Inventory Methods for Nighthawk and Poorwill

Standards for Components of British Columbia's Biodiversity No. 9

Prepared by
Ministry of Environment, Lands and Parks
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Preface

This manual presents standard methods for inventory of Common Nighthawks and Common Poorwills in British Columbia at three levels of inventory intensity: presence/not detected (possible), relative abundance, and absolute abundance. The manual was compiled by the Elements Working Group of the Terrestrial Ecosystems Task Force, under the auspices of the Resources Inventory Committee (RIC). The objectives of the working group are to develop inventory methods that will lead to the collection of comparable, defensible, and useful inventory and monitoring data for the species component of biodiversity.

This manual is one of the Standards for Components of British Columbia's Biodiversity (CBCB) series which present standard protocols designed specifically for group of species with similar inventory requirements. The series includes an introductory manual (Species Inventory Fundamentals No. 1) which describes the history and objectives of RIC, and outlines the general process of conducting a wildlife inventory according to RIC standards, including selection of inventory intensity, sampling design, sampling techniques, and statistical analysis. The Species Inventory Fundamentals manual provides important background information and should be thoroughly reviewed before commencing with a RIC wildlife inventory. RIC standards are also available for vertebrate taxonomy (No. 2), animal capture and handling (No. 3), and radio-telemetry (No. 5). Field personnel should be thoroughly familiar with these standards before engaging in inventories which involve either of these activities.

Standard data forms are required for all RIC wildlife inventory. Survey-specific data forms accompany most manuals while general wildlife inventory forms are available in the Species Inventory Fundamentals No. 1 [Forms] (previously referred to as the Dataform Appendix). This is important to ensure compatibility with provincial data systems, as all information must eventually be included in the Species Inventory Datasystem (SPI). For more information about SPI and data forms, visit the Species Inventory Homepage at:
http://www.env.gov.bc.ca/wld/spi/ric_manuals/

It is recognized that development of standard methods is necessarily an ongoing process. The CBCB manuals are expected to evolve and improve very quickly over their initial years of use. Field testing is a vital component of this process and feedback is essential. Comments and suggestions can be forwarded to the Elements Working Group by contacting:

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The Resources Inventory Committee consists of representatives from various ministries and agencies of the Canadian and the British Columbia governments as well as from First Nations peoples. RIC objectives are to develop a common set of standards and procedures for the provincial resources inventories, as recommended by the Forest Resources Commission in its report “The Future of our Forests”.

For further information about the Resources Inventory Committee and its various Task Forces, please contact:

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Terrestrial Ecosystems Task Force

All decisions regarding protocols are the responsibility of the Resources Inventory Committee. Background information and protocols presented in this document are based on the unpublished draft manual, *Preliminary Inventory Manual for Sampling Goatsuckers (Caprimulgidae) in British Columbia,* prepared for the Resources Inventory Committee by Darren J. Bender and R. Mark Brigham with editorial assistance by Ann Eriksson.

The Standards for Components of British Columbia’s Biodiversity series is currently edited by James Quayle with data form development by Leah Westereng.

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1. INTRODUCTION

One of the least studied groups of birds in North America is the goatsuckers (Family: Caprimulgidae). The members of the family, which have a world-wide distribution (approximately 90 species), are better known outside of North and South America as nightjars, due to the "night jarring" sound they make (Jackson 1994). The name "goatsucker" is the literal translation of the family name.

The primary reason for the poorly known status of goatsuckers is their nocturnal and crepuscular habits. North American goatsuckers, and most others, are active by night or in the dusk and dawn period, limiting our ability to observe and study these birds in their natural setting. Although nighthawks sometimes forage or migrate during the day, goatsuckers are rarely observed during daylight hours. Relative to diurnal birds, much less is known about goatsucker basic biology and natural history. Further study of these birds is certainly warranted, but the techniques commonly used to study diurnal birds are inappropriate for nocturnal birds. Similar problems have been encountered for other nocturnal birds such as owls (Family: Strigidae), albeit to a lesser degree. Therefore, to study goatsuckers, one requires either a set of field techniques modified from those used for diurnal birds or techniques designed specifically for nocturnal species.

