening positions. Plot the compass bearings on a map, use triangulation to approximate

locations of any owls detected, and record the estimated location. Record ("mark") the GPS waypoint and write the GPS waypoint label in your field notebook.

Owls may start moving towards a mate, a core roost area, or a nest area. Record position changes to identify the general direction that the owl is moving. In addition, if the same owl is detected at a subsequent station cease broadcasting and listen for a mate, juvenile or second territorial pair through the full 15 minutes for that station. Record observations of all owl species heard during the session even if the project is targeting a specific species.

Visual Searches for Owls

Visual searches are performed after an initial detection is made, to confirm the location and species. They are also used to determine pair status, condition of nests, the number of nestlings, and dispersal status of fledglings. When conducting a visual search, begin 1 hour before dawn on the day following the initial detection. As you walk towards the estimated location from the previous night, start broadcasting 100 to 200 metres away from it. Broadcast calls for approximately 10 minutes every 30 minutes and use a lower broadcast volume than during the initial detections. Move quietly and slowly (between 0.5 and 2.0 km per hour).

If you arrive at the estimated position and you still have not located the owl, survey around the area in concentric circles of increasing radius. Stop the survey if an owl is undetected within 4 hours and resume searching at sunset. If you have not located the owl at this point, it may have moved. To determine whether the owl is still in the area repeat the initial detection protocol for the full transect during the next night.

Cease broadcasts immediately if the owl responds to avoid alarming it, since continued broadcasting may cause the owl to abandon its territory or nest. At this point, move as quickly and quietly as possible towards the owl, stopping only to re-affirm its position.

As you continue the visual search, record the location of owl nests, whitewash, pellets, feathers, and prey remains either as a separate data record or in the same record if more than 1 piece of evidence occurs at the same location. Place each owl pellet in a plastic bag and label the bag with survey name, suspected species, and location (UTM) for subsequent analysis.

If you hear the owl but cannot see it after broadcasting, move to the owl's suspected position and conduct an intensive visual search. Wait at least 1 hour before attempting to rebroadcast. Adjust the volume of the call so that it can be heard between 50 and 100 m. Broadcast a single call then pause for 5 minutes before calling again to reduce disturbance to the owl.

Considerations Relative to Mode of Transport

- Surveys may be conducted on foot or by using automobiles, boats, or a helicopter.
- When on foot, if a well defined trail exists that allows surveyors to travel from station to station with a minimum of noise, include the time spent walking between sample stations in total search effort (the total time of call-playback for that sample station).
- Position surveyors 50 metres apart to optimize listening capacity and area.
- Walk when conducting targeted sample sessions (Spot checks).
- When using a motor vehicle; do not sit in the vehicle while listening for responses.
- Instead, 1 surveyor may drive the vehicle to the next sample station and begin the call-playback recording while the other surveyor walks between the stations listening for responses.

- To facilitate pick-up and drop-off when conducting surveys in remote areas via helicopter, initiate the sampling at the transect centre. During the day, begin at the centre point and move outward, plotting the transect route and stations for the evening's work. At night, initiate call-playback broadcasts at the periphery of the area and follow the transect routes back to the centre. The following day repeat this procedure for the other half of the area. In this way, 3 survey teams can sample half of a remote area the first night and the other half during the second night of the session.

Safety Protocols

- Follow Workers' Compensation Board (WCB) and any other applicable standard requirements for safety and first aid certification.
- Design the survey and map transects and sample stations prior to commencement of the field work.
- Sketch a map of notable landmarks to aid nocturnal navigation.
- Visit routes and stations during daylight hours before conducting the nocturnal survey.
- Before starting the survey, record the waypoints of the vehicle parking spot, and/or the campsite in the memory of the GPS unit and on the survey form. During the survey, record the waypoints of the sample stations.

Field Protocols

- Minimize conversation and movement during listening periods.
- Minimize contact with owls and avoid unnecessary disturbances.
- During daytime breeding surveys, cease call-playback broadcasts if owl predators such as Great Horned Owl (*Bubo virginianus*), Northern Goshawk (*Accipiter gentilis*), Red-tailed Hawk (*Buteo jamaicensis*), Common Raven (*Corvus corax*), and for some species, the Barred Owl (*Strix varia*) are detected.
- Do not provide live prey to owls beyond what is necessary for status determination. Owls may habituate to human contact and food supplements.
- Do not broadcast recordings of owl pairs in which both males and females can be heard calling.
- Do not aim flashlight or laser pointer beams directly at the owls' eyes, as it may temporarily blind them and endanger their flight.

Other Recommendations

- Reduce survey overlap and minimize owl harassment by coordinating with other inventory efforts.
- Report COSEWIC/Provincial Red and Blue-listed owl detections to regional biologists and to the Conservation Data Centre (CDC) immediately. CDC rare animal observation data forms are available at <http://www.env.gov.bc.ca/cdc/contribute.html>.

Data Collection

Use the owl data template provided with this manual to organize transects during survey design, for generating field forms, and for final data collection. The template is a Microsoft® Excel worksheet and is required to load data into the provincial database. The following tables illustrate the column headings of the template. At the end of each project, send the completed Owl Data Template to the Ministry of Environment as described at <http://srmwww.gov.bc.ca/wildlife/wsi/contributions.htm>

There are 3 parts to data collection. First record the project metadata (Table 4). Second, define the transect sampling stations on the Sample Station worksheet (Table 5), prior to entering the field. Third, add field data to the Sample Station and Call Playback and Visuals worksheets (Table 5 and Table 7). Some owls, such as Northern Spotted Owl, require additional field procedures and data collection (Table 8).

Table 4. Project metadata.

Project Metadata	Project Name Project Agency Project Coordinator Project Start Date Funding Agency Name Funding Agency Project ID BAPID MOE Region	Project ID. Obtain the project ID when you register the project
Survey Metadata	Survey Name Survey Start Date Survey Type Survey Intensity Target Taxa Surveyors' Names Survey Objectives	
Study Area Metadata	Study Area Name Study Area Description	

Table 5. Sample Stations Worksheet.

Study Area Name:	
DC Type	Sample station
Sample Station Label	Sample station name or number
Sample Station Zone	Sampling station UTM
Sample Station Easting	
Sample Station Northing	
Sample Station NAD 83 or 27?	

Table 6. Sampling Conditions Worksheet.

Observation # Study Area Name: Sample Station Label Sample Station Visit Date Sample Station Visit Time	
Air Temperature (°C) Wind speed Class Wind Direction Class Rainfall Over 24 hours Rainfall Over 48 hours Cloud Type Ceiling Cloud Cover Class Official Sunrise Precipitation Class Lunar Phase Class Temperature Variance Prec 48hr Air Temp Prec 48hr Wind Speed Prec 48hr Precip Prec 48hr Cloud Cover Class Sampling Condition Note	

Table 7. Call Playback and Visuals Worksheet.

General	Observation # Study Area Name Sample Station Visit Date Sample Station Visit Time Sample Station Visit Date & Time Sample Station End Time Sample Station Label Surveyor Species Count UTM Zone UTM Easting UTM Northing NAD 83 or 27?	Some data devices nest date and time. In that case enter here Sample station name or number Of species or sign Actual or projected location of a bird or sign. If nothing is observed, do not enter UTMs.
Initial Detection/Visual Search	Time Elapsed at Station Response Time (mm:ss) V/C Call Type Detection Direction (degrees) Dist to Detect (m) Detection Duration (mm:ss)	
Visual search	Bird ID Activity or sign Actv Desc Sex Life Stage	
Visual search/ Nest	Nest Label Nest Stage Nest Type Nest Ht (m) Supp Struct Tree Species DBH (cm) Tree Ht (m) Slope (Deg) Aspect	

Table 8. Additional survey observation data specific to Northern Spotted Owl, within the Call Playback and Visuals Worksheet.

Live Lure	Prey offered
	Number taken
	Live Prey Fate
	Pair Status
	Breeding Status
	Productivity Status
	Dispersal Status
	Dispersal Date

Table 9. Nest Surveys Worksheet.

General	Observation # Study Area Name Sample Station Visit Date Sample Station Visit Time Sample Station Visit Date & Time Sample Station Label Surveyor Species Count UTM Zone UTM Easting UTM Northing NAD 83 or 27?	Some data devices nest date and time. In that case enter here Sample station name or number Of species or sign Actual or projected location of a bird or sign. If nothing is observed, do not enter UTMs.
Nest Surveys	Nest Label Occupied Nest Stage Adult Present Nest Count – F Nest Count – H Nest Count – I	

Species-Specific Survey Requirements

These species-specific survey notes supplement or clarify the previous sections that apply to all species. For occupancy and breeding survey timing for all species, see Table 2. Additional life history information is given in Appendix 1.

Barred Owl

B-BDOW, *Strix varia*

Survey Timing

Barred Owls are highly responsive to taped recordings during the breeding season (RISC 2001) and although they will respond diurnally, the ideal calling time begins half an hour after sunset and ends before sunrise. Peak vocalization times appear to be prior to egg laying and again in the fall corresponding to dispersal of young (Mazur and James 2000).

Nests can be located through triangulation at night or during daytime follow-ups to previous detection areas or known core and nesting areas. Call-playback can be used during daytime to help determine nesting status (Mazur and James 2000). Unpaired, non-resident owls of this species may be identified as floaters.

Sample Station Procedures

Field surveyors must know the calls and ecology of the Barred Owl, know the territorial calls of owl species within the study area, and be able to identify calls of any Northern Spotted/ Barred Owl hybrids.

