Survey Protocol and Standards
for the
Northern Spotted Owl
(*Strix occidentalis caurina*)
in British Columbia

Occupancy Status

Pair Status

Breeding Status

Productivity Estimates

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Preface

This document details field standards and field methodology for conducting call play-back (acoustic-lure) and live-lure surveys for the Northern Spotted Owl (*Strix occidentalis caurina* (Merriam)) in British Columbia. These standards were prepared for endorsement by the Ministry of Sustainable Resource Management (MSRM), and the Resource Inventory Standards Committee (RISC) in 2004. It is an expectation of the British Columbia Provincial Government that any surveys conducted for Northern Spotted Owls within the province of B.C., will adhere to the field protocols established in this report.

These standards have been developed in consideration of several previously existing standards:

- Resources Inventory Committee (RIC): Inventory Methods for Raptors: Standards for Components of British Columbia's Biodiversity. No. 11. (British Columbia Ministry of Sustainable Resource Management 2001);
- Northern Spotted Owl Survey Protocol in British Columbia (Blackburn and Lenihan 1995);
- Methods and Materials for Locating Spotted Owls (Forsman 1983);
- Spotted Owl Monitoring Protocols for Demographic Studies (Forsman 1995); and,
- Northern Spotted Owl Effectiveness Monitoring Plan for the Northwest Forest Plan (Lint *et al*. 1999).

Other relevant literature from British Columbia and the United States was also reviewed and incorporated where applicable.

Data entry requirements are not addressed in this document. Criteria specifically pertaining to the entry of survey data for all Spotted Owl survey work are outlined in the existing Resources Inventory Committee (RIC) Standards and should be followed as appropriate.

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1. Introduction

The Northern Spotted Owl (*Strix occidentalis caurina* (Merriam)) population consists of adult owls (>3 years old), subadult owls (1 to 2 years old) and juvenile owls (<1 year old). The population structure is comprised of resident owls (adult and subadult), and non-territorial "floaters" (adult, subadult and juvenile owls). Resident Spotted Owls remain in the same general area for most of their lives, and defend their territory against intruding owls. Floaters are not sedentary, but are actively traversing through habitats, searching for vacant territories and available mates. Floaters are stealthy and rarely respond vocally to territorial Spotted Owl calls. The following survey methods are specifically designed to collect information regarding resident Spotted Owls and their offspring. Because floaters may occasionally respond to these survey methods, efforts should be made to determine resident / floater status of all Spotted Owls detected.

1.1 Occupancy Surveys

Occupancy surveys are used to determine the presence of the species within a study area. Resident Spotted Owls can be located most efficiently by broadcasting imitations of their calls at night during their peak activity period. When a resident Spotted Owl hears a call (actual or recorded) from a conspecific, it will typically approach the suspected intruder, and/or vocalize in response. This behaviour facilitates the detection of Spotted Owls in their environment through the use of call-playback (acoustic-lure) surveys (RIC. 2001; Forsman 1983, 1995). In many cases, Spotted Owls will travel long distances to respond; hence, the habitat surrounding each detection location generated as a result of the use of acoustic-lures does not necessarily reflect true habitat use by Spotted Owls. Although Spotted Owls will respond in daylight, the likelihood of response during the daylight is greatly diminished, and is usually limited to the immediate vicinity (e.g., within a few hundred meters) of roosts or nests (Forsman 1983; Reid *et al*. 1999).

1.2 Breeding Surveys

Once an owl has been detected, breeding surveys, which typically involve a combination of acoustic-lure and live-lure ("mousing") techniques during daylight, are applied to find its mate, nest, roosts and offspring. Resident Spotted Owls may annually re-use core nest and roost areas within their territories. Once these core areas are known, total survey effort in subsequent years may be reduced depending on the overall project goals, by initially focusing survey efforts at these core areas.

The intensity of the survey effort will depend on the goal of the project (e.g., occupancy, population abundance, demographic studies, population trends, habitat use, and/or forest management related issues), the timing of surveys, and the available resources. Ideally, the following six objectives will be completed for each study area:

1. Occupancy Status (Is the study area occupied by an owl?)
2. Resident/Floater Status (Is the study area occupied by resident owls?)
3. Pair Status (Is the study area occupied by a single owl or pair of owls?)
4. Breeding Status (Is the female nesting?)
5. Productivity Status (How many offspring successfully fledged?)
6. Dispersal Status (How many offspring survived to dispersal stage?)

Despite the range of objectives, the primary survey objective is to determine **occupancy status** within each study area. Once a Spotted Owl has been detected, the remaining five objectives (secondary survey objectives) may be implemented.

The following standards and methods should provide sufficient information to collect field data to address these six objectives. Adhering to these standards and methods will result in Spotted Owl surveys generating comparative data that can be analyzed using the same assumptions for all of the survey data. To provide comparative data that can be analysed with the same assumptions, it is essential that surveys for Spotted Owls in British Columbia follow these standards and methods. Modifications to these standards and methods should not be done without prior consultation or agreement with British Columbia Ministry of Water, Land and Air Protection (MWLAP) Spotted Owl biologists.

2. Project Design

2.1. Project Area

The project area represents the broad geographic area in which all Spotted Owls surveys will be performed. Project area may be defined at the watershed, landscape unit, district or regional scale.

2.2. Study Area

Within the project area, study areas represent the portion of the land base where surveys will be conducted. Study areas should be established to represent the median annual home range (3,200 ha) for a pair of Spotted Owls. Study areas that are smaller than 3,200 ha may result in biased data, since two adjacent small study areas may detect the same owl (actual number of owls = 1), but count the number of owls as two occupied study areas (detected number of owls = 2). In this case, the number of owls detected in a survey would be double the actual number of owls, resulting in a bias towards over-estimating the population. Conversely, study areas that are larger than 3,200 ha may underestimate the number of owls, if two adjacent resident owls (n=2) are counted as only one owl (n=1).

Generally, study areas are stratified by habitat composition. The Spotted Owl is closely associated with mature and old growth coniferous forests that exhibit uneven-aged, multi-layered, multi-species canopies. These canopies contain numerous large trees with broken tops, deformed limbs and large cavities. These 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 (Forsman *et al*. 1984; Thomas *et al*. 1990; USDI 1992). Forest stand characteristics are the best indicators of suitability for Spotted Owl use (Appendix 2). However, this level of forest stand information is lacking for most areas in BC where Spotted Owls occur. As a result, surrogate suitable habitat definitions have been defined. Type A Suitable Habitat (Superior Quality - preferred habitats selected by owls) is defined as forest stands found below 1,380 m, older than 140 years, and with dominant trees taller than 19.4 m. Type B Suitable Habitat (Moderate Quality - habitats used, but not preferred) is defined as forest stands found below 1,380 m, aged between 100 to 140 years, with dominant trees taller than 19.4 m. In dryer ecosystems, these forest stand characteristics used by owls may be found in younger forests (e.g., 80 to 100 year-old stands); however, owl use is not consistent among all forest stands in this age range.

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 usually have higher likelihoods of Spotted Owl presence; however, other factors also may influence territory selection by the owls.

3. Survey Design Component

3.1. General Standards

The following guidelines should be adhered to for all BC Spotted Owl surveys:

- Do not call for Spotted Owls or be in the presence of owls any more than is necessary. Stimulating the owls to move around may increase their risk of predation. Excessive calling and human presence near nest sites may cause disturbance to nesting owls by luring females off nests.

- Do not "mouse" (live-lure) owls any more than is necessary to determine their status. Owls may become habituated to human contact and food supplements.

- Do not call for Spotted Owls in the presence of predators (e.g., Great Horned Owls (*Bubo virginianus*), Northern Goshawks (*Accipiter gentilis*), Common Ravens (*Corvus corax*), etc).

- Consult with and submit a detailed inventory plan to an MWLAP Spotted Owl biologist to reduce potential survey overlaps among different projects and to reduce excessive harassment of Spotted Owls.

- Report all Spotted Owl detections to an MWLAP Spotted Owl biologist as soon as possible following the initial detections.

- Total search effort (time) is the quantitative statistic used to determine the total amount of effort applied to the study area to locate Spotted Owls. Total search effort is calculated by the sum of time spent surveying at each call-playback survey station. Although surveyors may detect owls when walking between call-playback survey stations, the time spent walking **should not** be considered towards the total search effort. Surveyors may make noise while walking, particularly on loose gravel surfaces, and/or may traverse through areas of high noise or unsuitable habitats, which would decrease the potential for detection and increase the likelihood of disturbance to Spotted Owls.

- Surveyors **must** be outside the vehicle at all times during the call play-back listening period. Minimize conversation and movement. Ideally, surveyors should position themselves approximately 50 m apart to eliminate conversation, and improve the likelihood of detecting an owl.

Detections of Spotted Owls, as a result of the use of acoustic-lures, should be interpreted with caution as, in many cases; Spotted Owls detected at night may have traveled away from their preferred habitat to respond to surveyors. The habitat surrounding each survey station, and the habitat at each detection location generated as a result of the use of acoustic-lures may not reflect the true habitat use of Spotted Owls.