Two goatsucker species occur in British Columbia. These are the Common Nighthawk (*Chordeiles minor*) and the Common Poorwill (*Phalaenoptilus nuttallii)* (Campbell *et al.* 1990; Brigham 1994). Like other goatsuckers, both species rely on their cryptic plumage to remain undetected while roosting during the day. In the daytime, roosting goatsuckers are seldom detected by the casual or untrained observer. Thus, common bird census techniques are likely to produce poor estimates of presence and abundance information for these birds. To census this group of birds accurately, census and capture techniques for goatsuckers must be suited for use during the crepuscular and nocturnal periods of the day.

The purpose of this manual is to recommend methodologies that can be used to survey Common Nighthawks and Common Poorwills in British Columbia. This manual provides a standardized sampling protocol for obtaining presence and relative abundance estimates in the field in British Columbia.

2. INVENTORY GROUP

2.1 Common Nighthawk *Chordeiles minor*

Common Nighthawks (hereafter referred to as nighthawks) are most commonly seen feeding high in the air during the dusk and dawn hours. Like most other goatsuckers, nighthawks feed on flying insects, but unlike most other caprimulgids (*e.g.*, poorwills) insects are captured or "hawked" during continuous flight. Nighthawks are well-known for the non-vocal "booming" calls which are thought to be produced by air rushing through the primary feathers of males. These sounds are presumably used for courtship display and territorial advertisement. The typical vocalization given by both sexes during level flight is a nasal "peent", somewhat similar to some sounds made by European Starlings (*Sturnus vulgaris*).

Nighthawks breed during the summer months from the southern Yukon across most of southern Canada to the southern United States and parts of Mexico and Central America (Campbell *et al.* 1990). Wintering ranges extend as far south as Argentina (American Ornithologist's Union 1983). Nighthawks have been reported to occur throughout British Columbia during the summer months, although sightings are rare west of the coastal mountains north of Vancouver Island (Campbell *et al.* 1990).

In British Columbia, nighthawks usually arrive in late May or early June. Breeding occurs shortly after arrival, and a single clutch, almost always consisting of two eggs, is laid in early June. Nesting habitat is diverse, and includes logged or burned areas of the coastal forests, open ponderosa pine forest, the grassland habitat of the semi-arid interior, and sand and gravel habitats of marine and fluvial beaches. Less common habitats include many human-made habitats such as farmland and pasture lands, old gravel pits, and even gravel roof-tops in urban areas (Cannings *et al.* 1987, although see Brigham 1989; Campbell *et al.* 1990). Nighthawks are frequently observed to aggregate in large numbers prior to fall migration, which occurs in late August or early September. Typically, nighthawks are among the last migrants to arrive on the breeding grounds and the first to depart. More detailed information can be obtained in Campbell *et al.* (1990) and Cannings *et al.* (1987) and shortly, the Birds of North America Account for the species currently being prepared by S.D. Grindal.

2.2 Common Poorwill *Phalaenoptilus nuttallii*

Common Poorwills (hereafter referred to as poorwills) are most famous for their ability to enter deep torpor and potentially even hibernate. Torpor is a physiological state in which metabolism is substantially reduced and as a result, body temperature declines, often to only a few degrees above ambient temperature, presumably to reduce the energetic costs of thermoregulation (Brigham 1992; Csada and Brigham 1992, 1994b). Jaeger (1948, 1949) reported bouts of torpor that lasted for extended periods, and concluded that poorwills may be capable of hibernating, although this has yet to be substantiated (although see French 1993).

Poorwills get their common name from the interpretation of the sound of their calls, which are a distinctive "poor-will" or "poor-will-up." To the best of our knowledge, these calls are

given only by males, especially during the breeding season, presumably to attract a mate and/or advertise territorial ownership (Csada and Brigham 1992).

Unlike nighthawks, but similar to most other goatsuckers, poorwills forage for flying insects by making short sallies or 'leaps' from the ground (Brigham and Barclay 1992). Although they can be active at all times of the night, there is evidence that poorwills increase foraging activity during nights when moonlight is present (Brigham and Barclay 1992; Bender 1994). Evidence from diet studies seems to corroborate this (Csada *et al.* 1992; Bayne and Brigham 1995). There are no quantitative data on the influence of lunar condition on vocal activity by poorwills, something that may have direct implications for surveying.