Because Barred Owls typically respond slowly to broadcasts and response rates increase rapidly in the initial 15 minutes of survey effort, surveyors must listen for a long time after the initial broadcast (McGarical and Fraser 1985). Surveyors must watch carefully for approaching individuals, because many (e.g., 47% of those surveyed in Connecticut: McGarical and Fraser 1985) fly silently to the sample station prior to vocalizing.

When walking between sample stations, wait at least 8 minutes at each station to ensure that at least 15 minutes of search effort is spent per 500 m interval (i.e., if > 250 m spacing is used, more survey time at each station is required). Spacing between stations must be 250 m (range 150 to 350 m) apart.

When driving between sample stations, surveyors must spend at least 15 minutes per station. Sample stations must be spaced about 500 m apart (400 to 800 m).

Transect lengths depend on survey objectives but must cover a minimum of 8 stations over 4 km to survey the typical home range of a Barred Owl (Appendix 1).

Home Range Size

Home range size has not been estimated for this species in British Columbia. Annual home range averaged 971 ha (572–1,766 ha, $n = 8$) in Saskatchewan (Mazur and James 2000). Breeding home range has been estimated as 526 ha in Washington (Pearson and Livezey 2003). Home ranges for the species are considerably larger in winter than summer (Mazur and James 2000).

Boreal Owl

B-BOOW, *Aegolius funereus*

Survey Notes

Detectability for the Boreal Owl is highly variable annually, seasonally, and on nights with little calling during low prey years (Hayward et al. 1987, Palmer 1987). For this reason, multiple repetitions of survey transects over multiple years are recommended for long term trend evaluation.

Survey Timing

Occupancy surveys for Boreal Owls must coincide with nightly calling, which typically begins within an hour of sunset and continues throughout night (Palmer 1987). Daytime responses are rare (Hayward and Hayward 1993). In Idaho, calling intensity was greatest prior to midnight but could be heard anytime prior to dawn. Call initiation varies from dusk to > 4 hours after dark (Hayward and Hayward 1993).

The peak calling period in British Columbia was from late January to early April (Cannings 1986). Peak calling periods reported in Idaho, Colorado and Alaska were late March, late April, and mid-February to March, respectively (Hayward and Hayward 1993). The greatest likelihood of response in British Columbia is from February to early April.

Nests can be located at dusk or at night with a spotlight by approaching a male that is calling from a nest cavity (RISC 2001). These cavities must be confirmed later in the breeding season. A daytime follow-up to the nest cavity and rubbing or tapping on the nest tree may facilitate locating nesting cavities. Dispersal dates are unknown for the species.

Sample Station Procedures

In Northern Ontario, 50%–60% of owl responses occurred within the first minute of a 3-minute listening period (Francis and Bradstreet 1997). Humans can frequently hear the call of the Boreal Owl from 1.5 km to 3.5 km away (Hayward and Hayward 1993).

Each sample station requires 15 minutes of survey time with at least 700 m between stations (Palmer 1987). Transect lengths depend on survey objectives but must cover a minimum of 8 stations over 4 km to survey the typical home range of a Boreal Owl (Appendix 1).

Home Range Size

Boreal Owls in central Idaho used home ranges extending along drainages with nest sites in the lower elevations of home ranges and roosting and foraging throughout (Hayward et al. 1987). Winter ranges covered 1,451 ha ($\pm$ 522 CI, n = 13, range = 320–3,390 ha), while summer ranges extended to 1,182 ha ($\pm$ 334 CI, n = 15, range = 229–2,386 ha) (Hayward et al. 1987).

Flammulated Owl

B-FLOW, *Otus flammeolus*–Blue-listed

Survey Notes

The numbers of birds detected by audio-visual searching alone may be a misleading indicator of population abundance. Successive years of survey and nest site searches indicated that clusters of calling birds were often attributed to a single nest location (van Woudenberg and Christie 1997). Therefore, nesting must be confirmed so that population estimates can be made with greater confidence (van Woudenberg 1999). Additionally, surveys must be repeated seasonally over multiple years.

Survey Timing

Flammulated Owls respond best to audio broadcasts and imitated calls between a half hour after sunset and a half hour before sunrise (Reynolds and Linkart 1998). After hatching of nestlings, calling is later at night (McCallum 1994). Flammulated Owl surveys conducted in British Columbia to determine distribution or occupancy must be conducted during territory establishment and incubation and prior to hatching (Appendix 1).

Nests can be located through triangulation (van Woudenberg and Christie 1997), stealthily approaching calling birds or viewing potential cavities from a blind (RISC 2001). Daytime follow-ups to projected/triangulated calling locations will help locate potential nesting cavities.

Positive responses of Flammulated Owls later than October are believed to be incidental migrants whose migration has been disrupted (van Woudenberg 1999). Floater status is not applicable to this species because it is not a year-round resident.

Sample Station Procedures

Sample stations require at least 15 minutes of survey time each and must be no more than 500 m apart (Howie and Ritcey 1987). Howie and Ritcey (1987) felt that transect sample stations greater than 500 m apart may underestimate the actual number of birds present by up to 50%, due to complex terrain and acoustics not allowing the birds to hear the callers. Under ideal conditions, nests have been documented as close as 300 m (McCallum 1994).

Because each sample station represents a potential home range size of the species (Appendix 1), transect length depends on survey objectives but must cover the entire amount of suitable habitat in the study area.

Home Range Size

Breeding home range size estimates from British Columbia are poorly documented, although foraging distances have been > 500 m from nests (Cannings and van Wouderenberg 2004). Home ranges sizes reported from 2 nests in British Columbia were estimated at 2.2 ha and 3.7 ha (Cannings and van Wouderenberg 2004). Home range estimates from Colorado and Oregon are approximately 16 ha (McCallum 1994).

Great Horned Owl

B-GHOW, *Bubo virginianus*

Survey Timing

Great Horned Owls are most active ≤ 1 hour after sunset until sunrise. The peak calling period near Calgary, Alberta was 12–17 February (Houston et al. 1998).

Males typically roost and call from the immediate nest vicinity and females respond with at least 1 to several hoots, or the pair may duet for a while immediately after dusk. Through triangulation, this behaviour will aid in locating owl nests by revisiting the site in daylight (Houston et al. 1998). Additionally, signs of Great Horned Owl nest or roost sites include the presence of whitewash, prey remains, or pellets. A distinguishing feature of an active nest site is the presence of down on the edge of nests or adjacent branches (RISC 2001).

Positive responses of Great Horned Owls in non-breeding periods may indicate owl presence as members of a pair often remain on the same territory year-round, often over several years (Houston et al. 1998). However, negative results outside of the breeding period cannot be interpreted as absent. Non-breeding individuals remain in the population as floaters (Houston et al. 1998).

Sample Station Procedures

Each sample station requires a minimum of 15 minutes listening time after initial broadcasts. Recommended distance between sample stations has been as great as 1.0 km (e.g., Doyle 2000) but must be no more than 600 m in the terrain and acoustic conditions of British Columbia. Transect lengths must be at least 2 km to cover the minimum home range of the species (Appendix 1) or cover the entire section of suitable habitat within a study area.

Home Range Size

Territorial sizes taken from daily location of owls in southwest Yukon from early February to late April ranged from 230 to 883 ha (average 483 ± 40 SE, $n = 16$) (Rohner 1997). Home ranges of 7 floaters overlapped with those of territorial birds and averaged 725 ha, 5 times the size of those of territory owners (Rohner 1997).

Northern Saw-whet Owl

B-NSWO, *Aegolius acadicus*

Ssp. brooksi—Red-listed

Survey Timing

The territorial call is given within a half-hour of sunset to just before sunrise. Early in the breeding season, call-playbacks will often elicit a short burst of response at midday (Cannings 1993). Emphasize surveys in the peak period of vocal activity 15 February to 15 July (Appendix 1). The peak calling period in southern British Columbia is late February and early March (Cannings 1993). Call-playback surveys in Ontario decreased in efficiency with increasing survey date (Swengel and Swengel 1997).

Nests can be identified through triangulation of nocturnal calls and daytime visits to identify potential cavities. Some females may respond to a nest tree being rubbed (Hausleitner, personal

observation) or tapped (RISC 2001). Positive responses of Northern Saw-whet Owls in non-breeding periods must not be used as an indication of territory occupancy as some individuals migrate south in winter (Cannings 1993).

Sample Station Procedures

Inter-station distances have ranged from 100 m (Swengle and Swengle 1997) to 1 km (Gill and Cannings 1997), depending on study objectives. The male territorial call is audible to the human ear from a distance of up to 300 m away through forest and 1 km over water (Cannings 1993). Due to varying acoustic conditions, the mandatory distance between stations is less than 500 m, with call-playback 15 minutes in duration. An initial call-playback of approximately 20 seconds is recommended (RISC 2001) due to quick responses. Francis and Bradstreet (1997) reported that 70% of responses were recorded in the initial 4 minutes after a broadcast, and at least 50% within the first minute.

Because each sample station represents a potential home range size of the species (Appendix 1), transect length depends on survey objectives and must cover the entire amount of suitable habitat to be surveyed within a given study area.

Home Range Size

Home range analysis is limited for the species. Two breeding radio-marked males were tracked for about 20 hours each over several nights. They used areas of 142 and 159 ha respectively, although 1 of the males spent 85% of his active time in a core area of only 27 ha (Cannings 1987).

Northern Spotted Owl

B-SPOW, *Strix occidentalis caurina*

Survey Notes

Estimation of Northern Spotted Owl site status was outlined in detail in Hobbs et al. (2005) which has been the provincial protocol outlining survey repetitions and assigning breeding status for Northern Spotted Owls (Appendix 2). This protocol supersedes Hobbs et al. (2005).

