Inventory Methods for Raptors

Standards for Components of British Columbia's Biodiversity No. 11

Prepared by
Ministry of Sustainable Resource Management
Environment Inventory Branch
for the Terrestrial Ecosystems Task Force
Resources Inventory Committee

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Preface

This manual, version 2.0, is a revised and improved presentation of standard methods for inventory of raptors in British Columbia at three levels of inventory intensity: presence/not detected (possible), relative abundance, and absolute abundance. The manual was compiled by 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 that present standard protocols designed specifically for groups 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 species 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), voucher collection (No. 4), and radio-telemetry (No. 5). Field personnel should be thoroughly familiar with these standards before engaging in field inventories which may involve any of these activities.

Standard dataforms are required for all RIC species inventory. Survey-specific dataforms accompany most manuals while general wildlife inventory forms are available in *Species Inventory Fundamentals No. 1 [Forms].* This is important to ensure compatibility with provincial data systems, as all information must eventually be included in the Species Inventory (SPI) Datasystem (visit the website at http://srmwww.gov.bc.ca/rib/wis/spi/).

It is recognized that development of standard methods is necessarily an ongoing process. The CBCB manuals are expected to evolve and improve 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 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 access the Resources Inventory Committee Website at: http://www.for.gov.bc.ca/ric.

Terrestrial Ecosystems Task Force

All decisions regarding protocols are the responsibility of the Resources Inventory Committee.

The current version of this manual was the result of the hard work of Frank Doyle (Wildlife Dynamics Consulting). Section 5, species accounts and survey notes, was largely based on materials adapted from the RIC Raptors Inventory course compiled by Michael Setterington (AXYS Environmental Consulting Ltd.) and Frank Doyle. Statistical review comments were provided by John Boulanger (Integrated Ecological Research). Helpful comments were provided by Erica McCLaren, Laura Darling, Andy Stewart and Ross Vennesland

The Components of British Columbia's Biodiversity series is currently edited by Leah Westereng.

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1. INTRODUCTION

In western cultures, raptors, or birds of prey, are celebrated as one of the most spectacular forms of wildlife. The Bald Eagle is the national symbol of the USA, falcons have been the prized possession of kings and noblemen, and owls are portrayed as wise in myth and folklore. Today, for many people, raptors symbolize the majesty and wildness of nature.

In ecology, raptors are considered ecological indicators for environmental pollution and habitat degradation and destruction. Raptors are generally long-lived birds that feed high in the food chain; this makes them more susceptible to poisoning from pollution and pesticides than short-lived or plant-eating species. Some pesticides accumulate in organisms over time and become concentrated as they move up the food chain. The most well documented case of this sequence of events was in the Peregrine Falcon, which was extirpated east of the Mississippi due to the wide scale use of DDT after World War II (Johnsgard 1990). The concentration of DDT, or more correctly the stable metabolite DDE, led to egg shell thinning causing complete reproductive failure in this population.

Although organochlorine pesticide use has been brought under control in North America since the ban of DDT in the mid 1970's, the less resolvable and more serious problem of habitat degradation remains. The gradual yet consistent destruction of wild lands and subsequent conversion into agricultural, recreational and urban lands, contracts and fragments the geographic range of many raptors (Wilcox 1987). The best known case is the California Condor, which lost habitat at an exceedingly fast rate between the 1850's and 1950's. Through much captive breeding effort, there now exists about 50 birds in the wild and about 130 birds in captivity. Recently, in the Pacific Northwest and in southern British Columbia, declines in the number of Spotted Owls have been attributed to tree harvesting in old growth systems (Dunbar *et al.* 1991). The fact that raptors are negatively affected by human activities is evident by the disproportionate number of raptors on the red and blue lists in British Columbia (Conservation Data Center 2001). Raptors, however, can also be positively influenced by human activities (i.e. Barn Owl, Red-tailed Hawk). Certain management actions such as providing nest boxes and nest perches have increased or led to the return of species to an area. In addition, agricultural fields often provide good hunting habitat for raptors.