3.2. Occupancy Surveys

Transects and **spot-checks** are two survey methods that may be used to determine Spotted Owl occupancy of a study area. The key difference between the two methods is that **transect surveys provide continuous coverage** of the study area, while **spot-check surveys provide localized coverage**. The spot-check method results in distinct "gaps" between adjacent spot-check locations (i.e., spot-checks greater than 1 km apart from each other) that are not surveyed for owls. Because of the gaps in survey coverage associated with the spot-check method, it is recommended that transect surveys be performed where practicable to determine occupancy of a study area. Section 3.2.1 Transects, and Section 3.2.2 Spot-checks describe these methods in detail.

3.2.1. Transects

Transect Design

Transects should be designed to provide continuous acoustic coverage of suitable habitat within the entire study area or survey route. Transects may be driven or walked. Call-playback survey stations should be spaced about 500 m (range 400 m to 800 m) apart for transects that are driven, and approximately 250 m (range 150 m to 500 m) for transects that are walked. On average, linear transects should be a minimum 8 km in length, with a minimum of 17 call play-back survey stations for transects that are driven, and a minimum of 33 call play-back survey stations for transects that are walked. Placement of call play-back survey stations should consider site-specific topographic and habitat conditions to determine the optimal placement of these stations. Transect typically will be linear in nature (i.e., follow along the valley), which may result in poor acoustic coverage of portions of the study area (e.g., tributaries). Where possible, additional call play-back stations, or spot-checks, should be placed in areas thought to be poorly surveyed by the linear transect. Wherever possible, avoid locating call play-back survey stations at sites with moderate to high levels of environmental noise (e.g., rushing water). Poor placement of survey stations may influence acoustics and the surveyor's ability to detect an owl's response. In addition, poor placement of survey stations may result in data rejection by MWLAP Spotted Owl biologists.

In remote areas where an entire transect survey cannot be conducted in one night, consider designing multiple transects, or using spot-check stations at regular intervals (refer to Section 3.2.2 Spot-checks), that can be surveyed in consecutive nights. To address safety concerns, surveyors should first plan, map, and hike the transect survey route during daylight hours, before conducting the actual night time survey. Global Positioning System (GPS) waypoints of the stations and the vehicle / campsite should be recorded (both on the GPS unit and on the survey form), and a map with notable landmarks should be sketched to aid night navigation back to the campsite.

To increase listening time, but not total search effort (see above), on transect surveys that are driven, one surveyor could drive the vehicle to the next station (and start the station), while the second surveyor walks between survey stations. This ensures that, at all times, at least one observer is outside the vehicle. This may increase the likelihood of detecting an owl response.

Note: Previous survey protocols describe a "leapfrog" technique. This involves one surveyor starting at the beginning of the transect, while the other surveyor drives a certain distance (e.g., 3

km) further along the transect. Both surveyors begin surveying at the same time, walking in the same direction. When the first surveyor arrives at the vehicle (parked at 3 km), he or she drives past the second surveyor, and parks/begins surveying a distance past the second surveyor (e.g., 9 km mark on transect). Although this technique can almost double the area surveyed, this technique is no longer recommended. This is in part due to the possibility that both surveyors may hear each other calling for owls, and the possible confusion of Spotted Owls that hear 2 different owl calls at the same time. Additionally, having only one surveyor listening for owls may cause bias when data are compared to other surveys in which two surveyors were listening at the call play-back survey station.

Call play-back Survey Station Requirement for Transects

After arriving at each station, surveyors should refrain from broadcasting for a period of 1 to 2 minutes to allow their hearing to adjust, before beginning Spotted Owl call play-backs. Spotted Owl call play-backs should be broadcast in three distinct bouts. Each bout should last for approximately 1.5 minutes, with a 3- to 4-minute pause in between bouts. The megaphone should be pointed in different directions, at chest height or overhead, for each call series, to maximize projection of the acoustic-lure. Each station requires a minimum of 15 minutes (after the first call) to complete for driving transects (500 m interval), and a minimum 8 minutes (after the first call) to complete for walking transects (250 m intervals).

For transects that are walked, surveyors must ensure that a minimum of 15 minutes of total search effort is performed per 500 m interval (i.e., if greater than 250 m spacing is used, more survey time at each station is required). More time and/or extra call bouts may be allotted to a station at the surveyor's discretion, to compensate for unfavorable acoustic conditions (i.e., airplane noise, traffic noise, river / creek noise, etc.), or if the surveyor suspects the presence of an owl.

If No Owl is Detected:

If no owl is detected at a station, record all of the required data fields in a data form as specified in the section on "Field Data Requirements" for each station, and then move on to the next station.

If A Spotted Owl is Detected:

If a Spotted Owl is detected, stop the call play-backs immediately. Continue to listen at the station for a minimum of 30 minutes after the owl's last vocalization, in an attempt to locate a second Spotted Owl (mate or juvenile) that may also be present. The location of females during the nesting period (April 19 – June 20) may reveal the approximate location of the nest stand. Record the movements of detected owls. Consider following a detected owl that seems to be moving away from the survey station, as this may reveal the owl's mate, its core roost area, and/or its nest area. Move on to the next survey station once the 30-minute time requirement has elapsed, and resume the call play-backs. If an owl is again detected and it is believed to be the same owl as in the most recent detection, stop the call play-back, and resume listening for an additional 15 minutes in an attempt to locate a possible second Spotted Owl. Record the required fields and move on to the next station.

If A Great Horned Owl or Other Owl Species is Detected:

If a Great Horned Owl is detected, stop the survey call-broadcasts immediately. Continue to listen at the station for the remainder of the 15-minute period, and attempt to determine the breeding status of the detected owl. Record all of the required fields. Once the 15-minute time requirement has elapsed, move at least 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 Spotted Owl predator.

If a Barred Owl (*Strix varia*) is detected in close proximity (within 1 km of the call-broadcast location) stop the call play-backs immediately. Continue listening at the station to ascertain the breeding status of the owl. Spotted Owls typically do not vocalize when a Barred Owl is calling. Once the Barred Owl has stopped calling, the surveyor can resume the call play-back for Spotted Owls, adding on extra survey time to make up for time lost during the Barred Owl vocalization period. Once the 15-minute time requirement has elapsed, surveyors should move to the next station. If the Barred Owl continues to call for more than 15 minutes, or resumes calling after the re-initiation of the call play-back, the surveyor should consider moving to the next station. If the Barred Owl follows the surveyor to the next station, apply the same guidelines as above.

Note: It is likely that multiple Barred Owls will respond during the transect survey, and it is possible that the same Barred Owl may be heard from two or more stations. Surveyors should try to determine the actual number of Barred Owls detected, to avoid double counting individuals. Also note that Barred Owls may have Spotted Owl mates, or hybrid-Spotted Owl-Barred Owl ("Sparred" Owl) mates. Consider conducting a follow-up breeding survey at single-Barred Owl detection locations to determine breeding status.

Note: If an unidentified owl responds to a call play-back, surveyors should try to elicit more responses by continuing call play-backs in the immediate vicinity for an additional 30 minutes. If surveyors are unable to identify an owl species during night visits, a day survey should be conducted, and/or the night survey repeated.

Field Data Requirements for Transects

For each study area, record a brief description of the survey route, including notes on the start and end locations, and the number of stations included in the survey route each night. Record the following fields need as specified.

For each transect station, surveyors must record:

- **Survey Name** – Use the name assigned to the survey transect previously or, in previously unsurveyed areas, assign a survey name based on the nearest gazetted topographic feature (typically a river, creek or lake).
- **Sampling Conditions** (wind, precipitation, temperature) – Wind speed should be noted using the Beaufort Scale (refer to Section 4.3), precipitation should be noted (N-None, MD-Misty drizzle, LR-Light Rain, HR-Heavy rain (surveys should not be conducted)), and temperature should be recorded in degrees Celsius.
- **Survey Date**
- **Surveyors' Names** – Include first and last name of all surveyors.
- **Station UTM** – The NAD 83 UTM coordinates for the station (attempt to ensure 3D coverage).

- **Start Time** – The exact military time (24 hour) in minutes that the first Spotted Owl call was broadcasted.
- **End Time** – The exact military time (24 hour) in minutes that the station was completed. This will typically be 15 minutes after the start time, but may vary to accommodate site-specific conditions (i.e., extensions to compensate for extraneous noise).
- **Any Other Raptor Observations** – All other raptor observations should be recorded.
- **Incidental Observations** – Any Red- or Blue-listed species (flora and fauna) that are incidentally observed should be recorded, with notes on location (UTM), and behaviour (for fauna).