All surveys must be performed in the presence of a qualified field surveyor who not only has knowledge of the calls and ecology of the Northern Spotted Owl, but also has reliable identification skills with the territorial calls of British Columbia owls within the study area (including those of any hybridized “Spurred” owls). Failure to have a qualified field surveyor present during the survey may result in data rejection by Ministry of Environment biologists. The qualified field personnel must have normal to excellent hearing ability, a minimum of 1 season of documented field experience, or proven training from qualified personnel.

Survey Timing

Most efficacy estimates for Northern Spotted Owl surveys were derived from nocturnal surveys conducted during the breeding period (Appendix 1). Surveys for Northern Spotted Owls in British Columbia must follow these conventions for timing restrictions to provide comparable data that can be analyzed with the same assumptions of efficacy. Northern Spotted Owl surveys conducted in British Columbia to determine occupancy, resident, and pair status must be conducted during the breeding period of 1 April to 30 September (Table 2). Surveys must be repeated 3 times at least 5

days apart and preferably a month apart. These repetitions cannot occur entirely in July and August (Appendix 2). To identify nests and determine nesting status, breeding surveys must be conducted between 15 April and 15 June (Appendix 2). To determine productivity status, breeding surveys must be conducted between 15 June and 15 July. Breeding surveys to determine dispersal status must be between 15 August and 15 September (Table 2). Additional tips for visual searches for nests are given in Appendix 3.

Positive responses of Northern Spotted Owls in non-breeding periods may validly determine owl presence but do not necessarily indicate that a territory has been established because owls detected could be floaters or dispersing juveniles. Therefore, all Northern Spotted Owl detections recorded outside of these timing windows must be re-surveyed during the breeding period to confirm occupancy. Negative results outside of the breeding period cannot be interpreted as probably absent (i.e., the status "Not Detected" cannot be assigned) for the study area.

Time of Day

Northern Spotted Owls are nocturnal and their peak activity period begins within a half hour after sunset, and ends a half hour before sunrise. Although Northern Spotted Owls may respond in daylight, the likelihood of response diminishes with distance and is limited to within a few hundred metres of roosts or nests (Forsman 1983).

Occupancy surveys must be performed at night during the breeding period. If Northern Spotted Owls are known to occur within a study area, the known core area of owl activity (based on previously documented owl activity) can be surveyed initially during the day to determine owl presence. If no Northern Spotted Owls are detected, then a nocturnal occupancy survey must be conducted to attempt to locate the owl(s) within the study area. Occupancy or breeding surveys during daylight may determine presence, but if none is detected, the surveys must be repeated at night before "Not Detected" status can be assigned, due to the reduced likelihood of detections during the day.

Breeding surveys may be performed during the day to allow for visual identification and recording of behavioural response of the owls. Following night time detections of Northern Spotted Owls, when feasible, surveyors may attempt to estimate pair status and/or nest locations at dusk or at night. Otherwise, follow-up breeding surveys must commence before sunrise to take advantage of the relatively increased responsiveness of owls at dawn. The amount of search time spent in owl territories must be minimized and must not exceed 4 hours.

Sample Station Procedures

Each station requires a minimum of 15 minutes to complete for driving transects, and a minimum 8 minutes (after the first call) to complete for walking transects. For transects that are walked, surveyors must spend at least 15 minutes of total search effort per 500 m (i.e., if > 250 m spacing is used, more survey time at each station is required). Driving transects should be about 8 km in length, with a minimum of 17 sample stations, or cover the entire amount of suitable habitat within a given study area. In most terrain types it is possible to cover 3 to 5 km/night for walking transects. Remote (helicopter access) study areas can generally be covered over 2 successive nights with the origin of each night's transect at the centre of the area requiring survey. Sample stations can then be visited at equal intervals in opposing directions on 2 successive nights, to ensure adequate coverage of a 6 to 8 km transect.

Call-playback sample stations for spot checks must be spaced about 500 m (range 250 to 1,000 m) apart. Although spot-check areas will vary in size and shape, they must be designed to sample not

only the core area of interest (i.e., large forest stands of suitable habitat), but also the entire home range of the targeted species if suitable habitat exists outside the targeted area (i.e., the 6–8 km transect).

Call-playback recordings must feature calls from either gender (not both): 4 to 5 4-note location calls, and 2 to 3 series location calls (Appendix 1). Each call must last approximately 1.5 minutes. Although only the 4-note and series location calls may be broadcast, the audio media must include all commonly recorded call types for Northern Spotted Owl, hybrid Spotted/Barred Owl (Sparred), and those of other owl species in the region for reference.

Protocol for Owl Detections

If a Northern Spotted Owl is detected, the broadcasts must be stopped immediately. The surveyor must continue to listen at the station for the remainder of the 15-minute period, for additional clues on pair/breeding status of the detected owl. Record all required fields on the survey form.

If a Barred Owl calls close (≤ 100 m) to the sample station, the surveyor must cease broadcasting calls immediately until the Barred Owl has stopped vocalizing. Surveyors must, nevertheless, try to ascertain the breeding status of any Barred Owls encountered. Northern Spotted Owls may be less likely to vocalize when a Barred Owl is calling (Kelly et al. 2003). If the Barred Owl is vocalizing > 100 m from the sample station, surveyors must continue with broadcast calls for the duration of the sampling interval.

It is likely that multiple Barred Owls will respond during a survey, and the same individual may be heard from more than 1 station (Hausleitner, personal observation). Surveyors must try to determine the actual number of Barred Owls detected, to avoid double counting individuals. Barred Owls may have Northern Spotted Owl mates, or hybrid Spotted/Barred Owl (“Sparred”) mates. Surveyors should consider conducting follow-up breeding surveys at single Barred Owl detection locations to determine their breeding status if feasible.

If a Great Horned Owl is detected, the broadcasts must cease immediately. Surveyors must listen at the station for the remainder of the 15-minute period. All of the required fields must be recorded. After the 15-minute time requirement has elapsed, surveyors must move ≥ 1 km from the detection location (i.e., skip a station), before resuming the survey to avoid the possibility of attracting the Great Horned Owl, a known Northern Spotted Owl predator.

If an unidentified owl responds to a call-playback, surveyors must try to elicit more responses by continuing broadcasts in the immediate vicinity for an additional 30 minutes. If surveyors are unable to identify an owl species during night visits, a day survey must be conducted, and/or the night survey repeated. This additional effort is required to ensure that no Northern Spotted Owls are missed or misidentified.

Use of Live Lures

If a Northern Spotted Owl is located during the daytime, a live prey offering may effectively achieve the following objectives:

- 1) identification of nest location,
- 2) assessment of pair status,
- 3) assessment of breeding status,
- 4) assessment of productivity status,
- 5) assessment of dispersal success, and

6) band identification.

When an adult Northern Spotted Owl has been visually located during the day, the surveyor may place an untethered live mouse on a prominent perch that is visible to the owl. Place the mouse so that it offers a clear line of flight for approach and exit for the owl. Generally, the perch used to offer the mouse should be within 30 m of the roosting owl. After placing the mouse on the perch, the surveyor may “squeak” to get the owl’s attention if the owl has not already seen it. After placing the lure, move at least 3 m away, and seek concealment behind available vegetation (the second surveyor must already be concealed).

If the owl does not take the mouse, it may be necessary for the surveyors to move further from mouse and owl. Surveyors must remain motionless and silent to avoid diverting the owl’s attention from the mouse. Some owls will be reluctant to take offered prey, even when tending an active nest. If an owl refuses to take the prey within 60 minutes, it must be removed, and surveyors must leave the territory. A second attempt may be made again at dusk. If paired, even when nesting, the male and female (and the juveniles, later in the season) will typically reunite briefly at dusk and call to each other; 1 may give the other prey at this point.

In most cases, the Northern Spotted Owl will take the mouse within a few minutes. Surveyors must be prepared to follow an owl to monitor and record its actions concerning the live prey. For each live prey item presented, record which of the following behaviour(s) occurred:

- ate prey,
- delivered prey to female,
- delivered prey to nest,
- delivered prey to juvenile(s),
- cached prey,
- held prey,
- owl dropped prey,
- refused prey (≥ 1 hour),
- surveyor lost prey, or
- unknown.

Surveyors must provide the maximum separation between themselves and the owl without risking losing sight of it. Movement must be as quiet as possible and vegetation must be used to conceal surveyor position when an owl pauses. Owls may be reluctant to deliver prey items to a nest (or young) if they are being too closely observed.

Surveyors must offer ≥ 4 mice to an owl to adequately assess reproductive status. If the fate of the mouse is unknown, that prey item does not count towards meeting the requisite 4-mouse protocol. If the owl caches all 4 mice, or roosts with a mouse ≥ 60 minutes, then live prey surveys must be stopped and surveyors must leave the territory. If an owl eats 4 mice, surveyors must offer additional mice until the owl begins to cache or roost holding the mouse to a maximum of 8 mice. An owl will sometimes make a prey delivery to its young after ingesting > 4 mice. If an owl is caching mice repetitively, it may be reluctant to deliver prey due to surveyor proximity. In this case, surveyors must allow more space between themselves and the owl, and use cover to conceal their position.

If live prey techniques are being used after fledging (> 15 June), surveyors must focus search for juveniles within 1 km of the known or suspected nest location. Juveniles use a 500 ha area centred on the nest tree, referred to as the post-fledging area (PFA), until natal dispersal begins. The closer the

survey date is to 15 June, the greater likelihood that the juveniles and attending adults will be found within a few hundred metres of the nest tree.