The inventory and monitoring of raptors is extremely important. To have a reference point for comparing present status with that of the past is a prerequisite for informed land use decisions and better management. The purpose of this manual is to provide standard protocols for raptor censuses at different levels of intensity (presence/not detected, relative abundance and absolute abundance), at various times of the year.

2. INVENTORY GROUP

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 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.

For species information including species-specific protocol, see Section 5, Species Accounts and Survey Notes. For the most current taxonomic listings please check for the most recent version of the *Vertebrates of British Columbia: Scientific and English Names* (Resources Inventory Committee 2002).

ORDER **CICONIIFORMES:** Storks, Herons, Ibises and New World Vultures

FAMILY **CATHARTIDAE:** New World Vultures

Cathartes aura (Linnaeus)	Turkey Vulture	B-TUVU	--
ssp: *teter* Friedmann			--

ORDER **FALCONIFORMES:** Diurnal Birds of Prey

FAMILY **ACCIPITRIDAE:** Kites, Eagles, Hawks and Allies

Pandion haliaetus (Linnaeus)	Osprey	B-OSPR	--
ssp: *carolinensis* (Gmelin)			--
Haliaeetus leucocephalus (Linnaeus)	Bald Eagle	B-BAEA	--
ssp: *alascanus* Townsend		B-BAEA-AL	--
leucocephalus (Linnaeus)		B-BAEA-LE	--
Circus cyaneus (Linnaeus)	Northern Harrier	B-NOHA	--
ssp: *hudsonius* (Linnaeus)			--
Accipiter striatus Vieillot	Sharp-shinned Hawk	B-SSHA	--
ssp: *perobscurus* Snyder		B-SSHA- PE	--
velox (Wilson)		B-SSHA- VE	--
Accipiter cooperii (Bonaparte)	Cooper's Hawk	B-COHA	--
Accipiter gentilis (Linnaeus)	Northern Goshawk	B-NOGO	--
ssp: *atricapillus* (Wilson)		B-NOGO-AT	--
laingi (Taverner)		B-NOGO-LA	R
Buteo platypterus (Vieillot)	Broad-winged Hawk	B-BWHA	R
ssp: *platypterus* (Vieillot)			--
Buteo swainsoni Bonaparte	Swainson's Hawk	B-SWHA	R
Buteo jamaicensis (Gmelin)	Red-tailed Hawk	B-RTHA	--
ssp: *alascensis* (Grinnell)		B-RTHA-AL	--
calurus (Cassin)		B-RTHA-CA	--
harlani (Audubon)		B-RTHA-HA	--

Buteo regalis (Gray)	Ferruginous Hawk	B-FEHA	R
Buteo lagopus (Pontoppidan)	Rough-legged Hawk	B-RLHA	--
ssp: *sanctijohannis* (Gmelin)			--
Aquila chrysaetos (Linnaeus)	Golden Eagle	B-GOEA	--
ssp: *canadensis* (Linnaeus)			--

FAMILY **FALCONIDAE:** Caracaras and Falcons

Falco sparverius Linnaeus	American Kestrel	B-AMKE	--
ssp: *sparverius* (Linnaeus)			--
Falco columbarius Linnaeus	Merlin	B-MERL	--
ssp: *columbarius* Linnaeus		B-MERL-CO	--
richardsonii (Ridgway)		B-MERL-RI	--
suckleyi (Ridgway)		B-MERL-SU	--
Falco peregrinus Tunstall	Peregrine Falcon	B-PEFA	--
ssp: *anatum* (Bonaparte)		B-PEFA-AN	R
pealei (Ridgway)		B-PEFA-PE	B
tundrius White		B-PEFA-TU	--
Falco rusticolus Linnaeus	Gyrfalcon	B-GYRF	B
ssp: *obsoletus* (Gmelin)		B-GYRF-OB	--
uralensis (Severtzov and Menzbier)		B-GYRF-UR	--
Falco mexicanus Schlegel	Prairie Falcon	B-PRFA	R