Within Canada, poorwills normally occur only in the southern interior of British Columbia, and in the Cypress Hills region and adjacent areas of southwestern Saskatchewan and southeastern Alberta. These two areas represent the northernmost limits of the species breeding range. The southern breeding range extends into southern California, Guanajuato, and central Mexico. Within British Columbia, most breeding poorwills are found in the Okanagan valley. They have been recorded as far north as the Nicola and Thompson valleys, and as far east as the Kettle valley (Cannings *et al.* 1987; Campbell *et al.* 1990). However, this is a species that often turns up in places not previously recorded when active searching occurs (Brigham 1994). Poorwill nesting habitat appears very similar to that of nighthawks, and these two species are sometimes found in close proximity. The preferred poorwill nesting habitats are dry, open, grassy or shrubby areas on hillsides, but forested parkland margins and logged sites are also used (K. Wang, personal communication).

Poorwills arrive in British Columbia between late April and late May (Csada and Brigham 1994a). Two clutches of two eggs each are usually attempted each summer, with the first laid in late May or early June, and the second typically laid in mid- to late-July (Csada and Brigham 1994a). Like nighthawks, "nests" are on the ground, usually in a small depression or hollow, and consist only of a bare patch of ground with no nesting material present. Following the breeding season, most poorwills leave for their wintering grounds by mid-September (Csada and Brigham 1992, 1994a). Currently, little is known about poorwill migratory routes or behaviour. A complete review of the current knowledge about the basic biology of this species can be found in Csada and Brigham (1992).

3. PROTOCOLS

Current monitoring strategies for landbirds (*e.g.*, Ralph *et al.* 1993; Canadian Wildlife Service 1994) have focused primarily on monitoring diurnal bird populations. However, the methods employed in these monitoring programs are not adequate for monitoring crepuscular and nocturnal bird species. Thus, the only way to account for nocturnal species in these monitoring strategies is to incorporate new survey methods. Except for the techniques developed for surveying boreal owl populations, little has been done to standardize methods of monitoring nocturnal bird species. Recently, the Canadian Wildlife Service (CWS) identified some shortcomings of the present Canadian Landbird Monitoring Strategy, and has made recommendations to incorporate new methods suitable for censusing nocturnal birds (CWS 1994). However, it is important to point out that at present there are no standard survey methods or monitoring protocols for goatsuckers. Table 1 outlines recommended methods for sampling goatsuckers in British Columbia.

Table 1. Recommended methods for sampling goatsuckers in British Columbia at three levels of intensity.

Level of intensity	**Recommended method(s)**
Presence/Not detected	Point counts at night with audio playback
Relative abundance	Point counts at night with audio playback
Absolute abundance	No recommended methods

3.1 Sampling Standards

The following standards are recommended to ensure comparison of data between surveys, and to mitigate several sources of common bias.

3.1.1 Habitat Data Standards

A minimum amount of habitat data must be collected for each survey type. The type and amount of data collected will depend on the scale of the survey, the nature of the focal species, and the objectives of the inventory. As most, provincially-funded wildlife inventory projects deal with terrestrially-based wildlife, the terrestrial Ecosystem Field Form developed jointly by MOF and MELP (1995) will be used. However, under certain circumstances, this may be inappropriate and other RIC-approved standards for ecosystem description may be used. For a generic but useful description of approaches to habitat data collection in association with wildlife inventory, consult the introductory manual, *Species Inventory Fundamentals* (*No.1).*

3.1.2 Time of year

The best time of the year to census goatsuckers is early in the breeding season when birds are most vocal. For populations in British Columbia, nighthawks should be censused in mid- to late-June during the early nesting period. Poorwills should be censused in mid- to late-May just prior to egg-laying. After egg-laying, male poorwills often reduce or completely suspend all calling (Kalcounis *et al.* 1992; D. J. Bender, pers. obs.), and surveys based on listening for vocalizations are probably less accurate.