For each owl detection, surveyors must record:

- **Species Name** – The species should be identified following the conventional species code format as detailed in Appendix 1.1.
- **Response Time** – Record the exact time elapsed (in minutes and seconds (mm:ss)) between the first broadcasted call and the first detected response from the owl. This field can aid determination of the owl's initial proximity to the call play-back station (prior to the first detected response).
- **Detection Type (Visual or Acoustic)** – Record whether the first detection of the owl was visual or acoustic.
- **Call Type** – Record and describe the type(s) of calls for each owl detected. Call types can allow inference of the degree of territoriality demonstrated by the responding owl. Describe what call types exist?
- **Call Duration** – Record the exact duration, or length, of each calling bout (mm:ss). Bouts are defined as a series of calls with no more than 2 minutes of silence between calls. In the event that the owl calls in a series of bouts, the location and duration of each bout should be recorded. This field is useful for inference regarding the degree of territoriality demonstrated by the responding owl. Relative knowledge of call duration can aid inferences regarding breeding status and distance to daytime activity centres (e.g., roosts and nests).
- **Time Since Sunset** – Record the exact time, in hours and minutes (hh:mm) that has elapsed since sunset. The exact time of sunset for each day can be obtained from the GPS unit. This field is useful for inferring the potential proximity of the owl from the daytime roost or activity (nest) area.
- **Sex of Owl** – Record the sex of the owl responding. If there is uncertainty, make a guess and note your uncertainty. The sex of the owl responding can be used to infer information about the distance to daytime activity centers (roosts and nests).
- **Call Direction** – Record the direction (in degrees), from the station to the owls estimated location, for each successive calling bout.
- **Call Distance** – Record the distance (metres) from the station to the owl's estimated location, for each successive calling bout.
- **Location** – Record the UTM at the owl's calling location, or record the projected UTM if the location of the calling owl could not be approached safely at night. Separate numbered locations should be recorded for each successive calling bout. Ensure 3-D GPS coverage is available when acquiring owl detection coordinates.
- **Owl Movements** – If the owl seems to have moved, record all detection locations.

3.2.2. Spot-checks

Spot-check Design

In remote, or difficult to access study areas, a series of spot-checks established in core habitat areas throughout the study area is an alternative to transects. Ideally, all spot-checks should be surveyed during the same night. Where this is not possible, surveys may be performed over consecutive nights. The consecutive night spacing of spot-check stations is required to ensure that the survey coverage does not "skip over" an owl if it moves through its territory between non-consecutive survey nights. Close temporal and spatial placement of stations will minimize the likelihood of surveyors missing a resident owl.

Spot-check surveys are more localized in survey coverage than are transects, and are designed to intensively survey specific areas within a study area. A study area may have several spot-check survey stations. Spot-checks may be the preferred method to use in remote, or difficult to access areas.

Although spot-check areas will vary in size and shape, they are typically designed to cover a 1 km radius around the core area of interest (e.g., large stands of suitable). Call play-back survey stations should be spaced about 500 m (range 400 m to 800 m) apart for spot-checks that are driven, and about 250 m (range 150 m to 350 m) apart for spot-checks that are walked. It is recommended that spot-checks be walked to allow for continuous listening coverage. In a typical 1 km radius spot-check, additional call play-back stations should be positioned to ensure thorough coverage of the area being surveyed (e.g., five stations spaced 500 m apart and radiating at 90^{o} angles away from the centre of the site, or up to 9 call play-back stations spaced 250 m apart and radiating at 90^{o} angles away from the centre of the site).

Consider site-specific topographic and habitat conditions in determining the optimal placement of call play-back survey stations. Avoid locating call play-back survey stations at sites with moderate to high levels of environmental noise (e.g., rushing water, etc.). Poor placement of survey stations may influence acoustics and the surveyor's ability to detect an owl's response. In addition, poor placement of survey stations may result in data rejection by MWLAP Spotted Owl biologists.

Survey Station Requirements for Spot-checks

After arriving at each spot-check station, surveyors should refrain from broadcasting for a period of 1 to 2 minutes to allow their hearing to adjust, before beginning Spotted Owl call play-backs. Spotted Owl call play-backs should be broadcast in three distinct bouts, with each bout lasting for approximately 1.5 minutes, and with a 3- to 4-minute pause between bouts. Point the megaphone in different directions, at chest height or overhead, for each call series, to maximize projection of the acoustic-lure. Broadcast the Spotted Owl call play-back at 15- to 30-minute intervals at each station. Allow more time and extra call bouts at a station to compensate for unfavorable acoustic conditions (i.e., airplane noise, traffic noise, river / creek noise, etc.), or if the presence of a Spotted Owl is suspected.

The total search effort per spot-check is the cumulative survey time at each call play-back station. Although survey effort at spot-checks may exceed the minimum time requirement, total search

effort calculated at spot-checks should not exceed the minimum time required needed to survey all call play-back stations. For example, the total search effort for the1 km radius spot-check described above would be capped at 1.25 hours; that is, 5 stations at 15 minutes per station. In difficult to access areas, spot-checks may be surveyed twice in the same night, provided that a minimum 4-hour interval separates the ending of the first survey and the beginning of the second survey (e.g., 2 surveys may be performed: one at dusk, and another at pre-dawn). The 1.25-hour cap for the survey station still applies as it is established to prevent survey bias of obtaining high total search efforts with relatively limited coverage of the study area.

In remote, or difficult to access areas, surveyors should arrive at the designated survey station before dusk. Allow sufficient time to set up camp, and explore the habitat near the spot-check station for owl signs, and document potential night time hiking transects (of shorter duration), using the campsite as a base. If it is safe to do so, attempt to use the spot-check station as a base, and hike at night to other locally (within 1 km) prominent points to expand the area of survey coverage for the station. Use flagging tape and/or GPS waypoints to mark transect routes to reach stations located at 400 to 800-m intervals from the campsite for night surveys. Record GPS waypoints of the survey stations and the campsite in the GPS unit and on the survey form, and sketch a map with notable landmarks to aid night time navigation back to the campsite.

If No Owl is Detected:

If no owl is detected at a station, record all of the required data fields in a data form as specified in the section on "Field Data Requirements" for each station, and then move on to the next station.

If A Spotted Owl is Detected:

If a Spotted Owl is detected, stop the call play-backs immediately. Continue to listen at the station for a minimum of 30 minutes after the owl's last vocalization, in an attempt to locate a second Spotted Owl (mate or juvenile) that may be present. The location of females during the nesting period (April 19 – June 20) may reveal the approximate location of the nest stand. Record the movements of detected owls. Consider following a detected owl that seems to be moving away from the survey station, as this may reveal its mate, its core roost area and/or its nest areas. Move on to the next survey station and resume call play-backs once the 30-minute time requirement has elapsed. If an owl is again detected and it is believed to be the same owl as in the most recent detection, stop the call play-back, and resume listening for an additional 15 minutes in an attempt to locate a possible second Spotted Owl.

If A Great Horned Owl or Other Owl Species is Detected:

If a Great Horned Owl is detected, stop the survey call-broadcasts immediately. Continue to listen at the station for the remainder of the 15-minute period, and attempt to determine the breeding status of the detected owl. Record all of the required fields. Once the 15-minute time requirement has elapsed, move at least 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 Spotted Owl predator.

If a Barred Owl is detected in close proximity (within 1 km), stop the call play-backs until the Barred Owl has stopped vocalizing. Continue to listen at the station to determine the breeding status of the owl. Spotted Owls typically do not vocalize when a Barred Owl is calling. Once the Barred Owl is silent, resume the call play-back for Spotted Owls, adding on extra survey time to

make up for time lost during the Barred Owl vocalization period. Move to the next station once the 15-minute time requirement has elapsed. If the Barred Owl continues to call for more than 15 minutes, or resumes calling after the re-initiation of the call play-back survey, consider moving to the next station. If the Barred Owl follows the surveyor to the next station, apply the same guidelines as above.

Note: It is likely that multiple Barred Owls will respond during the transect survey, and it is possible that the same Barred Owl may be heard from two or more stations. Surveyors should try to determine the actual number of Barred Owls detected, to avoid double counting individuals. Also note that Barred Owls may have Spotted Owl mates, or hybrid-Spotted Owl-Barred Owl ("Sparred" Owl) mates. Consider conducting a follow-up breeding survey at single-Barred Owl detection locations to determine breeding status.

Note: If an unidentified owl responds to a call play-back, surveyors should try to elicit more responses by continuing call play-backs in the immediate vicinity for an additional 30 minutes. If surveyors are unable to identify an owl species during night visits, a day survey should be conducted, and/or the night survey repeated.

Field Data Requirements for Spot-checks

Record a brief description of the survey route, including number and location of spot-check stations included in the survey route for each spot-check survey. Record the following fields as specified.