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

3. GENERAL PROTOCOL

Detecting breeding and non-breeding raptors is difficult due to their low densities and generally secretive nature (Fuller and Mosher 1987). Survey methods for raptor inventories vary with the behaviour of the bird, its nest location and time of year. This manual distinguishes between conspicuous and inconspicuous raptors, based on life history and behaviour, as each requires different inventory techniques. For all raptors, standard definitions to describe occupancy and activities at nesting areas can be found in Postupalsky (1974, 1983), Newton and Marquiss (1982), and Steenhof (1987). Inconspicuous raptor surveys are labour intensive, requiring surveyors to actively search, using aural detection, broadcast calls and sign of conspecifics to locate raptor species and/or their nests. Inconspicuous breeding raptors utilize concealed nest sites, nocturnal lifestyles, and/or secretive hunting strategies. This group includes most species of owl, accipiters, and Merlin (Table 1).

Conspicuous breeding raptors are defined as raptors characterized by large nests in open habitat, soaring flight, and/or perches out in the open. This group includes the Turkey Vulture, Osprey, eagles, most hawks, some falcons, and Burrowing Owl (Table 2). In general, the techniques for detecting conspicuous raptors involve a "look and see" approach, with the only difference between survey methods being the mode of transportation (i.e., aircraft, boat, land vehicle or foot; Bibby *et al*. 1992).

Depending on the level of intensity, the survey design will be more or less rigid. For presence/not detected objectives, a fairly *ad hoc* survey design will probably suffice; however, for the minimal additional effort of utilizing a more systematic survey design, investigators can realize considerable benefits, particular with regard to sample size calculations and statistical power. As well, adhering to a sample design will allow most surveys to produce relative abundance estimates, which can be used for comparing populations between sites and/or trend monitoring.

Absolute abundance, however, is more difficult to determine for raptors due to their low breeding densities and secretive nature. There are exceptions to this general rule for estimating the abundance of breeding populations of eagles, ospreys and some falcons. For these birds, it is possible to locate conspicuous nest sites from the air while employing a stratified random quadrat sampling design. No methods are recommended for deriving an absolute abundance estimate for inconspicuous raptors.

It should always be kept in mind that raptors may be very sensitive to human activity. As a general rule nests should not be disturbed, especially during the egg laying and incubation stages or the nesting attempt may be abandoned (Fyfe and Olendorff 1976). Observers should therefore leave the area if the birds are obviously being disturbed. When disturbed during this sensitive nesting period, they will sometimes abandon nests disturbed at the egg stage, or move to a new location in succeeding years. Other consequences of disturbance include eggs and young being fatally exposed to overheating or hypothermia or to predators when the females are forced to leave the nest to defend the nest.

Information pertaining to Table 1 and 2 below.

Survey Timing: “B” indicates breeding surveys;
“NB” indicates surveys outside the breeding season.

Survey Intensity: Call Playback, Roadside and Boat surveys can be used to determine Presence/not detected or Relative Abundance. Foot surveys will likely only be able to provide Presence/not detected due to low sample sizes. Aerial surveys can also be used to estimate absolute abundance. Migration surveys are only used for Presence/not detected and are less preferred than other methods.

Note that standwatches and ground nest searches are not inventory methods on their own and so are not listed in Table 1 or 2.

Table 1. Recommended inventory methods during the breeding and non-breeding seasons for inconspicuous raptor species of British Columbia.

Species	Call Playback	Roadside Survey	Foot Survey	Migration Survey
Sharp-shinned Hawk	B			NB
Cooper's Hawk[1]	B			NB
Northern Goshawk	B			NB
Merlin	B			NB
Barn Owl	B	B	B	NB
Flammulated Owl	B			
Western Screech-Owl	B			
Great Horned Owl	B			
Snowy Owl		NB		
Northern Pygmy-Owl	B			
Spotted Owl	B			
Barred Owl	B			
Great Gray Owl	B			
Long-eared Owl	B			
Short-eared Owl		B	B	NB
Boreal Owl	B			
Northern Saw-whet Owl	B			

[1] Dawn vocalization surveys during the breeding surveys can also be used. See Section 5, Species Accounts and Survey Notes.

Table 2. Recommended inventory methods during the breeding and non-breeding seasons for conspicuous raptor species of British Columbia.