The use of live mice to entice a behavioural response from an owl enables efficient detection of pairs, nests, and juveniles. When the nest location, or the location of the juveniles, has been confirmed, the area must be left to minimize further disturbance of the nesting pair of owls and avoid potential disruption of successful breeding. To avoid habituating owls to humans and causing undue stress, care must be taken to minimize the amount of mouse fed and the time spent performing live lure surveys.

Home Range Size

In Washington, the median annual home ranges for a pair of owls for the west and east sides of the Cascade Mountain range were 3,321 ha (range 1,302 ha to 7,258 ha) and 2,675 ha (1,490 ha to 6,305 ha), respectively (Hanson et al. 1993). In British Columbia, home range estimates for 3 pairs of owls in a dry region of British Columbia ranged from 1,732 ha to 4,644 ha (Blackburn and Godwin 2003). Annual home range sizes for British Columbia are likely comparable to or slightly larger than those in Washington (Blackburn and Godwin 2003).

Study areas must be established to represent the median annual home range of 3,200 ha for a pair of Northern Spotted Owls. Survey of adjacent areas < 3,200 ha may result in multiple detections of the same owl, hence overestimating the population. Conversely, study areas > 3,200 ha may underestimate the number of owls, if 2 adjacent resident owls are subsequently counted as 1 owl. Although each 3,200 ha study area will contain multiple habitat types and stand ages, study areas are typically chosen by the percentage of suitable habitat contained within each study area. Study areas with higher percentages of suitable habitat should have higher likelihood of Northern Spotted Owl presence; however, other factors also may influence territory selection by the owls.

Western Screech-owl

B-WSOW, *Megascops kennicottii*
ssp. *macfarlanei*—Blue-listed

Survey Notes

Multiple repetitions of survey transects are recommended for this species as response rates may vary throughout the breeding season (Cannings and Angell 2001). Hardy and Morrison (2000) recommend 4–5 survey repetitions per year mid-April to August. At least 3 survey repetitions annually are recommended for this species.

Survey Timing

Surveys for estimation of occupancy of Western Screech-owls in British Columbia must be conducted at night (between 30 minutes after sunrise and 30 minutes before sunset) during the breeding period. Males begin territorial calls at dusk during courtship and territory establishment. Response rates of Western Screech-owls to conspecifics are greatest during territory establishment/pair bonding and nest-site selection, dropping off during incubation and nesting (Cannings and Angell 2001). Unsolicited calling was observed for radio-marked owls in the Shuswap River drainage in February and March (Davis and Weir 2006).

Breeding surveys must be conducted during courtship and territory establishment, 1 February to 1 June. Western Screech-owls in British Columbia respond to call-playback calls from February through May and are unresponsive in June and July (Cannings and Angell 2001). Nests can be located during courtship by listening to duets of males and females which occur near nest cavities. A daytime follow-up to the projected calling location may help locate nesting cavities.

Positive responses of Western Screech-owls in non-breeding periods can determine owl presence because they remain on territories year-round. However, because detections may be of dispersing juveniles, occupancy of pairs must be assessed in the breeding period.

Sample Station Procedures

Response times reported for call-playbacks conducted over 3 years on Vancouver Island and the Okanagan ranged from 1 to 44 minutes with an average response time of 6 minutes ($n = 254$) (Tripp 2004). Smith et al. (1987) noted that the species responded less frequently when call-playbacks were repeated at short intervals. Thus, surveyors must give ample waiting time (at least 4 minutes) between 1-minute broadcasts.

When driving between sample stations, each station requires a minimum of 15 minutes and must be 300 to 500 m apart. When walking between sample stations, sampling time must last at least 12 minutes and must be spaced about 250 m (range 150 m to 350 m) apart. Sample stations should be placed within a portion of suitable habitat (i.e., not calling across unsuitable habitat to the riparian) $\leq$ 300 m of the riparian area being targeted (Davis and Weir 2006). This inter-station distance is recommended because surveys for Western Screech-owls are associated with riparian areas (Campbell et al. 1990) and their territorial call can not be heard at great distances by humans. Additionally, it has been documented that Western Screech-owls do not respond to broadcast calls outside of their home range, thus larger increments may accidentally miss territories (Davis and Weir 2006).

Additionally, given their small home range size, larger increments may accidentally miss territories. Since each sample station represents a potential home range size (Appendix 1), total transect length depends on survey objectives but must cover the entire amount of suitable habitat to be surveyed within a given study area.

Home Range Size

Home range size for this species has not been well documented (Cannings and Angell 2001), but is thought to vary between 2.5 and 10 ha for the interior subspecies (Cannings 2004). The mean 95% home range utilization distribution based on radiolocations for 3 Western Screech-owl males was 106.9 ha (range 74.3 ha – 144.4 ha) (Davis and Weir 2006).

Spacing for the coastal subspecies was as close as 300 m under ideal conditions in the Pacific Northwest and averaged 420 m in California ($n = 14$) (Cannings and Angell 2001). Spacing appears greater for the interior sub-species in the Shuswap Drainage of British Columbia (H. Davis 2006, pers. comm.). Pairs remain on breeding sites year-round (Cannings and Angell 2001).

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Appendices

Appendix 1. Species Accounts

Barred Owl

B-BDOW, *Strix varia*

Due to the recent range expansion of the Barred Owl to British Columbia (since 1943), little information has been collected with regard to demography and natural history in western North America.

Species Description

Appearance

The Barred Owl is a large, gray-brown woodland owl (43–50 cm length; 31.5–35.5 cm wing; 470–1,050 g mass) (Mazur and James 2000). It has a round head, lacking ear tufts, with well developed facial disc, dark eyes, and a dull yellow bill. From the back it looks like the Northern Spotted Owl, but can be distinguished by vertical barring of feathers on the upper breast. The remaining underparts are whitish with bold, dark, elongated streaks. This owl is more often heard than seen. (Mazur and James 2000).

Immature birds differ only slightly from adults, with markings less distinct (especially around the head) and may retain downy tips to feathers after fledging in the first year (Mazur and James 2000).

Vocalizations

This species is more vocal than most other northern-temperate owls. It exhibits vocal differences by gender, with females exhibiting a higher pitched voice than males (Mazur and James 2000). The most common calls are the 2-phrase hoot, ascending hoot, and raucous hoot/caterwauling. The 2-phrase hoot is the primary call and usually consists of 2 groups of 4 or 5 syllables each, uttered rhythmically and strongly accented as hoo-hoo-to-hoo-ooo, hoo-hoo-hoo-to-whooo-ooo and commonly phoneticized as, “Who cooks for you? Who cooks for you all?” (Mazur and James 2000).

Habitat and Distribution

The Barred Owl was first recorded in British Columbia at Liard Crossing in 1943 and has expanded its distribution since then (Mazur and James 2000). It is now found regularly on Vancouver Island and from central British Columbia (Prince Rupert, Everett, and McBride) south through montane and coastal forests (Campbell et al. 1990). They are also irregularly distributed north to Yukon and Alaska (Mazur and James 2000). Based on Northern Spotted Owl surveys, Barred Owls in British Columbia are found in mixed hardwood-conifer stands, along riparian corridors, and in upland mature and old-growth conifer forests (Dunbar et al. 1991). Similarly, Pearson and Livezey (2003) reported habitat use of Barred Owls in western North America tended to be in areas with a deciduous component, or old-growth coniferous areas. Barred Owl territories in eastern Washington tended to be found on flatter slopes and closer to water than those of Northern Spotted Owls (Pearson and Livezey 2003). Both species' territories were centred in areas characterized by higher concentrations of old forest than random (Pearson and Livezey 2003).

Nests site description

Nest sites are often in deciduous trees, primarily in cavities formed by disease, broken branches, or cavities in top of broken trees (snags). They also use open platform-style nests (Mazur and James 2000). Breeding sites in British Columbia have been described as being near water (Campbell et al. 1990). Ten nests described in eastern Washington were in cavities or platforms in black cottonwood, *Populus balsamifera* ($n = 3$), Douglas fir, *Pseudotsuga menziesii* ($n = 3$), Grand Fir, *Abies grandis* ($n = 2$), western hemlock, *Tsuga heterophylla* ($n = 1$), and western larch, *Larix occidentalis* ($n = 1$) (Buchanan et al. 2004).

Breeding Chronology

Knowledge of breeding chronology in British Columbia (Table) is limited to 8 nests (Campbell et al. 1990). Similarly, little data has been collected on the phenology of breeding in the Pacific Northwest.

Table 10. Breeding chronology reported for Barred Owls in British Columbia.

<i>Activity</i>	<i>British Columbia^a</i> <i>(Ranges reported)</i>
Breeding Period	
Nesting (egg laying)	15 March–15 May
Incubation	28–33 days ^b
Juveniles on nest	30–37 days (late April–19 August)
Fledging	42 days
Non-breeding Period	
Winter foraging/dispersal	October–February

^a Data estimated from 8 nests in British Columbia (Campbell et al. 1990).

^b Data summarized in Birds of North America Account (Mazur and James 2000).

Boreal Owl

B-BOOW, *Aegolius funereus*

Species Description

Appearance

The Boreal Owl is small (male length: 21–25 cm, female length 25–28 cm) with a large spotted head and long wings (wingspan: males 55–58 cm, females 59–62 cm) (Hayward and Hayward 1993). Distinguishing features are a white-gray facial disc, framed by a brown-black border and highlighted by white raised eyebrows, yellow eyes and a buff-white bill. Its legs and toes are thickly feathered to claws. Underparts are creamy-white with broad streaks of brown to russet. Young Boreal Owls can be distinguished from young Northern Saw-whet Owls by the relatively uniform dark rust-brown breast, compared to a paler, 2-tone breast and belly of the latter (Hayward and Hayward 1993). Immature plumage for this species is so distinct from adults that they have been misidentified as different species (M.Chutter 2006, pers. comm.).