For each spot-check station, surveyors must record:

- **Survey Name** – Use the name assigned to the survey transect previously or, in previously un-surveyed areas, assign a survey name based on the nearest gazetted topographic feature (typically a river, creek or lake).
- **Sampling Conditions** (wind, precipitation, temperature) – Wind speed should be noted using the Beaufort Scale (refer to Section 4.3), precipitation should be noted (N-None, MD-Misty drizzle, LR-Light Rain, HR-Heavy rain (surveys should not be conducted)), and temperature should be recorded in degrees Celsius.
- **Survey Date**
- **Surveyors' Names** – Include first and last name of all surveyors.
- **Station UTM** – The NAD 83 UTM coordinates for the station (attempt to ensure 3D coverage).
- **Start Time** – The exact military time (24 hour) in minutes that the first Spotted Owl call was broadcasted.
- **End Time** – The exact military time (24 hour) in minutes that the station was completed. This will typically be 15 minutes after the start time, but may vary to accommodate site-specific conditions (i.e., extensions to compensate for extraneous noise).
- **Any Other Raptor Observations** – All other raptor observations should be recorded.
- **Incidental Observations** – Any Red- or Blue-listed species (flora and fauna) that are incidentally observed should be recorded, with notes on location (UTM), and behaviour (for fauna).

For each owl detection, surveyors must record:

- **Species Name** – The species should be identified following the conventional species code format as detailed in Appendix 1.1.
- **Response Time** – Record the exact time elapsed (in minutes and seconds (mm:ss)) between the first broadcasted call and the first detected response from the owl. This field can aid determination of the owl's initial proximity to the call play-back station (prior to the first detected response).
- **Detection Type (Visual or Acoustic)** – Record whether the first detection of the owl was visual or acoustic.
- **Call Type** – Record and describe the type(s) of calls for each owl detected. Call types can allow inference of the degree of territoriality demonstrated by the responding owl. Describe what call types exist?
- **Call Duration** – Record the exact duration, or length, of each calling bout (mm:ss). Bouts are defined as a series of calls with no more than 2 minutes of silence between calls. In the event that the owl calls in a series of bouts, the location and duration of each bout should be recorded. This field is useful for inference regarding the degree of territoriality demonstrated by the responding owl. Relative knowledge of call duration can aid inferences regarding breeding status and distance to daytime activity centres (e.g., roosts and nests).
- **Time Since Sunset** – Record the exact time, in hours and minutes (hh:mm) that has elapsed since sunset. The exact time of sunset for each day can be obtained from the GPS unit. This field is useful for inferring the potential proximity of the owl from the daytime roost or activity (nest) area.
- **Sex of Owl** – Record the sex of the owl responding. If there is uncertainty, make a guess and note your uncertainty. The sex of the owl responding can be used to infer information about the distance to daytime activity centers (roosts and nests).
- **Call Direction** – Record the direction (in degrees), from the station to the owls estimated location, for each successive calling bout.
- **Call Distance** – Record the distance (metres) from the station to the owl's estimated location, for each successive calling bout.
- **Location** – Record the UTM at the owl's calling location, or record the projected UTM if the location of the calling owl could not be approached safely at night. Separate numbered locations should be recorded for each successive calling bout. Ensure 3-D GPS coverage is available when acquiring owl detection coordinates.
- **Owl Movements** – If the owl seems to have moved, record all detection locations.

3.3. Breeding Surveys

Breeding surveys are used to determine breeding status (e.g., pair and nesting attempt / success), productivity (e.g., number of juveniles produced / dispersed), and identification of core areas (e.g., nests and roosts) of detected Spotted Owls. Two methods are used during breeding surveys: acoustic-lure and live-lure ("mousing"). The following sections describe these methods in detail.

3.3.1. Acoustic-lure / Visual Search

Acoustic-lure methods may be used to visually locate Spotted Owls in order to determine pair status, nesting status and nest productivity. Typically, these surveys should commence one hour before dawn on the day following the initial detection. Begin these surveys about 200 to 300 m away from the estimated location of the previous night's detection, and then expand the search, on foot, towards the estimated location. During the search, broadcast owl calls at intervals of approximately 10 of 30 minutes (depending on search speed). At the same time, visually search the forest for roost locations, and any evidence of owl activity (e.g., whitewash, pellets, feathers, prey remains, mobbing birds*, etc.). Surveyors should be observant and move slowly (between 0.5 – 2 km per hour) to maximize the likelihood of detecting any evidence of owl activity within the stand. Collect any feathers or pellets after noting the location. Minimize extraneous noise (e.g., talking, moving clumsily or quickly, etc.), and be alert for calls from responding owls. Upon arriving at the detection location from the previous night, expand the survey in increasingly concentric circles, to search all forested habitats within a 500 m to 1 km radius of the previous detection. Continue the search until one hour after sunset or until the owl is detected.

Stop the survey if a Spotted Owl is not detected within 4 hours, to avoid excessive disturbance to other Spotted Owls that may be present, but that are not responding to call play-backs. Re-survey the area (spot-check) at dusk of the same day, when the owl may be more active and more likely to respond. If an owl doesn't respond at dusk, it is possible that the owl has moved elsewhere, in which case a full transect may be required.

If a Spotted Owl response (visual or vocal) is elicited during the survey, cease further acoustic-lure broadcasts immediately. Do not continue playing the call after a response has been detected, as this may stress the bird, and cause it to abandon its territory or nest. Surveyors should note that by responding to the acoustic-lure, the Spotted Owl is altering its behaviour, which may interfere with critical breeding activities (i.e., feeding, courtship, and mating). If a Spotted Owl is detected calling in response to the acoustic-lure, "hone in" on the vocalizing owl as quickly as possible, but stop every time the owl calls, to re-affirm its estimated location. Typically, owls will not call for extended periods during the day, so surveyors need to move very quickly to locate the vocalizing owl before the bout ends. Move as quietly as possible, since excessive noise (e.g., yelling or breaking branches) will usually cause the owl to cease vocalizing. If the owl has not been located visually at the end of the calling bout, move to the estimated location of the owl and conduct an intensive search. It is required that surveyors wait at least one hour before again attempting to elicit a response. At this point, the acoustic-lure should be broadcast quietly, so as to carry only 50 to 100 m. Only one call at a time should be broadcast, with a 5-minute pause between each call. This will increase the likelihood of eliciting a second response, and will reduce excessive disturbance to the resident owl.

Tips for Visual Search for Spotted Owls:

- Mobbing birds are often an indicator of owl presence. Pay particular attention to any 'alarm calls' from American Robins (*Turdus migratorius*), as this species generally has a pronounced response to the presence of both Spotted Owl and Barred Owls. All mobbing birds should be investigated. Surveyors should also pay attention to the relative response level of passerines immediately following each daytime call play-back broadcast. Songbirds within a few hundred meters 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 broadcasted owl calls.
- In many cases, Spotted Owls will travel long distances to respond to call play-backs. The habitat surrounding each survey station, and at each detection location generated as a result of the use of acoustic-lures, is not necessarily reflective of true habitat use by Spotted Owls. Therefore, it is important to 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; instead use clues such as raptor response, whitewash, prey pluckings, and pellets as guides. However, in thick coniferous forests where nests are very difficult to see, search for owl signs by systematically combing the forest floor, back and forth. Surveyors should separate themselves by approximately 10 meters, 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.
- Once whitewash, pellets, or prey pluckings have been detected, search the nearby trees for nests.
- For cavity nesting species such as the Spotted Owl, lightly tapping on snags or trees with suitable nest cavities may bring adults to the entrance of the cavity. Look up and 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.

3.3.2. Live-lure ("Mousing")

Once a Spotted Owl is located during the day, live-lure techniques can be used effectively to achieve the following objectives:

- Identification of nest location
- Assignment of pair status ("Is a pair present, or is it a solitary resident at the site?")
- Assignment of breeding status ("If a pair is present, are they nesting?")
- Brood size ("How many young are present? How many fledged")
- Juvenile post-fledging / pre-dispersal survival ("How many young are still surviving (at the date of survey)?")

Once an adult Spotted Owl has been visually located during the day, place a live mouse on a prominent perch that is visible to the owl, and that offers the owl a clear line of flight for approach and exit. Generally, the perch used to offer the mouse should be within 30 m of the roosting owl. After placing the mouse on the selected perch, the surveyor should "squeak" to get the owl's attention (if the owl has not already observed the mouse), then move at least 3 meters away, and seek concealment behind a tree trunk (the second surveyor should already be concealed). If the owl does not take the mouse, try another perch (and possibly another mouse) for the owl's approach. Also, try moving further away from the mouse and owl, while remaining motionless and silent, to let the owl focus on the mouse. Any noise or movement can divert the owl's attention. Some owls will be reluctant to take offered prey, even when tending an active nest. If the owl refuses to take the prey within 30 minutes, remove the prey, and try again in one-hour intervals, continuing until 30 minutes after sunset.

In most cases, the Spotted Owl will take the mouse within a few minutes, so be prepared to follow the owl, its actions concerning the live-lure must be monitored and recorded. For each live-lure presented, record which of the following behaviours occurred:

- Ate prey;
- Delivered prey to female;
- Delivered prey to nest;
- Delivered prey to juvenile(s); and,
- Cached prey.