3.1.3 Time of day

- For **nighthawks**, censusing should begin at sunset, and continue until the end of the dusk crepuscular period. Nighthawks forage primarily in the crepuscular hours (dawn and dusk), which is the time between sunset/sunrise and nautical twilight (the point at which the sun is 12° below the horizon; the timing of various lunar/solar events on a daily basis are available for any location from the Dominion Astrophysical Observatory, 5071 West Saanich Road, Victoria, BC, V8X 4M6). On occasion, nighthawks are seen foraging diurnally, but there is some evidence that this occurs only at times when crepuscular foraging has been unsuccessful (*e.g.*, following poor weather conditions, Aldridge and Brigham 1991; Firman *et al.* 1993). If visual counts are to be employed, care should be taken not to sample for nighthawks after it has become too dark to accurately detect the birds in flight.
- Because **poorwills** tend to begin foraging between 15 and 35 minutes following sunset (Brigham and Barclay 1992; Bender 1994), censusing should begin at civil twilight (This is the point at which the sun is 6° below the horizon - approximately 1/2 hour past sunset.) and continue for no more than 1.5 hours (moonlight conditions may influence survey duration). Generally, there is not enough light to accurately make visual observations of poorwills, and so they are best surveyed by listening for their vocalizations between civil twilight and nautical twilight. The timing of surveys for poorwills with respect to the lunar cycle needs to be evaluated directly. It is known that foraging activity changes with the amount of lunar light, and it is a reasonable presumption that the amount of calling may also vary (Bender 1994).

3.1.4 Weather

Do not survey goatsuckers during the following weather conditions:

- When it is too windy to hear calling birds (usually occurs when wind speed exceeds about 8 km/hr);
- When ambient temperature is below 7° C. At low temperatures, insects are not abundant and goatsuckers tend to be inactive (and poorwills are potentially in torpor and incapable of activity); and
- When it is stormy or raining.

3.1.5 Survey Design Hierarchy

Nighthawk and Poorwill surveys follow a survey design hierarchy which is structured similarly to all RIC standards for species inventory. Figure 1 clarifies certain terminology used within this manual (also found in the glossary), and illustrates the appropriate conceptual framework for a point count survey. A survey set up following this design will lend itself well to standard methods and RIC data forms.