Vocalizations

Seven vocalizations are described for adult Boreal Owls: primary call, prolonged call, delivery call, screech, peeping call, weak call, and “hiss”. A *hooh-up*, *moo-a*, and *hooh* may all describe a 2-noted version of the delivery call (Hayward and Hayward 1993). Only males utter the primary call and they make it from near potential nesting cavities. It is described as a series of trills of consisting of

approximately 16 notes that increase in volume during each trill but are constant in pitch, lasting about 1.8 seconds. The trill is repeated after silence of 1 to several seconds. Calling typically lasts 20 min but may extend to 2–3 hours with infrequent pauses (Hayward and Hayward 1993).

Habitat and Distribution

The Boreal Owl is found throughout forested portions of the northern interior of British Columbia, and at high elevations in the southern interior (Campbell et al. 1990). Occurrences in the Coastal Mountain regions are rare (Wright 1998).

Nest Site Description

Nest sites are in pre-existing woodpecker nest cavities (Northern Flicker, *Colaptes auratus*, or Pileated Woodpecker, *Dryocopus pileatus*) or nest-boxes. Boreal Owl populations are likely limited in portions of their range by availability of cavities (Hayward and Hayward 1993).

Breeding Chronology

Breeding chronology has not been well documented for Boreal Owls in British Columbia but it should be similar to that reported by Hayward (1989) in central Idaho (Table). Calculated dates indicate that eggs could be found in April and young from mid-May to mid-July in British Columbia (Campbell et al. 1990).

Table 11. Breeding chronology reported for Boreal Owls in central Idaho.

Activity	Central Idaho ^a (Ranges reported)
Breeding Period	
Courtship	Late January–mid February
Nesting (egg laying)	12 April –24 May
Incubation	29 days
Juveniles on nest	28–36 days
Non-breeding Period	
Winter	October–February

^a Data from 13 nests over 5 years in central Idaho (Hayward 1989)

Flammulated Owl

B-FLOW, *Otus flammeolus*

Species Description

The Flammulated Owl was designated as a Species of Special Concern by COSEWIC in 2001 and listed on Schedule 1 of the Species at Risk Act. Provincially, the owl is Blue-listed by the Conservation Data Centre.

Appearance

The Flammulated Owl is small, standing 15–17 cm tall. It occurs in the grey phase in British Columbia (in contrast to the reddish phase of more southerly populations) where it is associated with Douglas-fir dominated forests (van Woudenberg 1999). It can be distinguished from all other small owls in British Columbia by its dark eyes.

Immature

Natal down is replaced by juvenile plumage in its first 10 days post-hatch and is nearly complete by fledging (McCallum 1994).

Vocalizations

The territorial call of the Flammulated Owl is a 1 or 2 noted, low pitched and often ventriloquial hoot repeated steadily for 2–3 seconds. The second note is stronger than the first (van Woudenberg 1999). At a distance, the first, lower note is often undetected, while at close range a third lower and quieter note can be heard immediately after the second (van Woudenberg 1999). Additional vocalizations include a variety of barks, shrieks and screams directed at nest intruders (McCallum 1994). Males broadcast for hours in early breeding season and more sporadically later on (McCallum 1994). Unmated males will continue broadcasting through summer.

Habitat and Distribution

Typical Flammulated Owl breeding habitat is mature Interior Douglas-fir (IDF) forest with scattered large ponderosa pine (*Pinus ponderosa*) (McCallum 1994). Multiage-class stands with snags containing woodpecker cavities are chosen for nesting and roosting. Regenerating thickets of Douglas-fir with adjacent shrub or grassy areas provide forage habitat (Cannings and van Woudenberg 2004). As the Flammulated Owl is an insectivore, it migrates south in the winter to follow its food supply (McCallum 1994). In British Columbia, Flammulated Owls are found in the southern and central interior of the province with some observations in the East Kootenay (van Woudenberg 1999).

Nests site description

Flammulated Owls nest in cavities excavated by the Pileated Woodpecker and Northern Flicker. These are found primarily in Douglas-fir and ponderosa pine snags and other veteran trees (McCallum 1994). They will also take to nest boxes. Mean cavity height near Kamloops was 8.9 m ($n = 29$) and cavity entrances tended to be facing south and east (van Woudenberg 1999).

Breeding Chronology

The earliest spring record of a Flammulated Owl in British Columbia is 24 April (Campbell et al. 1990) and most spring migrants arrive in early May (van Woudenberg 1999). Males may arrive prior

to females and commence territory establishment, locating foraging and suitable nesting habitat (Reynolds and Linkhart 1987). Incubation throughout the range of the species is 22–24 nights (van Woudenberg 1999). Young are believed to fledge from mid-July to late August (van Woudenberg 1999). They migrate south between early September and mid-October (van Woudenberg 1999) (Table).

Table 12. Breeding chronology reported for Flammulated Owls in British Columbia.

Activity	British Columbia ^a (Ranges reported)
Breeding Period	
Territory establishment	15 May
Incubation	28 May–28 July
Juveniles in nest	22 June–22 August
Fledging	15 July–15 August
Post-Fledging Area	Not available
Juvenile dispersal	Not available
Migrating South for winter	15 September–15 October

^a Data compiled from nests in British Columbia (van Woudenberg 1999).

Great Horned Owl

B-GHOW, *Bubo virginianus*

Species Description

Appearance

The Great Horned Owl is the only large (length 46–63 cm) and heavy (0.91–2.5 kg) North American owl with ear tufts, a white bib, and enormous yellow eyes (Houston et al. 1998).

By day 8 after hatching, its white downy plumage is replaced with immature yellowish white or grayish buff, grayish white plumage. After 3 weeks, ear tufts show as small compact patches. Facial disc and white bib are well defined by 11 weeks (Houston et al. 1998).

Vocalizations

Calls are varied for the species and include a variety of barks, chuckles, screeches and squawks. The most common vocalizations are territorial hooting and screams (Houston et al. 1998). The typical territorial call consists of solemn, deep-toned hooting with great carrying power. It is likened to the sound of a distant foghorn, a soft, somewhat tremulous, and subdued hoot, with little or no accent consisting of 3–6 notes “who-hoo-ho-oo or who-ho-o-o, whoo-hoo-o-o, whoo”, phoneticized as “who’s awake....me too”. Female vocalizations are higher in pitch and duetting is common (Houston et al. 1998).

Habitat and Distribution

The Great Horned Owl is found in virtually all of the forested and semi-forested regions of British Columbia except the Queen Charlotte Islands. It is less common with increased elevation and latitude (Campbell et al. 1990).

Nests Site Description

Nests sites are extraordinarily variable. This species primarily uses stick nests of other species in whatever tree is available, but also uses cavities or ledges in trees and snags, cliffs, deserted buildings, and artificial platforms; they will even occasionally lay eggs on the ground (Houston et al. 1998). Over half of the nests recorded in British Columbia were at a height of 7.6–14 m (Campbell et al. 1990).

Breeding Chronology

Breeding chronology is delayed from south to north in the province. Territory establishment begins as early as November–January (Houston et al. 1998). Reported dates of clutches in British Columbia range from 15 February to 20 May ($n = 35$) with 50% recorded between 24 February and 18 March (Campbell et al. 1990). Incubation is reported as 30–32 days and fledging ranges from 31–35 days (Campbell et al. 1990). Pairs often remain on a territory year-round (Table).

Table 13. Breeding chronology for Great Horned Owls in British Columbia.

Activity	British Columbia ^a (Ranges reported)
Breeding Period	
Territory establishment	November–January
Nesting (Egg laying)	15 February–20 May
Incubation	30–32 days
Juveniles in nest	31–35 days
Juvenile dispersal	September–November
Non-breeding	September–November

^a Based on data from 38 clutches and 203 broods in British Columbia (Campbell et al. 1990)

Northern Saw-whet Owl

B-NSWO, *Aegolius acadicus*

Species Description

Appearance

The Northern Saw-whet Owl is small (length: males 18 to 20 cm, mass 75 g; females 20 to 21.5 cm, mass 100 g) with short legs short and heavily feathered talons (Cannings 1993). It has a large round head, round facial disk, no ear tufts, and yellow to golden eyes. There is a tuft of black bristle-like feathers between the eyes (Cannings 1993). Adult plumage is white with brown to reddish brown streaks. The back and flight feathers are spotted white.

Juveniles lack white markings except on the wings and tails and have unmarked brown breasts and buff bellies. Their blackish brown facial disk is marked with a conspicuous white Y shape between and above the eyes (Cannings 1993). Immature plumage for this species is so distinct from adults that they have been misidentified as different species (M. Chutter 2006, pers. comm.).

Vocalizations

At least 9 different vocalizations are reported for the Northern Saw-whet Owl; territorial call, visiting call, nasal whine, short series of squeaking calls, high pitched “tsst”, nestling begging call, buzz, twittering call, and a “chuck” (Cannings 1993). The territorial call is the primary song, which consists of a monotonous series of whistled notes on a constant pitch of about 1,100 Hz and at a rate of about 2 per second. This call is given almost entirely by males.