Surveyors should provide a maximum separation between themselves and the owl when following it, although be careful not to leave too much distance between you and the owl as you risk losing sight of the bird. Move as quietly as possible, watching for twigs and branches, and talking quietly only when necessary. Use cover to conceal your position when the owl pauses. Owls are often reluctant to deliver prey items to a nest (or young) if they are being too closely observed. Record the fate (owl's behaviour) of each prey item, and note any uncertainty. Be prepared to offer up to four mice to an owl to accurately assign the owl a status. If the fate of the mouse (e.g., cached, eaten or delivered) was not observed, that prey item does not count towards meeting the requisite four-mouse protocol.

If the owl caches all four mice, or simply roosts with a mouse for a greater than 30 minutes, then live-lure surveys can be stopped. If the owl eats all four mice, continue feeding until the owl begins to cache or "roost with" mice. Note that if the owl is "caching" mice, it may be reluctant to deliver the prey due to surveyor proximity. In this case, allow more space between you and the

owl, and use cover to conceal your position. If this behavior continues, wait until nightfall to determine if the prey items are delivered to the nest, or delivered to young after dark. If paired, even when nesting, the male and female (and the juveniles, later in the season) will typically re-unite briefly at "first dark," and call to one another; prey exchange will occur at this point.

If live-lure techniques are being used after fledging (in BC, after June 15), focus searches within 1 km of the known or suspected nest location. Juveniles tend to use a 500-hectare 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 June 15, the greater likelihood that the juveniles, and attending adults, will be found within a few hundred meters of the nest tree.

Notes:

- Once the nest location, or the location of the juveniles, has been confirmed, leave the area to minimize any further disturbance of the nesting pair of owls in order to avoid potential disruption of successful breeding.
- The use of live mice to entice a behavioral response from an owl enables efficient detection of pairs, nests, and juvenile owls. Be cautious not to feed any more mice to owls than deemed necessary to avoid habituating the owls to humans.

Field Data Requirements for Acoustic and Live-lure Surveys

Record a brief description of the search area for each survey. Include notes on start and end time, total search time, and habitat comments as appropriate. Record the following information as specified below.

For each breeding status survey, record:

- **Survey Name** – Use the name assigned to the survey transect previously or, in previously unsurveyed areas, assign a survey name based on the nearest gazetted topographic feature (typically a river, creek or lake).
- **Sampling Conditions** (wind, precipitation, temperature) – Wind speed should be noted using the Beaufort, precipitation should be noted (N-None, MD-Misty drizzle, LR-Light Rain, HR-Heavy rain (surveys should not be conducted)), and temperature should be recorded in degrees Celsius.
- **Surveyors' Names** – Include first and last name of all surveyors.
- **Survey Date**
- **Centroid UTM** – The NAD 83 UTM coordinates for the centroid, this should be the same as the previous night's projected or actual detection UTM (attempt to ensure 3D coverage).
- **Start Time** – The exact military time (24 hour) in minutes that the first Spotted Owl call was broadcasted.
- **End Time** – The exact military time (24 hour) in minutes that the survey was completed. This will typically be 15 minutes after the start time, but may vary to accommodate site-specific conditions (i.e., extensions to compensate for extraneous noise).
- **Any Other Raptor Observations** – All other raptor species observations should be recorded.
- **Incidental Observations** – Any Red- or Blue-listed species (flora and fauna) that are incidentally observed should be recorded, and should include notes on location (UTM) and behavior (fauna).

If any owl sign, or any other owl species, is located during the survey, record for each observation:

- **Suspected Species** – The species should be identified following the conventional species code format, as detailed in Appendix 1.1. If the species can't be identified (i.e., whitewash only), describe the size and amount of whitewash present. Collect (after recording the location) any pellets, prey remains and/or feathers.
- **Detection Date / Time** – Record the time the owl sign was found.
- **Location** – Record the UTM (ensure acquisition of 3D navigation) of the owl sign. Separate numbered locations (cross-referenced with notes specific to each observation) should be recorded for each successive calling observation.

If a Spotted Owl is detected during daytime breeding status surveys, record:

- **Detection Date / Time**
- **Search Effort** – Number of minutes spent searching for the owl.
- **Location of the Owl in NAD 83 UTM Coordinates** (ensure 3D coverage).
- **Behavioral Notes and a Visual Assessment of the Owl's Condition** – Alert, etc.
- **Roost Site Characteristics**
- **Stand Characteristics** – As specified by project requirements.
- **Color Description of Leg Band** (if the owl is banded) – Note: in dimly lit forested conditions, the band can be most easily identified by lying on the ground directly below the owl and use a very strong (million candlepower) flashlight to illuminate the back of the ankle, near the cloaca, where the band is always visible.
- **Quantity of Owl Sign in the Stand** – Note: if whitewash, and/or pellets, and/or feathers are found, quantify the amount as sparse 1-3, moderate 3-10, or abundant >10.
- **Behavioral Response of the Owl to a Live-lure Survey** (refer to Section 3.3.2).
- **Number of Mice Offered and Taken**
- **Fate of Each Prey Item** – Cached, delivered or eaten.
- **Monitoring Effort** – Number of minutes / hours spent performing live-lure surveys.

If a Spotted Owl nest is located during daytime breeding status surveys, record the following:

- **Detection Date / Time**
- **NAD 83 UTM 3D coverage coordinates for the nest tree**
- **Nest Tree Diameter at Breast Height** (DBH) (cm)
- **Estimated Nest Height** (m)
- **Estimated Nest Tree Height (m)**
- **Description of Nest Structure**
- **Nest Tree Species**
- **Stand Crown Height (m)** – Height from the ground to beginning of the live crown.
- **Stand Structure Heterogeneity** – Presence of dominant, co-dominant, intermediate, suppressed, B1 and B2 layers in the stand (within 500-m radius).
- **Dominant Tree Species in the Stand** – Top 3 species listed by percent canopy cover.
- **Dominant Shrub Species in the Stand** – Top 3 species listed by percent cover).
- **Slope (degrees)**
- **Aspect (cardinal direction)**
- **Behavioral Notes**

4. Survey Standards

4.1. Survey Timing

Most efficacy estimators to locate Spotted Owls are derived from nocturnal surveys conducted during the breeding period. Surveys for Spotted Owls in B.C. must follow these conventions for timing restrictions to provide comparable data that can be analysed with the same assumptions of efficacy.

4.1.1. Time of Day

Spotted Owls are nocturnal. Their peak activity period begins within a half hour after sunset, and ends a half hour before sunrise the following morning. Although Spotted Owls will respond in daylight, the likelihood of response during the daylight is greatly diminished and is usually limited to the immediate vicinity (e.g., within a few hundred meters) of roosts or nests (Forsman 1983).

Occupancy Surveys

Occupancy surveys must be performed at night during the peak activity period. If Spotted Owls are known to occur within a study area, the known core area of owl activity (based on previously documented owl activity) is usually first surveyed during the day, following standards detailed in the section on Breeding Surveys) to determine owl presence. If no Spotted Owls are detected, then occupancy surveys are used to locate the owl(s) within the study area. Occupancy or breeding surveys performed during daylight cannot be used to determine absence of Spotted Owls (i.e., not detected) from study areas, due to the reduced likelihood of owl detection during daylight hours.

Breeding Surveys

Breeding surveys should be performed during the day to allow for visual identification and recording of behavioural responses of individual owls. Following night detections of Spotted Owls, it is recommended that follow-up breeding surveys commence before sunrise, to take advantage of the relative increased responsiveness of the owls at dawn. Under favourable logistical conditions, surveyors may attempt to determine pair status and/or nest locations at dusk or at night, to take advantage of increased owl responsiveness during these hours.

4.1.2. Time of Year

Occupancy and Breeding Surveys:

Both occupancy surveys and breeding surveys must be conducted within the breeding period. The breeding period begins at the onset of breeding activity (courtship) in the early spring, about two weeks before the date of first egg-laying, and ends when the adults stop feeding the young, about one week prior to juvenile dispersal. This timing restriction for occupancy surveys is necessary because Spotted Owls become less vocal and more difficult to locate in the winter (Forsman 1983). This change in behaviour would decrease the likelihood of detection, and increase the amount of survey effort needed to conclude that a site was not occupied.

Table 1. Seasonal activities for Spotted Owls in Washington State (Forsman *et al.* 2002).