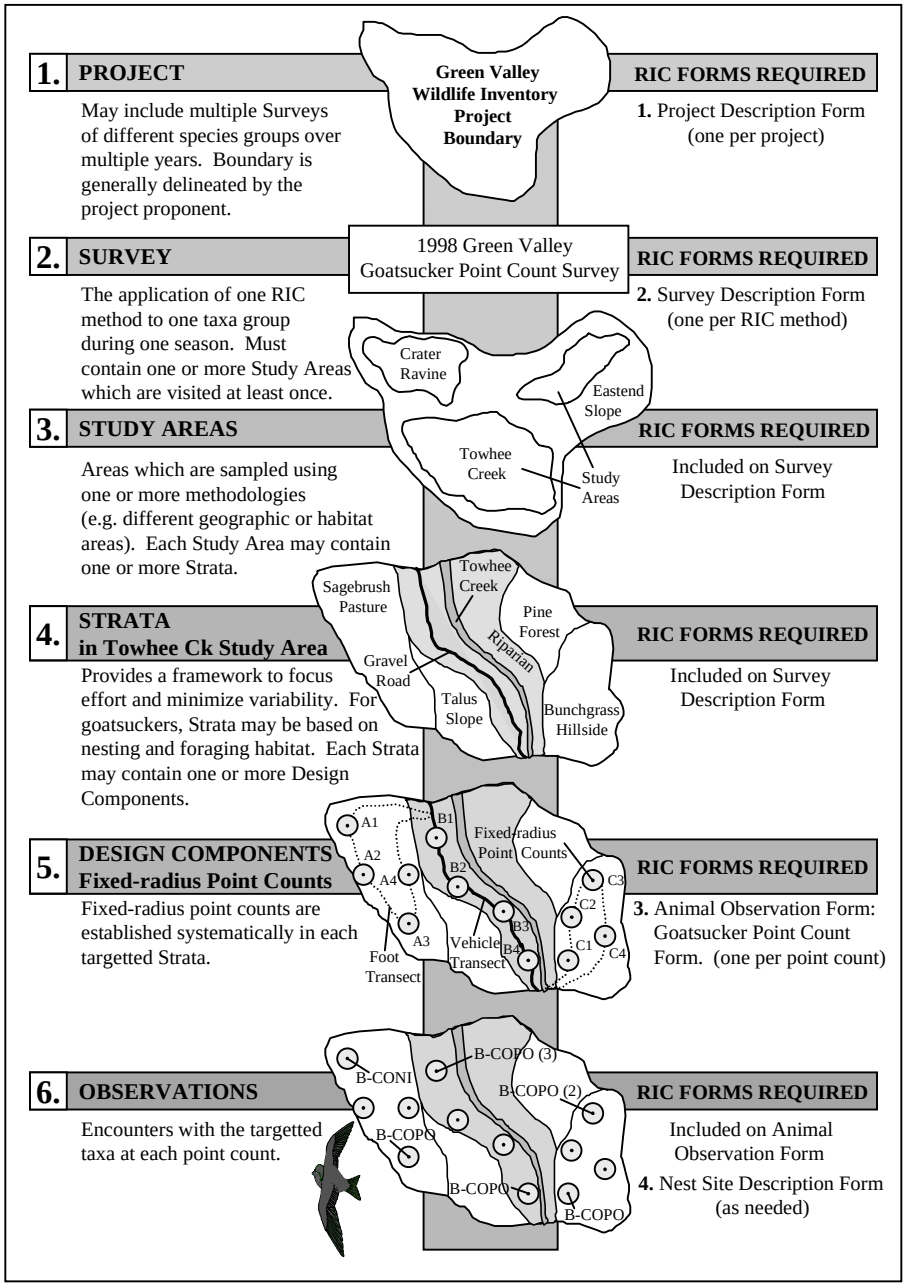

Figure 1. RIC species inventory survey design hierarchy with examples.

3.2 Inventory Surveys

The table below outlines the type of surveys that are used for inventorying Common Nighthawks and Common Poorwills for the various survey intensities. These survey methods have been recommended by wildlife biologists and approved by the Resources Inventory Committee.

Table 2. Types of inventory surveys, the data forms needed, and the level of intensity of the survey.

Survey Type	Forms Needed	*Intensity
Point Counts	• Wildlife Inventory Project Description Form • Wildlife Inventory Survey Description Form- General • Animal Observation Form- Goatsucker Point Counts • Ecosystem Field Form	• PN • RA

* PN = presence/not detected (possible); RA = relative abundance; AA = absolute abundance

3.3 Presence/Not detected and Relative Abundance

Recommended method(s): Point counts at night with audio playback.

3.3.1 Point Counts

The point count method is the most efficient and data-rich method of monitoring landbirds, and it is probably the most common census method (Ralph *et al.* 1993). The North American Breeding Bird Survey is a well known study that uses this method. Although no single standardized point count protocol exists, a detailed description of this method can be found in Hilden *et al.* (1991).

In its simplest form, the point count consists of a single observer visiting an established network of points or a series of points along a predetermined route (*e.g.*, road, trail, railway line). At each point, the observer spends a set period of time, and looks and listens for all birds in the area, noting what was detected. If counts are done within an arbitrary fixed radius, or if distance-to-bird estimates are used, then relative abundance can be estimated (*e.g.*, Buckland 1987; Bibby and Charlton 1991; Hilden *et al.* 1991). Points are usually revisited at subsequent dates to generate data on population trends over time.

Point counts are an attractive method because they are simple, efficient, data-rich, easily repeatable, and they require little equipment and few resources. The greatest limitation to point counts is the competence of the observer. A great deal of expertise is required to census large bird communities, and the observer must be highly skilled at both visual and vocal recognition. Another shortcoming occurs if birds approach or flee from the observer before he/she has reached the census point. This is especially common in open areas, such as prairies or meadows. In these locales, line transect methods may be preferable because they can account for fleeing birds. The assumptions of the point count method are as follows (Bibby *et al.* 1992):

1. Birds do not approach the observer or flee;
2. Birds are 100% detectable at the observer;
3. Birds do not move much during the count period;
4. Birds behave independently of one another;
5. Violations of the above assumptions do not interact with habitat or elements of study design;
6. Distance estimates are accurate; and
7. Birds are fully and correctly identified.

Point counts are the easiest and most productive method for censusing nocturnal birds, such as goatsuckers. This method is recommended above other methods because of its simplicity and efficiency. Point counts for goatsuckers differ from normal methods in a number of ways. The foremost difference is that the census period must be in the evening rather than the morning.

The drawback, as for all activities involving nocturnal birds, is that sampling must occur during twilight hours or at night, not a traditional time for most ornithologists to be active. To our knowledge, in North America there is only one published account of a method

specifically for a poorwill census (Kalcounis *et al.* 1992) and nothing exists for nighthawks. Kalcounis *et al.* (1992) used point counts along existing roads, trails, and footpaths to census poorwill distribution and abundance in the Cypress Hills region of Saskatchewan. A similar protocol could be applied to nighthawks.