Habitat and Distribution

The Northern Saw-whet Owl is found year-round on its breeding range on the Queen Charlotte Islands, southeast Vancouver Island and across interior British Columbia south of Prince George (Campbell et al 1990). Within British Columbia, the Northern Saw-whet Owl’s breeding habitat is generally in low to mid-elevation forests characterized by a variety of conifer species such as ponderosa pine, Douglas-fir, western red cedar (*Thuja plicata*), grand fir, and western larch. They are found in lower densities in subalpine forests including Engelmann spruce (*Picea engelmanni*), lodgepole pine (*Pinus contorta*), and subalpine fir (*Abies lasiocarpa*), and are usually restricted to riparian areas at that elevation (Cannings 1993).

Nests Site Description

Nest sites are in pre-existing woodpecker nest cavities (Northern Flicker or Pileated Woodpecker) or nest boxes. Eggs are laid on wood chips or other debris in the cavity (Cannings 1993).

Breeding Chronology

Territory establishment begins as early as February and March in southern British Columbia (Cannings 1993). Egg laying for 27 clutches in British Columbia was reported from 3 March to 1 June with 52% ($n = 14$) occurring between 20 April and 7 May (Campbell et al. 1990). The average incubation period in southern British Columbia is 27.3 nights ($n = 9$) and fledging is 30–37 days (Cannings 1987). Dates for broods range from 7 April to 17 August with 52% recorded from 25 May to 29 June ($n = 47$) (Campbell et al. 1990). Most young disperse by mid July (Campbell et al. 1990).

There is no specific information on dispersal in British Columbia but it is thought to be at 6–8 weeks (Table).

Table 14. Breeding chronology for Northern Saw-whet Owls in Southern British Columbia.

Activity	British Columbia ^a (Ranges reported)
Breeding Period	
Territory establishment	February–March
Nesting (egg laying)	1 March–15 May
Incubation	27 days ^b
Juveniles in nest	30–37 days
Juvenile dispersal	45–60 days
Non-breeding	September–January

^a Estimated from 27 clutches and 47 broods of Northern Saw-whet owls in British Columbia (Campbell et al. 1990).

^b Estimated from nest observations of 9 Northern Saw-whet owls in the Okanagan (Cannings 1987).

Northern Spotted Owl

B-SPOW, *Strix occidentalis caurina*

Species Description

The Northern Spotted Owl population consists of adult (≥ 3 years old), subadult (1 to 2 years old), and juvenile owls (< 1 year old). The population structure is comprised of resident (adult and subadult), and non-territorial “floaters” (adult, subadult, and juvenile owls). Resident Northern Spotted Owls remain in the same general area for most of their lives and defend their territory against intruding owls. Floaters actively traverse through habitat, searching for vacant territories and available mates. Floaters may not always respond vocally to territorial Spotted Owl calls.

Appearance

The Northern Spotted Owl is medium-sized (490–850 g), chocolate brown, with elliptical or irregular white spots on the head, neck, back, and underparts (Gutiérrez et al 1995). The round face with brown facial disk, dark brown eyes, and yellow-green bill are distinguishing features. Legs and feet are fully feathered. Females are 10%–20% larger in mass than males (females: 540–850 g, males: 490–690 g) (Courtney et al. 2004).

Hatchlings are sparsely covered with white natal down until they are about 10 days old (Forsman 1981). The pre-juvenile molt is completed in 34 to 36 days, and retrices reach full development by 75 days (Forsman 1981). A molt begins at 8 to 9 weeks of age and is completed by late September or October when plumage color is chocolate brown (Forsman 1981). Subadults can be distinguished from adults until 26 months; tips of retrices are a characteristic white with pointed, downy tips (Courtney et al. 2004).

Vocalizations

Although 13 vocalizations have been described, 7 main vocalizations are used by adult Northern Spotted Owls: 4-note location call, agitated location call, series location calls, contact call, agitated contact call, bark series, and a “wrack” call (Gutiérrez et al 1995). Both genders utter these calls and

most calls can be distinguished from each other by pitch. The most common call is the 4-note location call used to announce territory occupancy or prey deliveries, which is often given in replicates of 2 (Gutiérrez et al. 1995).

Habitat and Distribution

The Northern Spotted Owl is closely associated with mature and old growth coniferous forests with uneven-aged, multi-layered, multi-species canopies. These canopies contain numerous large trees with broken tops, deformed limbs, and large cavities. Forest stands are further characterized by numerous large snags, large accumulations of large woody debris, and canopies open enough to allow owls to fly within and beneath them (Thomas et al. 1990).

Forest stand characteristics are the best indicators of habitat suitability for the Northern Spotted Owls and study areas should ideally be stratified according to quality. This level of forest stand information is lacking, however, for most areas in British Columbia where the Northern Spotted Owl occurs. Pending the availability of better forest stand data, surrogate suitable habitat definitions have been defined. Type A Suitable Habitat (Superior Quality: preferred habitats selected by owls) is defined as forest stands at < 1,380 m elevation, > 140 years old, and with dominant trees > 19.4 m tall. Type B Suitable Habitat (Moderate Quality: used but not preferred) is defined as forest stands at < 1,380 m elevation, 100–140 years old, with dominant trees > 19.4 m tall (Table). In dryer ecosystems, these forest stand characteristics may be found in younger forests (80–100 years old); however, habitat use is not consistent among all forest stands in this age range.

The British Columbia Northern Spotted Owl population has been divided into 3 subpopulations: Fraser, Coastal, and Lillooet subpopulations (Hausleitner et al. 2006, in prep.). The Fraser subpopulation (Chilliwack Forest District) includes areas south of the Fraser River eastward to Harrison Lake. It follows Harrison Lake north to Big Silver, and includes the Nahatlatch and Mehatl Valleys and eastward. The Coastal subpopulation (Squamish and Chilliwack Forest Districts) includes the Elaho and Whistler area eastward, through Garibaldi Park at the height of land to Harrison Lake. Drainages that flow into the Lillooet River and northward are included in the Lillooet subpopulation. The Stein Valley may be included in either the Fraser or Lillooet subpopulation.

Table 15. Northern Spotted Owl habitat characteristics in wet and dry ecosystems in British Columbia.

<i>Superior Habitat (nest, roost, forage, and dispersal)</i>	<i>Moderate Habitat (roost, forage, and dispersal)</i>
Wet ecosystems: Maritime Coastal Western Hemlock and Mountain Hemlock Biogeoclimatic Zones. Natural disturbances: rare to infrequent stand-initiating events*.	
• 3 or more canopy layers, multi-species canopy dominated by large (> 75 cm DBH) overstory trees (typically 37–185 stems/ha), • moderate to high (60%–80%) canopy closure, • 5 or more large (> 50 cm DBH) trees/ha with various deformities (e.g., large cavities, broken tops, dwarf mistletoe infections), • 5 or more large (> 75 cm DBH) snags/ha, and • accumulations ($\geq 268 \text{ m}^3/\text{ha}$) of fallen trees and other coarse woody debris on the ground.	• 2 or more canopy layers, multi-species canopy dominated by large (> 50 cm DBH) overstory trees (typically 247–457 stems/ha, although densities as low as 86 stems/ha are possible where large diameter trees are present), • moderate to high (60%–80%) canopy closure, • 5 or more large trees/ha (> 50 cm DBH) with various deformities (e.g., large cavities, broken tops, dwarf mistletoe infections), • 5 or more large (> 50 cm DBH) snags/ha, and • accumulations ($\geq 100 \text{ m}^3/\text{ha}$) of fallen trees and other coarse woody debris on the ground.
Dryer ecosystems: Submaritime Coastal Western Hemlock and Mountain Hemlock, and Interior Douglas-fir Biogeoclimatic Zones. Natural disturbances: frequent stand-maintaining fires but naturally infrequent stand initiating events,* although fire suppression has unnaturally increased the frequency of stand-initiating events.	
• 3 or more canopy layers, multi-species canopy dominated by large (> 50 cm DBH) overstory trees (typically 173–247 stems/ha, although densities as low as 86 stems/ha are possible where large diameter trees are present), • moderate to high (60%–85%) canopy closure, • 5 or more large trees/ha (> 30 cm DBH) with various deformities (e.g., large cavities, broken tops, dwarf mistletoe infections), • 7 or more large (> 50 cm DBH) snags/ha, and • accumulations ($\geq 268 \text{ m}^3/\text{ha}$) of fallen trees and other coarse woody debris on the ground.	• 2 or more canopy layers, multi-species canopy dominated by large (> 30 cm DBH) overstory trees (typically greater than 247 stems/ha), • stands must contain 20% Fd and/or Hw in the overstory, • greater than 50% canopy closure, • 5 or more large trees/ha (> 30 cm DBH) with various deformities (e.g., large cavities, broken tops, dwarf mistletoe infections), • 5 or more large (> 30 cm DBH) snags/ha, and • accumulations ($\geq 100 \text{ m}^3/\text{ha}$) of fallen trees and other coarse woody debris on the ground.

Adapted from SOMIT 1997.

DBH=diameter at breast height; Fd = Douglas-fir; Hw= Western Hemlock

*"stand-initiating events" are fires or other disturbances that result in complete replacement of the forest stand. These are usually high-intensity fires that kill all the trees, as opposed to low-intensity fires that burn the underbrush and woody debris, thus maintaining park-like, mature forest.

Nests site description

Between 1985 and 2005, nest sites in British Columbia were located in Douglas-fir, western redcedar, western hemlock, and black cottonwood trees and all were large diameter trees or snags (Blackburn and Godwin 2003, Hobbs 2005). Nests ranged from 5.1 to 38 m in height ($n = 11$) (Manley et al. 2003). Northern Spotted Owl nests in British Columbia have occurred in 3 structural categories: chimney nests (snags or trees with snapped tops creating a large cavity at the breakage site), cavities created at the site of broken branches or tree leaders, and platform nests (platforms created by mistletoe or abandoned Northern Goshawk nests) (Manley et al. 2003).