Activity	Duration (days)	Washington (n=77)
Breeding Period		
Courtship begins	28 - 42	February 26-March 22
Copulation	14-21 prior to nesting	March 19-April 5
Nesting (Egg laying)	1 - 6	April 9-April 19
Incubation	28 - 32	April 9-May 17
Juveniles on nest	34 - 36	May 11-June 20
Fledging	1	June 16-June 20 (Range: May 13-July 15)
Post-Fledging Area (PFA)	80 - 120	June 16 – October 4
Juvenile dispersal	1	September 25 – October 4
Non-breeding Period		
Winter foraging/dispersal	-	October – February

Information on the chronology of the Spotted Owl breeding period in BC is limited (Hobbs 2002, 2004), but it is thought to similarly follow the chronology for Spotted Owls in Washington State (Table 1). Based on these dates, all BC surveys to determine occupancy, resident status, and pair status must be conducted during the breeding period of April 1 to September 30 (Table 2)*. To identify nests, and to determine nesting attempts, breeding surveys must be conducted between April 19 and June 16, although some females may be observed on the nest, and nest trees may be identified or suspected (e.g., abundant whitewash, and pellets or egg fragments under a nest cavity or platform) outside of this period. To count the number of fledglings (young successfully produced), breeding surveys must be conducted between June 20 and July 15. The longer the period between the actual fledging date and the date of surveyor observation the greater the likelihood that the number of young fledged will be underestimated. This is because some fledged young may have died, undetected by surveyors. Breeding surveys to determine numbers of dispersing juveniles must occur between September 1 and September 15, although juveniles observed with their parents after this date may be included in the count.

Table 2. Recommended survey timing for surveys conducted in B.C.

Survey Objective	Recommended Survey Periods
Occupancy Surveys	
Presence/Not detected (Vacancy)	April 1 – September 30
Resident/floater status	April 1 – September 30
Breeding Surveys	
Pair status	April 1 – September 30
Identify nest trees and nesting status	April 19 – June 16
Productivity estimates (Fledglings)	June 20 – July 15
Juvenile dispersal estimates	September 1 to September 15

***Note:** The April 1 start-up date is a conservative date chosen to provide the highest probability that Spotted Owls are nesting, and/or defending their territory. Some protocols reviewed for this report suggest a March 1 or March 15 start-up date, depending on geographic and ecological location of project areas, with earlier start-up dates in southern warm climates (e.g., Oregon and California).

Note: Positive responses of Spotted Owls in the non-breeding period are still valid in the determination of owl presence; however, negative results during this period cannot be used to determine vacancy for the study area. Any Spotted Owl detections recorded outside of these timing windows should be re-surveyed the following year during the breeding period, to confirm occupancy.

4.2. Field Equipment

Field survey equipment for each independent 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.

Broadcasting Equipment (Required):

- Megaphone: One of two portable megaphone brands are identified for conducting call play-back surveys for Spotted Owls. Either the Fanon™ (recommended) or the Radio-shack™ (10 watt) megaphones are satisfactory for Spotted Owl survey purposes. Other brands of megaphones may also be acceptable. Megaphones should be able to broadcast owl calls that are heard by humans at least 1 km away under ideal conditions. Both of these megaphone brands need to be modified by a qualified electrician to facilitate attachment, via a mono cord, to a Walkman or portable compact disc (CD) player (preferred).
- A high quality portable CD or cassette player to play recorded owl calls. Water-resistant portable CD players with a repeat function, a function memory and no audible operating tones are recommended.
- CDs or tapes of owl calls. CDs and tapes of Spotted Owl calls designed specifically for surveys can be purchased from various sources. If you are creating your own CD or tape, recordings should feature bouts from both sexes of five "Four-Note" Spotted Owl calls (in close sequence), and bouts of "Series" calls. Each bout will last for approximately 1.5 minutes. Other owl calls should be included for reference on the CD (or on a separate tape). These reference calls should include other potential species of owls that may be encountered, other Spotted Owl call types, and hybrid-Spotted Owl-Barred Owl ("Sparred" Owl) calls. Samples of these CDs or tapes must be provided for review by MWLAP Spotted Owl biologists, prior to survey initiation, to ensure the quality and repertoire of required calls is included. **Note:** The Spotted Owl "Series" call is similar to the "Series" call of Barred Owls. Because of this similarity, Barred Owl detections may increase if Spotted Owl "Series" calls are the only call type used for surveying. Therefore the "Four-Note" call (unique to Spotted Owls), should be the predominant call used to detect Spotted Owls. When preparing recordings, ensure that the species' calls are not cut off at an unnatural point.
- **Note:** Voice calling sometimes can be an effective tool to lure and detect Spotted Owls. However, consistency (e.g., quality and amplification) of calls produced among different

surveyors will be variable, and as such, frequency of success by surveyors may also be variable. Surveys to determine presence/not detected **must use recordings** of Spotted Owl calls broadcasted from a megaphone to ensure consistency.

Field Equipment for Spotted Owl Surveys:

Required Equipment:

- One Global Positioning System (GPS unit) per crew. Carry the GPS in the field at all times. It is recommended that each crew carry 2 GPS units plus extra batteries in case of malfunction and/or if crews separate to search different areas.
- A compass to accurately plot detection directions.
- Binoculars to enable thorough searches (of tree crowns) for roosting owls and/or molted feathers.
- Hand-held two-way radios for each crewmember, to enable continuous voice communication during daytime breeding surveys. These are necessary to eliminate the need for surveyors to communicate by yelling to one another.
- 1:40,000 scale topographic maps (or photocopies of original maps) of each survey area should be available in the field. These are essential to ensure efficient transect design and to aid navigation. Maps should depict habitat suitability reconciled against TRIM topography and, depending on project goals, all existing/previous Spotted Owl location information (symbol codes by season, sex and photoperiod).
- Data recording device (usually waterproof notebook to record all information).

Recommended Equipment:

- A one-million candlepower spotlight with at least a 2-hour battery is recommended. This is useful for spotlighting owls in dim or dark condition to confirm both species identification and individual owl identification (reading bands). Be careful not to aim the beam directly at the owl.
- It is recommended that each crew be equipped with a satellite phone, and a list of contacts in case of emergency and/or direction from project biologists.
- Camera (digital preferred) to photograph owls (i.e. leg-bands), nests, roosts, habitats, etc.
- Flashlights and head-lamps.

4.3. Weather

Surveys should not be conducted under inclement weather conditions, such as high winds (>Beaufort 3), rain, heavy fog, or during high noise levels (e.g., stream noise, machinery, constant highway traffic, etc.). These conditions limit the surveyor's ability to hear owls, and may jeopardize the well being of an owl by unnecessarily increasing the owl's exposure to adverse elements. If weather conditions or noise conditions are in doubt, be conservative. Survey visits conducted under marginal conditions will reduce the quality of the overall survey effort. Negative results collected under inclement weather conditions may not be adequate for evaluating Spotted Owl presence/absence. Some general guidelines for appropriate and inappropriate weather conditions for surveying are provided in Table 3 (RIC 2001).

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 (winter)	Steady rain Heavy snow
Temperature	As local conditions allow. Ideally, temperatures should be close to the season average. Be aware that equipment often malfunctions in cold conditions (<10°C). There is also evidence that owls may be less vocal in very cold weather (Takats *et al.* 2001).	

4.4. Surveyor Qualifications

Due to the sensitive socio-economic impacts of detecting or not detecting Spotted Owls, and the critical endangerment of the species' persistence in BC, surveyor qualifications are stringent, and will be monitored by MWLAP Spotted Owl biologists. It is recommended that all surveys performed have at least 1 qualified Spotted Owl field surveyor present during the field work. Failure to have a qualified Spotted Owl field surveyor present during the survey may result in data rejection by MWALP Spotted Owl biologists.

- Qualified Spotted Owl field surveyors must be familiar with the standards and methodology for conducting Spotted Owl surveys, the repertoire of all BC owl vocalizations (particularly the numerous vocalizations of Spotted Owls, Barred Owls, and "Sparred" Owls) and the ecology of the Spotted Owl. Qualified Spotted Owl field surveyors must have normal hearing ability, and a minimum of one year of documented Spotted Owl field experience in British Columbia or Washington State.

5. Survey Site Status Determination

Six levels of information are collected at each study area regarding the status and numbers of Spotted Owls (Figure 1). The necessity of collecting all or portions of this information is largely dependent on the goal of the project. Consider project goals and objectives carefully at the initiation of a project, as each incremental level has an associated increased cost of survey effort and some levels may have timing restrictions.