Point counts also appear to be the most common method for other Caprimulgid species. Kepler and Kepler (1973) used roadside point counts in conjunction with call playbacks to assess distribution of the Puerto Rican Nightjar (*Caprimulgus noctitherus*) in Puerto Rico. Two similar studies have been conducted by Vilella and Zwank (1987, 1993). Cooper (1981) used roadside point counts to assess the distribution and relative abundance of two Caprimulgid species (Whip-poorwills *(Caprimulgus vociferus*) and Chuck-will's-widows (*C. carolinensis*) in Georgia, U.S.A. In addition, point counts and small scale area searches have been used in Great Britain to determine the distribution and relative abundance of European Nightjars (1989). In all cases, point counts have relied on listening for calls. Although a drastic change to this protocol is not recommended, the usefulness of "night-lighting" for eyeshine to enhance the method needs to be evaluated.

Call Playbacks

During the breeding season, male poorwills and nighthawks are territorial, and will respond aggressively to another male that is calling within its territory. Normally, the playback of recorded calls using a portable tape player will elicit a response from these birds, and thus, will increase the chance of finding birds.

This is a useful technique to determine the total number of males within a relatively small area. Assuming that the sex ratio is 1:1, and that mates have already been found, the total number of adult birds in the area can be approximated by multiplying the total number of males by two (*e.g.*, Kalcounis *et al.* 1992). It should be noted that this type of censusing should be conducted only during the early breeding season when calling activity is at its greatest. At other times in the summer, birds may be less likely to elicit a response to playbacks which may lead to inaccurate and highly variable population estimates (see McNichol 1981). This is especially true for male poorwills, who apparently suspend calling, late in the breeding season (R.D. Csada, pers. comm.; D. J. Bender, pers. obs.).

Office Procedures

- Review the introductory manual, *Species Inventory Fundamentals (No. 1)*.
- Obtain relevant maps for study area (*e.g.*, 1:50 000 air photo maps, 1:20 000 forest cover maps, 1:20 000 TRIM maps, 1:50 000 NTS topographic maps). 1:50 000 scale maps from the Canadian topographic map series provide the locations of roads, streams, human-made structures, lakes, the presence of vegetative cover, *etc*., and they can be used to interpret the layout and topography of the landscape. Aerial photographs or fine-grained remote sensing images can be used to obtain more precise details such as the location of trails and footpaths, or the composition of the vegetation cover.
- Based on map interpretation, identify routes (transects) for census.
- Determine Biogeoclimatic zones and subzones, Ecoregion, Ecosection, and Broad Ecosystem Units for census areas from maps.

Sampling Design

- This type of survey can be conducted either by foot, or if roadways exists, by vehicle. The latter is more efficient because less time is spent on travel between points, and more time can be spent observing and collecting data. Under optimal conditions, 25 to 30 five-minute point counts can be conducted in three hours using a vehicle. Surveys by foot may be preferable in areas of rough terrain where vehicle travel is not possible and because vehicle surveys tend to be biased against species that avoid roads. However, surveys by foot are more time consuming, and depending on the terrain, generally only one quarter to one half as many points are possible.
- The size of the survey area will depend on the level of monitoring desired, as well as the people-power available to survey the area. Once the area of the survey has been established, individual transects for the census can be set. The best routes are those that are easily recognizable, especially in the dark, such as roads, trails, or foot-paths.
- If transects are to be revisited, each point on the transect must be identifiable, again especially by night. When possible, permanent markers should be established to indicate the points. If this is not possible, as would be the case within a provincial or national park, then points may have to be selected at landmarks along the transect that are distinct enough to be recognized at night (*e.g.*, road intersection, signpost, bridge, *etc*.).
- When choosing a census route:
  - Follow existing roads, trails, footpaths, *etc*.
  - Use tertiary roads first, then secondary roads, and avoid well travelled, wide roads. Surveys conducted along less travelled roads frequently yield data that are most representative of the natural habitat because some birds may avoid (or prefer) high traffic roads.
  - If transects are surveyed by vehicle, points should be sampled about every 500 m. Assuming that an observer can cover approximately 15 five-minute stops in an evening, transects should be about 7 to 8 km in length.
  - Transects travelled by foot should have sample points spaced at least 400 m apart. Assuming that an observer can cover approximately seven five-minute stops in an evening plus travel time, realistic transects will be only 3 to 4 km in length.
- For relative abundance estimates a fixed radius or distance-to-bird method should be used. Distance to birds may be difficult to obtain in the dark, particular for flying nighthawks.