Species	Roadside Survey	Boat Survey	Aerial Nest Survey	Migration Survey
Turkey Vulture	B			NB
Osprey		B, NB	B, NB	NB
Bald Eagle		B, NB	B, NB	NB
Golden Eagle		B, NB	B, NB	NB
Northern Harrier	B, NB			NB
Broad-winged Hawk				NB
Swainson's Hawk	B			NB
Red-tailed Hawk	B			NB
Ferruginous Hawk	B			
Rough-legged Hawk	B, NB			NB
American Kestrel	B, NB			NB
Peregrine Falcon		B	B	NB
Gyrfalcon		B	B	
Prairie Falcon	B	B	B	NB
Northern Hawk Owl	B			
Burrowing Owl [1]	B			

[1] Call Playback has also been used at known breeding sites.

3.1 Survey Standards

The following are guidelines for conducting standardized raptor inventories in British Columbia. Close adherence to these guidelines will permit the collection of reliable data that should satisfy individual and corporate inventory needs, as well as contribute to biodiversity monitoring at local, regional, and provincial scales.

3.1.1 Personnel

Probably the most essential component for the collection of accurate data is a competent observer. This can not be over emphasized. Many papers have been written on the variability and error between observers. Fuller and Mosher (1987) state that observers should be familiar with both bird behaviour and their habitat and have excellent raptor identification skills. To maintain a high skill level, the project leader should assess all potential workers, and provide guidance where needed. Field training sessions should be held prior to data collection to increase observer expertise and to evaluate and correct differences between observers (e.g., Kepler and Scott 1981).

As well as visual identification, personnel should be familiar with the calls of those raptors expected to be within the study area as well as any similar sounds that they could be confused with. This is particularly important for detecting inconspicuous raptors in forested habitats. Thus, good hearing is essential and differences in hearing ability between observers may strongly affect results of surveys (Scott and Ramsay 1981).

It is valuable to know that a Raptor Inventory training course with a raptor identification component has been developed. For more information or to register, contact the Forest Continuing Studies Network: http://www.fcsn.bc.ca.htm.

It is also important that crew members have First Aid training (with a Transportation Endorsement as needed) as it is up to the project leader to ensure his/her work team has the necessary training to carry out a reliable and safe raptor inventory.

3.1.2 Weather

Poor weather such as high winds, rain, and fog can influence both the bird's behaviour and the observer's ability to visually and aurally identify raptors. High winds and rain are potentially a greater problem in forests due to the increased noise in the canopy than in open grasslands. Some general guidelines for appropriate and inappropriate weather conditions for surveying are provided in the Table 3.

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^{o}C). There is also evidence that owls may be less vocal in very cold weather (Takats *et al.* 2001).	

3.1.3 Time of Year

Raptors are widely distributed in British Columbia with at least one species present in each geographic area (Munro 1979). Their distribution and density is mostly dependent on food supply and during the breeding season, nest site availability. Raptor behaviour and location varies with season. Therefore, it is important to consider the time of year when determining which inventory method should be used for each raptor species (see Tables 1 and 2).

Surveys during the breeding season

Many raptor surveys are conducted during the breeding season, when species are territorial and active nests may be located. For example, owls and accipiters are most easily found during the breeding season when they respond to call playback surveys (Fuller and Mosher 1987). However, care should be taken not to disturb raptors during courtship, egg laying or incubation (see Section 5, Species Accounts and Survey Notes, for timing guidelines).

Migration surveys

Raptors move in relation to the available food supply. Newton (1979) classified these movements into five categories: dispersal, local movement, migration, irruptions and nomadism. Raptor surveyors are most concerned with migrations. Newton (p.180, 1979) defines migration as "a massive shift of birds twice each year between regular breeding and wintering ranges". It is different from the other movements in that the distance traveled is much further and the flight path is generally restricted to one direction.

Migration tends to concentrate birds along flyways, and in winter, some areas increase in raptor density (e.g., Fraser Lowlands). Although the overall migration direction is the same each year, the actual paths that individual birds use can change. This should be remembered when explaining yearly variation at individual hawk watch stations (see Section 3.8).