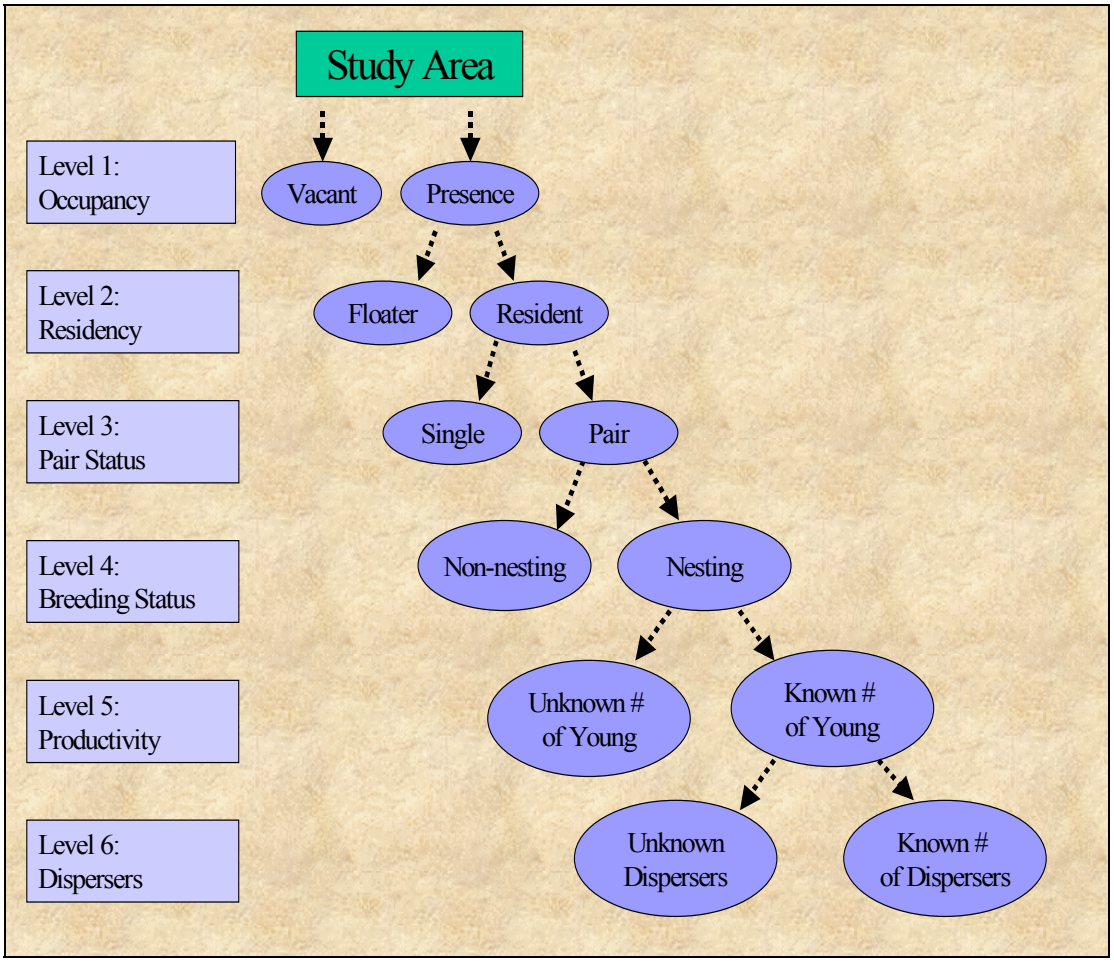

Figure 1. The six levels of owl status and study area designation.

5.1. Level 1: Determination of Occupancy Status

The term "occupancy" refers to the presence, or absence (e.g., not detected), of Spotted Owls (resident or floater) within the survey area. This level of information is required prior to concluding the absence of Spotted Owls from a survey area for forest management related issues. Because owls detected may move to other areas outside of the study area, occupancy status for each survey area is only relevant for the year in which the surveys were conducted.

If the following minimum survey effort criteria are not met within the study area, then the study area may be deemed "**Status Unknown**". A quantifier for "unknown" may be assigned by applying the total search effort for subsequent surveys to Figure 1.

5.1.1. Assignment of Occupied Status

A survey area is considered "**Occupied**" if a Spotted Owl is detected within the survey area at any time throughout the year, and during the night or day.

5.1.2. Assignment of Vacancy (Non-detected) Status

A study area may be considered "**Vacant**" if no Spotted Owls are detected when more than 13.0 hours of total search effort collected during the breeding period (April 1 to September 30) is expended over 3 or more night-time surveys (transects or spot-checks), and spaced a minimum 5 days apart (preferably 1 month apart), throughout the study area.

These criteria provide for a minimum 90% chance of detecting a Spotted Owl if one were present in the study area. Conversely, accepting these criteria means that there is a 1-in-10 chance that a study area will be wrongly deemed "Vacant," despite the presence of a Spotted Owl. As such, for forest management-related issues, prior to officially declaring a study area "Vacant," there is a minimum requirement to obtain "vacant" status over two or more consecutive years, with at least three occupancy surveys conducted per year. For population monitoring, it is assumed that these undetected Spotted Owls will be detected in subsequent survey years.

Breeding surveys and surveys performed in the non-breeding period cannot be used to conclude the absence or vacancy of Spotted Owls in the study area. Surveys for Spotted Owls in the winter period (October 1 to March 31) are not encouraged, as they may result in increased Spotted Owl energy expenditure during this critical period, and information collected from these surveys may be of limited value.

5.2. Level 2: Determination of Resident Status

Owls detected within a study area may be "resident" owls (adults and subadults) that defend their territories against intruding owls or non-territorial "floaters" (adults, subadults and juvenile owls), that are actively searching for vacant territories and available mates. Because floaters may occasionally respond during surveys, efforts should be made to determine resident/floater status of all Spotted Owls detected. If a "resident" status survey is incomplete, then the site may be deemed "**Occupied, Resident Status Unknown.**" A quantifier for "unknown" may be assigned for the subsequent surveys following initial detection by applying the total search effort for subsequent surveys to Figure1.

5.2.1. Assignment of "Resident" Status

A Spotted Owl may be considered "**Resident**" if any of the following criteria met:

- The detection (visual or auditory) of a Spotted Owl of the same sex within the study area on 3 or more occasions during the same breeding period (spaced at least 5 days apart, preferably 1 month apart).
- Multiple detections (2 or more) over 2 or more years, preferably consecutive years, of a single owl of the same sex within the study area.
- The detection of a pair of owls within the study area.
- The detection of juveniles with adult Spotted Owls.

5.2.2. Assignment of "Floater" Status

A Spotted Owl may be deemed a "**Floater**" if the following criteria are met:

- Following the initial detection of the owl, a minimum of three additional occupancy surveys (spaced a minimum five days apart, preferably one month apart) with total search effort greater than 13.0 hours during the same breeding period fail to detect the owl's presence. In areas with poor logistics (e.g., along highway corridors), additional surveys may be required.

Note: For management considerations, the study area will be deemed "**Occupied, Floater.**" If Occupancy surveys during the following year fail to detect Spotted Owls, then the study area may be deemed "V**acant.**" Conversely, if occupancy surveys during the following year detect a Spotted Owl of the same sex, then the study area may be deemed "**Occupied, Resident.**"

5.3. Level 3: Determination of Pair Status

If a single Spotted Owl is detected, at least two additional occupancy surveys should 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 prey (mousing) to the 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 surveyor's call play-backs. Additional surveys out side of the nesting and fledging stage may be required.

5.3.1. Assignment of "Resident Single" Status

A "**Resident**" Spotted Owl may be deemed "**Single**" if any of the following criteria are met:

- A Spotted Owl of the opposite sex is not detected (audio or visual) after three or more detections of the resident owl during the same breeding season.
- Multiple responses (two or more) over multiple years (two or more) of the resident owl, with no detection of a Spotted Owl of the opposite sex within the study area. These observations should result from a minimum of three surveys per year with at least two detections of a Spotted Owl of the same sex over a period of two or more years. For example, if a single male Spotted Owl could be heard on one of three surveys in one year, and again on one of three surveys in a subsequent year and, if no female Spotted Owls were heard during all six surveys (total for two years), the site could be assigned a status of "Resident Single Male".

5.3.2. Assignment of "Pair" Status

A survey area is considered occupied by a "**Pair of Spotted Owls**" if any of the following criteria are met:

- Two marked individual Spotted Owls that have been paired previously are found alive on at least one occasion, between April 1 and September 30, 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 Spotted Owl are detected within the study area on one or more surveys (breeding or occupancy surveys) within a single breeding period. These detections do not need to occur on the same visit.
- A male Spotted Owl delivers a mouse to a female 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 Spotted Owl is detected on a nest, and a male 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 Spotted Owls (confirmation of species identification is required to eliminate the possibility of a hybrid pair).
- Young are observed late enough in the season (late July to September) to identify conclusively, based on plumage characteristics, their identity as pure Spotted Owls. An observer who is familiar with the plumage characteristics of both Spotted Owls and Barred Owls should make this identification (based on tail and breast feather morphology).

5.4. Level 4: Determination of Breeding Status

Nesting status surveys must be conducted between April 19 and September 25 in BC; however, if a female Spotted Owl is detected on a nest before April 19, the observation can be counted for assignment of "**Nesting**" status. To avoid missing a late nesting attempt, it is important that nesting status surveys at a known occupied site do not all take place during the early part of this period. The live-lure survey method is the primary method used in the determination of nesting status.

If surveys to determine nesting status are incomplete or inconclusive, a status of "**Resident Pair, Nesting Status Unknown**" should be assigned to the study area.

5.4.1. Assignment of "Nesting" Status

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

- A female Spotted Owl is detected on a nest.
- A male or female Spotted Owl carries prey into a nest (or suitable nest structure) on two or more occasions, during the incubation and/or nesting period.
- A female has a well-developed brood patch when examined (in hand) between April 25 and June 25. This method is not recommended, as it subjects the bird to unnecessary handling stress, and because unskilled observers may not accurately recognize the brood patch.
- Young birds are observed in the presence of at least one adult during the breeding period. To accurately classify the site as a Spotted Owl pair, confirmation of identification of both parents is desirable (due to the possibility for hybridization with Barred Owls).
- Eggs, egg-shells, and/or remains of nestlings are found in or under a nest.