Sampling Effort

- Time requirements for censusing are determined by the extent of the census.
- Assume that only one transect can be conducted per night. Therefore, a minimum of 2 person•hours/night are required for each transect in the census.
- The time over which censusing can be conducted is limited by the length of the crepuscular period. Generally speaking, in May and June, the entire crepuscular period is only about 1.5 hours.
- Repeat census several times during early breeding season.

Personnel

- Minimum personnel required is just one person, although two are preferable for off-road work conducted at night.

- Personnel must be familiar with call identification for nighthawks and poorwills. This skill may be learned by listening to recorded calls. Once heard, nighthawk and poorwill calls are unmistakable and easily recognized.
- Off-road surveys must be conducted at night by personnel familiar with night navigation.
- Personnel must be very familiar with the use of a map and compass.
- When possible, sites should be visited during daylight hours so personnel can familiarize themselves with the route.
- Even with precautions, personnel will get lost on occasion; thus, the need for at least two individuals for surveying remote locations. It is also helpful to have two-way radios to enhance safety.

Equipment

- A hands-free light source, such as a headlamp
- Map and compass
- A battery-powered portable tape player
- An endless loop cassette with the appropriate call recorded on it
- A hand-held microcassette recorder (for taking notes during the census period - written notes are difficult to make in the dark)
- Notebook and pencil (for taking notes when a light source can be used)
- A countdown timer with an audible alarm
- Small flashlight or Cyalume light stick
- Extra batteries for headlamp and recorders

Field Procedures

- Upon arrival at each point on the survey, the observer should extinguish all light sources for a period of one minute before beginning the count.
- During this time, the observers should use a compass to orient themselves. If the compass lacks a luminescent dial, a small flashlight or Cyalume light stick may be used to provide just enough light to make the compass face visible.
- At this time, start the countdown timer and begin call playbacks.
- Call playbacks should be given in series of five or six calls, followed by approximately 30 seconds of silence during which the observer listens for a response.
- Once a response is heard, estimate and record a rough distance to the bird, and note its direction.
- This is more difficult for nighthawks who may be flying high in the air. In this case, try to note the distance and direction to the point on the ground directly below the bird.
- Male nighthawks will respond to call playbacks by diving and "booming" and, in this fashion, they can be distinguished from females.
- If a bird is seen, be careful to keep it in sight so that if it moves to a new location, it will not be counted twice. This sounds obvious, but at night this is not an easy task.
- Stop the observation period when the timer indicates that five minutes has passed.
- Information recorded on microcassette recorders should always be transcribed to data sheets immediately following each night of censusing before unrecorded information is forgotten.

Data Analysis

- **Presence/Not Detected**: Positive detection of a species in a sampling area provides evidence of presence. If a bird is not detected during an inventory, this does not necessarily mean that the species is not present within the sampled area. The probability of accurately determining which species are present and absent from a sample area is directly related to sampling effort. It is recommended that information about presence/not detected inventory be presented along with information about how much sampling effort was used during the investigation.
- **Relative Abundance:** Estimates are obtained by using the minimum number of detected males as follows:
    - Tallying the total number of detected birds within the census area to obtain the minimum number of males.
    - Multiplying the number of males by two to obtain the minimum population size for the area censused (assuming that all males and females have mates).

3.4 Absolute Abundance

Recommended method(s): No standard methods recommended at this time.

Unlike many diurnal birds, it is virtually impossible to visually detect roosting goatsuckers, especially at night. Nighthawks especially, are easily spotted when they are feeding, as they often forage high in the air over a large area (up to 12 km from nest site; Brigham 1988). Most often, nighthawks can be detected only by listening for their calls. Thus, it is very difficult to make distance estimates to observed birds. Because distance measures are difficult to make, estimates of absolute abundance are not possible using point counts.