Breeding Chronology

Published accounts of breeding chronology of Northern Spotted Owls in British Columbia is limited to anecdotal breeding records (Campbell et al. 1990) and 8 nest sites in 2002–2004 (Hobbs 2004, Hobbs 2005). Based on this data, the breeding chronology of the Northern Spotted Owl in British Columbia is similar to those in Washington State (Table).

Table 16. Breeding chronology reported for Northern Spotted Owls in British Columbia and Washington State.

Activity	British Columbia (n = 8) ^a (Ranges reported)	Washington (n = 77) ^b (Averages reported)
Breeding Period		
Courtship begins	Not available	26 February–22 March
Copulation	Not available	19 March–5 April
Nesting (egg laying)	6 April –22 April	9 April–19 April
Incubation	5 April –22 May	9 April–17 May
Juveniles on nest	6 May –26 June	11 May–20 June
Fledging	10 June–26 June	16 June–20 June
Post-fledging Area	26 June–29 September	16 June –4 October
Juvenile dispersal	10 Sept–29 Sept	25 September –4 October
Non-breeding Period		
Winter foraging/dispersal	October–February	October–February

^a Data collected from 8 nests 2002–2004 (Hobbs 2004, Hobbs 2005).

^b Subset of data collected from 1,151 banded and 324 radio-marked individuals in Oregon and Washington 1985–1996 (Forsman et al. 2002).

Western Screech-owl

B-WSOW *Megascops kennicottii*

Species Description

Two subspecies of Western Screech-owl persist in British Columbia. Under COSEWIC and the Species at Risk Act (SARA), the interior subspecies of the Western Screech-owl (*Megascops kennicottii macfarlanei*) is listed as Endangered. Provincially, it is Red-listed and is managed under the Identified Wildlife Management Strategy (IWMS) (MWLAP 2004). The coastal subspecies (*M. k. kennicottii*) has been listed as a Species of Special Concern under COSEWIC/SARA and Blue-listed provincially by the CDC.

Appearance

The Western Screech-owl is small (length 19–26 cm) with colour varying from brown to grey-brown in the interior of British Columbia to some reddish brown individuals on the coast (Cannings and Angell 2001). Females have the same plumage as the males. They exhibit fine dark streaks on the breast over top an off-white background, and a streaky mottled effect throughout most of the remainder of the plumage (COSEWIC 2002). They are distinguishable by feathered ear tufts, yellow eyes, and a blackish bill (Cannings and Angell 2001).

Immature Western Screech-owls are covered in white down. The juveniles of either colour phase are similar in plumage to adults, but the indistinct stripes and bars are more patterned, and many feathers are tipped with white.

Vocalizations

Seven main vocalizations are reported for adult Western Screech-owls: bouncing ball, double trill, bark, begging whinny, chirp, te-te-do, and chuckle up (Cannings and Angell 2001). The most

common call given by adults of both genders is the bouncing ball; 6–20 hollow, whistled hoots that speed up towards the end, similar to the pattern of a ball that is dropped and allowed to bounce to a standstill (Tripp 2004). During courtship and territory establishment, males begin calling with the “bouncing ball” at dusk. The call is often given near a prospective nest tree (Cannings and Angell 2001). Calling is done early in the breeding season (December–February). The second most common call is the “double trill”, which consists of a combination of 2 trills, the second being much longer than the first (Tripp 2004). Female vocalizations can be distinguished from male vocalization by the higher frequency (Tripp 2004).

Habitat and Distribution

The distribution center of the interior sub-species of Western Screech-owl in B.C. is in the Okanagan Valley, though they are also found in the Shuswap and the Kootenays (Beaucher and Dulisse 2004, Davis and Weir 2006). They can be found in low elevation forests (< 600 m), frequently close to water. They breed in either deciduous or mixed deciduous-coniferous forests. The coastal subspecies is found along the Pacific Coast ranges from Alaska to Oregon and prefers mixed forests of big leaf maple (*Acer macrophyllum*), red alder (*Alnus rubra*), Douglas-fir, and western hemlock (Cannings and Angell 2001).

Nests site description

Of 62 nests recorded in British Columbia, > 75% were in nest boxes. Of the remaining nests, 26% were in natural cavities within black cottonwood, red alder, Douglas-fir, western redcedar, and western hemlock trees, and 13% were in cavities excavated by Pileated Woodpeckers or Northern Flickers (Campbell et al. 1990). Natural nests range from 1.2 to 12.2 m above ground ($n = 43$) and all nests were in trees > 25 cm DBH (Campbell et al. 1990).

Breeding Chronology

Courtship begins in January or February throughout the range of the species (Cannings and Angell 2001). Copulations on Vancouver Island and in the Okanagan were reported in February ($n = 3$), March ($n = 7$), and April ($n = 2$) (Tripp 2004). Egg laying in British Columbia has been recorded from 17 March and 31 May ($n = 49$), with 53% recorded from 9 April to 21 April. Incubation was as early as 31 March in the Shuswap River drainage (H. Davis, 2006, pers. comm.). Young were found between 19 April and 21 August ($n = 53$), with 51% reported from 8 May to 3 June (Campbell et al. 1990) (Table 6).

Table 67. Breeding chronology reported for Western Screech-owls in British Columbia and Southern Idaho.

Activity	British Columbia ^a (Ranges reported)	Southern Idaho ^b (Ranges Reported)
Breeding Period		
Courtship	February–March	January–February
Nesting (egg laying)	17 March–31 May	29 Feb–5 Apr
Incubation	17 April–31 June	25 March–1 April
Juveniles in nest	19 April–21 August	Not available
Fledging	35–42 days	8 May–4 June
Post-fledging area	Not available	41–97 days
Juvenile dispersal	Not available	25 June–25 August
Non-breeding Period		
Winter	October–January	October–January

^a Data collected from 53 nests in British Columbia (Campbell et al. 1990).

^b Data compiled from 48 radio-marked juveniles (Ellsworth and Belthoff 1997) and 26 nests in southwestern Idaho (Rains 1998).

Appendix 2. Protocols for Northern Spotted Owl Site Status Determination

These protocols have been adapted from Hobbs et al. (2005)

Level 1: Determination of Occupancy Status

The terms "occupied" and "Not Detected" shall be used with reference to results of call-playback surveys conducted for Northern Spotted Owls within a survey area. This level of information is required prior to concluding that the Northern Spotted Owl was Not Detected in a survey area for forest management related issues. Because detected owls may move outside of the study area, occupancy status for each survey area is only valid for the year in which the surveys were conducted.

Assignment of Unknown Status

If the minimum survey criteria described herein are not met within the study area, then the study area shall be deemed "**status unknown**". A quantifier for unknown may be assigned by summing total search effort.

Assignment of Occupied Status

A survey area is considered "**occupied**" if a Northern Spotted Owl is detected within the survey area at any time during the day or night during the breeding season. If a detection occurs outside of the breeding season (1 April–30 September), an additional detection in the breeding season is required to deem the site occupied.

Assignment of Not Detected Status

As noted previously, "Not Detected" means that the species was undetected during a full and complete survey that followed these protocols. This is a formal designation that cannot be assigned prior to any surveys, after an incomplete or unsuccessful survey, or after a survey conducted outside of the breeding season. A study area shall be considered "**Not Detected**" if no Northern Spotted Owls were detected when > 13.0 hours of total search effort collected during the breeding period (April 1 to September 30) is expended over ≥ 3 night-time surveys (transects or spot checks), and spaced a minimum 5 days apart (preferably 1 month apart), throughout the study area. All 3 repetitions cannot be performed in July and August.

These criteria provide for an estimated 90% chance of detecting a Spotted Owl if 1 is present in the study area (Blackburn et al 2002). Conversely, there would be approximately a 10% chance that a Northern Spotted Owl would be present, but undetected. Consequently, for forest management purposes, prior to officially declaring a study area "**vacant**," it must have Not Detected status over ≥ 2 consecutive years, with the minimum survey criteria listed above in each year.

Breeding surveys and surveys performed in the non-breeding period cannot be used to assign Not Detected status of Northern Spotted Owls in the study area. Surveys for Northern Spotted Owls in the winter period (1 October to 31 March) are discouraged, as they may result in increased Northern Spotted Owl energy expenditure during this critical period, and information collected from these surveys may be of limited value for forest management purposes.

Level 2: Determination of Resident Status

Owls detected within a study area may be “**resident**” owls (adults and subadults that defend their territories against other resident owls), or non-territorial “**floaters**” (adults, subadults and juvenile owls that are actively searching for vacant territories and available mates). Because floaters may respond during surveys, efforts must be made to determine resident/floater status of all Northern Spotted Owls detected. If an owl is detected but the resident status survey is incomplete, then the site is deemed “**occupied, resident status unknown.**” A quantifier for “unknown” may be assigned for the subsequent surveys following initial detection by summing the total search effort.

Assignment of Resident Status

A Northern Spotted Owl shall be considered “**resident**” if any of the following criteria are met:

- detection (visual or auditory) of another Northern Spotted Owl of the same sex within the study area on ≥ 3 occasions during the same breeding period (spaced at least 5 days apart, preferably 1 month apart). All 3 repetitions must not be conducted in July and August,
- multiple detections (≥ 2) over 2 or more preferably consecutive years of a single owl of the same sex within the study area,
- detection of a pair of owls within the study area,
- detection of juveniles with adult Northern Spotted Owls, or
- detection of an adult at an active nest.