Surveys during the non-breeding season

Raptors are typically less common and non-territorial during the winter season. Although numbers are lower, survey results still have high management value since the birds surveyed are resident, and winter is often a limiting time due to factors such as extreme cold and food availability (Manuwal and Huff 1987, Huff *et al.* 1991, Ralph *et al.* 1993). Roadside surveys outlined in this manual are often used as an inventory technique during the winter when certain raptor species (e.g., Rough-legged Hawks) concentrate in agricultural fields.

3.1.4 Time of Day

Raptors can be crepuscular, nocturnal or diurnal and depending on the season and the species may be all three at the same time. Surveys should be planned for the active cycle of the species being studied, an example of this is nocturnal owl surveys being conducted between 0.5 hours after sundown and 0.5 hours before sunrise.

3.1.5 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, standard attributes from the terrestrial Ecosystem Field Form developed jointly by MOF and MELP (1995) will be used. The manual, *Species Inventory Fundamentals* (No.1), contains a generic discussion of habitat data collection as well as a list of the specific requirements for raptor surveys (Appendix E, RIC 1998).

3.1.6 Conducting surveys on foot vs other transportation

Surveys on foot enable you to search areas that can not be approached by vehicles. They also allow a better analysis of habitat, and a good opportunity to scan areas for bird sign. In many ways, they allow surveyors to escape background noise (from vehicles) and improve their awareness of surroundings.

The disadvantages of surveys on foot relative to surveys using other transportation are that less territory can be covered; therefore, these surveys can be more labour intensive. Surveyors may also miss action that is taking place above the forest canopy when they are concentrating their efforts on finding birds or nests within the forest.

Keep in mind the following factors:

- Stop and listen often or when in promising raptor habitat;
- Be aware of the noise you may be making and its effect on both your hearing and what the birds may be able to hear (e.g., Gortex™ and nylon clothing may be fairly noisy);
- Keep an eye on the ground for moulted feathers, kill or plucking sites, whitewash, etc. (see Section 3.1.7, Sign: Prey Remains, Pellets, Whitewash, and Feathers);
- Learn which species will react to your presence and at what time during their breeding cycle they will respond; and
- Be ready for flushing birds, and notice their reaction as well as location.

3.1.7 Sign: Prey Remains, Pellets, Whitewash, and Feathers

Identification of a raptor's use of a habitat can include more than an actual sighting of the bird itself. The sign left by the raptors after killing and consuming prey, and evacuating waste materials can also indicate habitat use. Prey remains, pellets and whitewash, combined with an evaluation of the habitat where the material was found, can be used as an indication of the presence of many species of raptors.

Prey remains

Of all the aids in identification of the raptor species, the use of prey remains is one of the most difficult to become familiar with and can be very misleading. Some generalizations can be made but in many cases the site and sign differ from kill to kill by the same species. In part, this is due to the actions of scavenging species, which are comprised of most of the mammals (including common herbivores and rodents), insects, and many bird species.

The sign left at the kill site will be a product of the raptor responsible, size of prey, the scavengers present, and the order in which they arrived at the kill site. Most scavengers will remove and cache any items they can carry. Therefore, if parts of a suspected kill are found in a tree, it does not necessarily mean it was killed by a bird, because it is just as likely that the remains were cached in the tree by a scavenging squirrel or bird.

Become familiar with the different ways the raptor species kill and pluck prey, this will help in the identification of the raptor species. As with whitewash and pellets, the information gained may not be conclusive in itself, but combined with other information will help narrow down the species responsible for the kill.

As a general rule, owls do very little plucking to remove feathers and fur whilst other raptors remove large amounts. Once again, be aware that many scavengers also pluck the fur and feathers before eating. Therefore, it is often difficult to determine if the animal was killed or died from other causes and was then scavenged. Furthermore, most raptors will also scavenge.