5.4.2. Assignment of "Non-nesting" Status

Confirmation of "**Non-nesting**" status must take place before June 15 in B.C. It is recognized that there is a possibility for some pairs to be erroneously classified as "non-nesting" when they are in fact failed nesters. As such, the proportion of the population classified as "non-nesting" may be overestimated.

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

- At least four mice were fed to at least one, or both, adult(s) as part of a breeding status survey on a minimum of two visits conducted between April 25 and June 25. To be considered a valid live-lure (mousing) attempt; at least two mice must be taken on each of at least two daytime breeding status surveys. If, on at least two different valid mousing attempts, both adults failed to deliver the prey to a potential nest structure or to a juvenile(s), the site should be classified as "non-nesting." Breeding status surveys (two surveys minimum) should be spaced a minimum five days (preferably 14 days) apart to reduce the potential for missing late breeding attempts.
- The female is captured and examined between April 19 and June 25 and does not possess a well-defined brood patch.

- Females are located on one visit, between April 19 and June 25, and show no indication of nesting (refusal to take mice or to deliver mice 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.
- Females are observed roosting for periods of 30 minutes or more between April 19 and May 20, as nesting females should be incubating eggs or brooding young during this period. Note that this technique cannot be used after May 20, because it is common for females with well-developed young to remain out of the nest for prolonged periods (Forsman 1995). **Caution:** Surveyor presence may cause the female to leave the nest. If a female is found roosting, move as far away as possible, but still keeping her in sight, to allow her to return to the nest, if nesting.

5.4.3. Assignment of "Nesting Failed" Status

A nesting attempt may be classified as "**Nesting Failed**" if one or more of the following criteria are met:

- A pair is initially classified as "nesting," but on at least two subsequent live-lure surveys, one or both of the adults fails to deliver mice to the nest or young. At least two mice must be taken during each live-lure survey to classify as a valid survey. These surveys must occur between April 19 and June 15.
- A pair is initially classified as "nesting" (i.e., nest location confirmed), but neither bird can be relocated on at least two subsequent breeding surveys between April 19 and June 15.

5.5. Level 5: Determination of Productivity

5.5.1. Identifying the "Number of Young" Produced

To measure reproductive success, surveyors must count the number of young that leave the nest. These counts should occur between June 20 and July 15, preferably as close to June 20 as possible to avoid missing young that may have died post-fledging, and were undetected. Similarly, young may be counted after July 15; 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 should 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" will be assigned a count of zero young for the relevant breeding season.

5.6. Level 6: Determination of Number of Dispersing Owls

5.6.1. Identifying the Number of Potential Dispersers

To measure the number of potential dispersers, surveyors must count the number of young observed between September 1 and September 15, preferably as close to September 1, as some young may disperse early. At least two separate visits to the PFA are required to ensure that no young have been missed. Surveyors should use live-lure survey techniques to record the maximum number of young seen or heard for each visit.

6. Appendices

6.1. Appendix 1: List of Species Codes

The following species codes are taken from the RIC's Inventory Methods for Raptors Standards for Components of British Columbia's Biodiversity (B.C. Ministry of Sustainable Resource Management 2001). Below are the raptor species belonging to this inventory group listed by scientific name, English name, and species code. The last column is for the status of the species in British Columbia, and indicates whether the species is on the provincial Red or Blue List (Conservation Data Centre 2001). Note that if the status is given at the species level, it pertains to all of the related subspecies; if the status varies below the species level, then it will be given at the subspecies level.

ORDER **STRIGIFORMES:** Owls
FAMILY **TYTONIDAE:** Barn Owls
Tyto alba (Scopoli) Barn Owl B-BNOW B
ssp: *pratincola* (Bonaparte)
FAMILY **STRIGIDAE:** Typical Owls
Otus flammeolus (Kaup) Flammulated Owl B-FLOW B
ssp: *idahoensis* (Merriam)
Otus kennicottii (Elliot) Western Screech-Owl B-WSOW --
ssp: *kennicottii* (Elliot) B-WSOW-KE --
macfarlanei (Brewster) B-WSOW-MA R
Bubo virginianus (Gmelin) Great Horned Owl B-GHOW --
ssp: *lagophonus* (Oberholser) B-GHOW-LA
saturatus Ridgway B-GHOW-SA
subarcticus (Hoy) B-GHOW-SU
Nyctea scandiaca (Linnaeus) Snowy Owl B-SNOW --
Surnia ulula (Linnaeus) Northern Hawk Owl B-NHOW --
ssp: *caparoch* (Müller)
Glaucidium gnoma Wagler Northern Pygmy-Owl B-NPOW --
ssp: *californicum* (Sclater) B-NPOW-CA --
grinnelli Ridgway B-NPOW-GR --
swarthi Grinnell B-NPOW-SW B
Athene cunicularia (Molina) Burrowing Owl B-BUOW R
ssp: *hypugaea* (Bonaparte)
Strix occidentalis (Xántus de Vesey) Spotted Owl B-SPOW R
ssp: *caurina* (Merriam)
Strix varia Barton Barred Owl B-BDOW --
ssp: *varia* (Barton)
Strix nebulosa Forster Great Gray Owl B-GGOW --
ssp: *nebulosa* (Forster)
Asio otus (Linnaeus) Long-eared Owl B-LEOW --
ssp: *tuftsi* Godfrey
Asio flammeus (Pontoppidan) Short-eared Owl B-SEOW B
ssp: *flammeus* (Pontoppidan)
Aegolius funereus (Linnaeus) Boreal Owl B-BOOW --
ssp: *richardsoni* (Bonaparte)
Aegolius acadicus (Gmelin) Northern Saw-whet Owl B-NSWO --
ssp: *acadicus* (Gmelin) B-NSWO-AC --
brooksi (Fleming) B-NSWO-BR B

6.2. Appendix 2: Suitable Spotted Owl Habitat Definitions for BC

Appendix 2. Table 4. Suitable Spotted Owl habitat definitions for British Columbia

Habitat Type	Superior Habitat (nest, roost, forage and dispersal)	Moderate Habitat (roost, forage, and dispersal)
Wetter ecosystems – Maritime Coastal Western Hemlock and Mountain Hemlock Biogeoclimatic Zones Natural Disturbances: Rare to infrequent stand initiating events.		
Suitable habitat characteristics	• three or more canopy layers, multi-species canopy dominated by large (>75 cm dbh) overstory trees (typically 37-185 stems/ha). • moderate to high (60-80%) canopy closure. • five or more large (>50 cm dbh) trees/ha with various deformities (e.g., large cavities, broken tops, dwarf mistletoe infections). • five or more large (>75 cm dbh) snags/ha. • accumulations ($\geq$ 268 m^3/ha) of fallen trees and other coarse woody debris on the ground.	• two or more canopy layers, multi-species canopy dominated by large (>50 cm dbh) overstory trees (typically 247-457 stems/ha, although densities as low as 86 stems/ha are possible where large diameter trees are present). • moderate to high (60-80%) canopy closure. • five or more large trees/ha (>50 cm dbh) with various deformities (e.g., large cavities, broken tops, dwarf mistletoe infections). • five or more large (>50 cm dbh) snags/ha. • accumulations ($\geq$ 100 m^3/ha) of fallen trees and other coarse woody debris on the ground.
Dryer ecosystems – Sub-maritime Coastal Western Hemlock and Mountain Hemlock, and Interior Douglas-fir Biogeoclimatic Zones Natural Disturbances: Infrequent stand initiating events to frequent stand maintaining fires, however, fire suppression has increase frequency of stand initiating events.		
Suitable habitat characteristics	• three or more canopy layers, multi-species canopy dominated by large (>50 cm dbh) overstory trees (typically 173-247 stems/ha, although densities as low as 86 stems/ha are possible where large diameter trees are present). • moderate to high (60 - 85%) canopy closure. • five or more large trees/ha (>30 cm dbh) with various deformities (e.g., large cavities, broken tops, dwarf mistletoe infections). • seven or more large (>50 cm dbh) snags/ha. • accumulations ($\geq$ 268 m^3/ha) of fallen trees and other coarse woody debris on the ground.	• two or more canopy layers, multi-species canopy dominated by large (>30 cm dbh) overstory trees (typically greater than 247 stems/ha). • stands must contain 20% Fd and/or Hw in the overstory. • greater than 50% canopy closure. • five or more large trees/ha (>30 cm dbh) with various deformities (e.g., large cavities, broken tops, dwarf mistletoe infections). • five or more large (>30 cm dbh) snags/ha. • accumulations ($\geq$ 100 m^3/ha) of fallen trees and other coarse woody debris on the ground.

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