Assignment of Floater Status

A Northern Spotted Owl shall be deemed a “**floater**” if the following criteria are met:

- following the initial detection of the owl, a minimum of 3 additional occupancy surveys (spaced a minimum 5 days apart, preferably 1 month apart) with total search effort > 13.0 hours during the same breeding period failed to detect the owl’s presence, and
- all surveys cannot occur entirely in July and August. In areas with poor logistics (e.g., along highway corridors), additional surveys may be required.

Note: For management considerations, in the scenario above, the study area shall be deemed “**occupied, floater.**” If occupancy surveys during the following year fail to detect Spotted Owls, then the study area shall be deemed “**Not Detected**”. Conversely, if occupancy surveys during the following year detect a Northern Spotted Owl of the same sex, then the study area shall be deemed “**occupied, resident.**”

Level 3: Determination of Pair Status

If a single Northern Spotted Owl is detected, at least 2 additional occupancy surveys must be conducted during the same breeding season to determine if a pair is present. Alternatively, pair status may be determined using breeding surveys; however, in non-nesting years, males may not take a live lure prey to a female. If subsequent surveys are incomplete or inconclusive, then the site may be deemed “**resident single, pair status unknown.**”

Note: Females on the nest or attending to young may not respond to surveyors’ call play-backs. Additional surveys outside of the nesting and fledging stage may be required.

Assignment of Resident Single Status

A “**resident**” Northern Spotted Owl shall be deemed “**single**” if any of the following criteria are met:

- a Northern Spotted Owl of the opposite sex is Not Detected (audio or visual) after ≥ 3 detections of the resident owl during the same breeding season, or
- multiple responses (≥ 2) over multiple years (2 or more) of the resident owl, with no detection of a Northern Spotted Owl of the opposite sex within the study area. These observations must result from a minimum of 3 surveys per year with at least 2 detections of a Spotted Owl of the same sex over a period of 2 or more years. For example, if a single male Northern Spotted Owl could be heard on 1 of 3 surveys in 1 year, and again on 1 of 3 surveys in a subsequent year and, if no female Northern Spotted Owls were heard during all 6 surveys over 2 years, the site must be assigned a status of “**resident single male**”.

Assignment of Pair Status

A survey area is considered occupied by a “**pair**” if any of the following criteria are met:

- 2 marked individual Northern Spotted Owls that have been paired previously are found alive on at least 1 occasion between 1 April and 30 September, within the study area. It is not required that they be roosting together as long as both birds are found,
- if a male and female Northern Spotted Owl are detected within the study area on ≥ 1 survey(s) (breeding or occupancy surveys) within a single breeding period. These detections do not need to occur on the same visit,
- a male Northern Spotted Owl delivers a live lure to a female Northern Spotted Owl. The confirmation of species identification for the female is required to eliminate the possibility of a mixed species or a hybrid pair,
- a female Northern Spotted Owl is detected on a nest, and a male Northern Spotted Owl is detected within a 1 km radius, as a result of any survey within the breeding period during which the female was observed,
- both adults are seen with young, and identified as Northern Spotted Owls (confirmation of species identification is required to eliminate the possibility of a hybrid pair), or
- young are observed late enough in the season (late July to September) to identify conclusively, based on plumage characteristics, their identity as pure Northern Spotted Owls. Only an observer who is familiar with the plumage characteristics of both Northern Spotted and Barred Owls may make this identification (based on tail and breast feather morphology).

Level 4: Determination of Breeding Status

Nesting status surveys must be conducted between 15 April and 15 June in British Columbia; however, if a female Northern Spotted Owl is detected on a nest before 15 April, the observation can be counted for assignment of “**nesting**” status. To avoid missing a late nesting attempt, nesting status surveys at a known occupied site must not all take place during the early part of this period. The live-lure survey method is the primary method used to determine nesting status.

If surveys to determine nesting status are incomplete or inconclusive, a status of “**resident pair, nesting status unknown**” must be assigned to the study area.

Assignment of Nesting Status

A pair of Northern Spotted Owls will be considered '**nesting**' if any of the following criteria are met:

- a female Northern Spotted Owl is detected on a nest,
- a male or female Northern Spotted Owl carries prey into a nest (or suitable nest structure) on ≥ 2 occasions, during the incubation and/or nesting period,
- a female has a well developed brood patch when examined (in hand) between 15 April and 15 June. This method is not recommended, as it subjects the bird to unnecessary handling stress, and because unskilled observers may not recognize the brood patch,
- young birds are observed in the presence of at least 1 adult during the breeding period. To accurately classify the site as a Northern Spotted Owl pair, confirmation of identification of both parents is desirable (due to the possibility for hybridization with Barred Owls), or
- eggs, eggshells, and/or remains of nestlings are found in or under a nest.

Assignment of Non-nesting Status

"**Non-nesting**" status may only be confirmed before 15 June in B.C. Otherwise, some pairs could be erroneously classified as non-nesting when they are, in fact, failed nesters. In such a case, the proportion of the population classified as non-nesting would be overestimated.

A pair of Northern Spotted Owls shall be considered '**non-nesting**' if any of the following criteria are met:

- at least 4 mice were fed to 1 or both adults as part of a breeding status survey on ≥ 2 visits conducted between 15 April and 15 June. If both adults then failed to deliver them to a potential nest structure or to juveniles, the site must be classified as non-nesting. At least 2 breeding status surveys must be spaced at least 5 days (preferably 14 days) apart to reduce the potential for missing late breeding attempts,
- the female is captured and examined between 15 April and 15 June and does not possess a well defined brood patch,
- a female is located on 1 visit between 15 April and 15 June and shows no indication of nesting (refusal to take or deliver live lure to nest or young), and cannot be located again on a subsequent visit. In poor nesting years, pairs may only briefly return to traditional nesting areas before separating. Once separated and away from their traditional nesting area/activity centres, females may become difficult to locate, or
- a female is observed roosting for periods of ≥ 60 minutes between 15 April and 15 June. Nesting females should be incubating eggs or brooding young during this period. Caution must be used with this criterion later in the nesting period, however, because females with well developed young commonly remain out of the nest for prolonged periods (Forsman 1995). Surveyor presence may cause a female to leave a nest. If a female is found roosting, surveyors must move as far away as possible keeping her in sight, to allow her to return to the nest, if nesting.

Assignment of Nesting Failed Status

A nesting attempt shall be classified as "**nesting failed**" if 1 or more of the following criteria are met:

- a pair is initially classified as "**nesting**," but on ≥ 2 subsequent live-lure surveys, 1 or both of the adults fails to deliver mice to a nest or young. At least 4 mice must be taken during each

live-lure survey to classify as a valid survey. These surveys must occur between 15 April and 15 June, or

- a pair is initially classified as “**nesting**” but neither bird can be relocated on ≥ 2 subsequent breeding surveys between 15 April and 15 June.

Level 5: Determination of Productivity

Identifying the Number of Young Produced

To measure reproductive success, surveyors must count the number of young that leave the nest tree. These counts must occur between 15 June and 15 July; preferably as close to 15 June as possible to avoid missing young that may have died post-fledging, and were undetected. Similarly, young may be counted after 15 July; however, those that have died likely will remain undetected. Two separate visits to the post-fledging area (PFA) are required to ensure that no young have been missed. Surveyors must use live-lure survey techniques to record the maximum number of young seen or heard for each visit.

Birds that are not classified as “**paired**” and “**nesting**” shall be assigned a count of zero young for the relevant breeding season.

Level 6: Determination of Number of Dispersing Owls

Identifying the Number of Potential Dispersers

To measure the number of potential dispersers, surveyors must count the number of young observed between 15 August and 15 September, preferably closer to 15 August, as some young may disperse early. At least 2 separate visits to the post fledging area are required to ensure that no young have been missed. Surveyors must use live-lure survey techniques to record the maximum number of young seen or heard for each visit.

Appendix 3. Visual Searches for Northern Spotted Owl Nest Sites

These tips were adapted from Hobbs et al. (2005).

Mobbing songbirds are often an indicator of owl presence. Pay particular attention to any alarm calls from American Robins (*Turdus migratorius*), as this species has a pronounced response to the presence of both Northern Spotted and Barred Owls. All mobbing songbirds must be investigated.

Surveyors must also pay attention to the relative response level of passerines immediately following each daytime broadcast call. Songbirds within a few hundred metres of an owl activity area (roost or nest) typically exhibit a heightened response (relative to passerines at a greater distance to the activity area) to broadcast owl calls.

In many cases, Northern Spotted Owls will travel long distances to respond to broadcast calls. The habitat surrounding each sample station, and at each detection location generated as a result of broadcast calls does not necessarily reflect true habitat use by Northern Spotted Owls. Therefore, surveyors must pay close attention to owl responses and movements from the previous night's survey.

When searching for a nest, do not follow a strict sampling design. Rather, search for owl sign such as raptor response, whitewash, prey plucking, and pellets as guides by systematically combing the forest floor. Surveyors should separate themselves by approximately 10 metres, depending on the terrain and visibility, to increase detection efficiency.

In close proximity to active nests, there will be fecal evidence (splattered whitewash), molted feathers (from the incubating female), evidence of the plucking of prey, and ejected pellets. When whitewash, pellets, or prey pluckings have been detected, search the nearby trees for nests. For cavity nesting species such as the Northern Spotted Owl, lightly tapping on snags or trees with suitable nest cavities may bring adults to the entrance of the cavity.

Look into potential nest holes for emerging adults. If a bird is seen, record the location and leave the area immediately to minimize disturbance. Return to the area later to record relevant habitat information.