Although mark-recapture studies may be able to yield estimates of abundance, mist-netting is ordinarily not suitable for determining abundance estimates for goatsuckers. Nighthawks and poorwills are territorial during the breeding season, and therefore, are widely dispersed in space. Generally, mist-netting efforts yield very low numbers of captured birds. An exception to this would be in situations where nighthawks (and rarely poorwills) flock together or aggregate at a common foraging site. One example occurs at Okanagan Falls Park near Okanagan Falls, British Columbia, where a large number of nighthawks aggregate to forage for emerging insects over the Okanagan River (see Brigham 1990; Firman *et al.* 1993). In such a situation it may be possible to conduct a mark-recapture study to estimate the size of the local population. However, the habitat and area over which the population resided would not be known unless radio-telemetry data about the range of individuals were available.

Nest searches are a valuable method that provide direct measurement of nest success for a given habitat. However, frequent nest visitation is necessary if nests are to be monitored to assess success or productivity. Nest searches have the advantage of yielding habitat specific information, something mist-netting can not do. However, nest-searching requires considerable time and people-power, and the area covered by this method is usually small.

Glossary

ABSOLUTE ABUNDANCE: The total number of organisms in an area. Usually reported as absolute density: the number of organisms per unit area or volume.

BIODIVERSITY: Jargon for biological diversity: the variety of life forms, the ecological roles they perform, and the genetic diversity they contain (Wilcox 1984 cited in Murphy 1988).

BLUE LIST: Includes any indigenous species or subspecies (taxa) considered to be Vulnerable in British Columbia. Vulnerable taxa are of special concern because of characteristics that make them particularly sensitive to human activities or natural events. Blue-listed taxa are at risk, but are not extirpated, endangered or threatened.

CIVIL TWILIGHT: The period of twilight that occurs: (1) between sunset and the time at which the sun is 6° below the horizon, and (2) between the time at which the sun is 6° below the horizon and sunrise.

CREPUSCULAR: Active at twilight

CRYPTIC: Difficult to distinguish from its surroundings.

DIURNAL: Active during the daytime

FORAGING SALLY: To leap upwards in a short burst of flight to catch a prey item flying overhead.

HIBERNATION: A lethargic condition in which endothermic animals slow metabolism and lower body temperature in order to avoid the energetic costs associated with maintaining an elevated body temperature. Hibernation is normally long-term over weeks or months.

MARK-RECAPTURE METHODS: Methods used for estimating abundance that involve capturing, marking, releasing, and then recapturing again one or more times.

NAUTICAL TWILIGHT: The period of twilight that occurs: (1) between sunset and the time at which the sun is 12° below the horizon and (2) between the time at which the sun is 12° below the horizon and sunrise.

NOCTURNAL: Active at night

PRESENCE/NOT DETECTED (POSSIBLE): A survey intensity that verifies that a species is present in an area or states that it was not detected (thus not likely to be in the area, but still a possibility).

PROJECT AREA: An area, usually politically or economically determined, for which an inventory project is initiated. A project boundary may be shared by multiple types of resource and/or species inventory. Sampling generally takes place within smaller study areas within this project area.

RANDOM SAMPLE: A sample that has been selected by a random process, generally by reference to a table of random numbers.

relative abundance: The number of organisms at one location or time relative to the number of organisms at another location or time. Generally reported as an index of abundance.

RED LIST: Includes any indigenous species or subspecies (taxa) considered to be Extirpated, Endangered, or Threatened in British Columbia. Extirpated taxa no longer exist in the wild in British Columbia, but do occur elsewhere. Endangered taxa are facing imminent extirpation or extinction. Threatened taxa are likely to become endangered if limiting factors are not reversed. Red-listed taxa include those that have been, or are being, evaluated for these designations.

STRATIFICATION: The separation of a sample population into non-overlapping groups based on a habitat or population characteristic that can be divided into multiple levels. Groups are homogeneous within, but distinct from, other strata.

STUDY AREA: A discrete area within a project boundary in which sampling actually takes place. Study areas should be delineated to logically group samples together, generally based on habitat or population stratification and/or logistical concerns.

SURVEY: The application of one RIC method to one taxanomic group for one season.

SYSTEMATIC SAMPLE: a sample obtained by randomly selecting a point to start, and then repeating sampling at a set distance or time thereafter.

THERMOREGULATION: The process of maintaining a consistent body temperature, elevated above ambient temperatures.

TORPOR: A lethargic condition in which endothermic animals slow metabolism and lower body temperature in order to avoid the energetic costs associated with maintaining an elevated body temperature. Torpor is normally short-term over a few hours or at most a few days.

YELLOW-LISTED SPECIES: Any native species which is not red- or blue-listed.

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