Pellets

Identification of raptor and corvid (ravens, crows, jays) pellets is a useful tool when conducting intensive foot searches for the presence of raptors and their nests. Pellets by themselves are an unreliable method of identifying the species of raptor or corvid that cast the pellet. However, when used in conjunction with knowledge of the likely perch and nest sites of different species, it is a powerful tool in identifying the species most likely to be present in a particular location. Information on perching/hunting and nest sites can be gained from field guides. Information on pellet size and shape can be obtained from Murie (1974).

Pellets come in many shapes and sizes, and most raptors cast pellets that are typical, and therefore identifiable, for each species. However, exceptions will also occur. For example, Great Horned Owl pellets are usually cylindrical (3 cm diameter), blunt ended, and 6–10 cm long, yet may also be smaller (2–3 cm) and round to pear shape.

In some locations, perches, nests, and roost sites are in short supply and thus are used by several species of raptor and corvid. Therefore, correct identification of the raptors casting the pellets is very difficult, unless this is supported by other evidence (visual sighting, type of whitewash, feathers).

It is difficult to determine the age of the pellets. The appearance of pellets varies with exposure to light, moisture, and temperature. The presence of a pellet or pellets at a nest/perch site may therefore not be of the species using that site at that time, even though it may appear to have a fresh appearance.

As a general rule, pellets cast by owls contain more small bones than those of other raptors, but beware of taking this generalization too literally and become familiar with pellets you know have been cast by a certain species.

Observers should also be aware that many species of birds cast pellets, and that corvid pellets, particularly raven pellets, can be easily mistaken for those of a raptor (Murie 1974). Similar confusion can arise with pellets cast by fish eating birds such as gulls and herons whose pellets can look very similar to those of fish eating raptors.

It should be noted that certain precautions should be exercised when examining pellets. Many raptors prey on rodents, which have a potential to carry Hantavirus. Therefore, when handling pellets, they should either be sterilized, and/or individuals should wear gloves and face masks when handling pellets.

Cautionary Note: Health risks associated with handling raptor pellets are minimal; the digestive process tends to kill harmful bacteria. However, although mice/vole content in the diet varies between raptors, wearing appropriate safety clothing is recommended particularly in areas where there is a risk of contacting Hantavirus.

Whitewash

Small owls (e.g., Northern Saw-whet Owl, Western Screech-Owl) leave small “blobs” of whitewash that are characterized by a central globular mass. Sites with this whitewash may sometimes be associated with moulted feathers or pellets. The larger owls (e.g., Barred Owl, Great Horned Owl) produce 3–4 cm “blobs” or blotches on the forest floor. Again, this whitewash may be associated with pellets. Owl whitewash sometimes contains a hint of yellow colour and is generally found near the base of trees near the trunks. Large owls tend to perch higher in the canopy, so whitewash may be spread out and difficult to identify.

Whitewash of Sharp-shinned and Cooper’s Hawks is characterized by streaks rather than blobs. Sharp-shinned Hawk whitewash streaks are usually 6–12 cm long and can sometimes be found in association with pellets. Cooper’s Hawk whitewash streaks range from 6–18 cm long. These are usually found on the forest floor or on understory vegetation below a perch or nest tree. Red-tailed Hawk whitewash is difficult to locate due to their preference of perch sites high in the canopy.

Crow and Raven whitewash is similar to owl whitewash. However, habitat differences help in identifying the differences between the corvid species and the owls. Corvid whitewash is usually found in more open, less concealed habitat, and not near tree trunks.

Moulted feathers

Feathers moulted by raptors around nest/perch and roost sites are a useful aid in identification, especially when combined with the presence of whitewash and pellets. Become familiar with the size, shape, markings and texture of feathers from different species either by

looking at feathers moulted by known raptors or by looking through museum and private collections of collected birds.

Females of most raptor species moult flight and tail feathers near the nest beginning around the time of incubation. These relatively conspicuous feathers are good indicators of nesting and are typically found within 50 m of a nest.

As a general guide, the feathers of owls have an external downy appearance and texture, which is used to muffle the sound of the wings as they hunt. Be aware that feathers of immature birds (which in Bald Eagles can be 4–5 years old) can look very different from those of adult birds, as can the feather of the different sexes (e.g., Northern Harrier male and female).

3.1.8 Data Entry

Ultimately, all species inventory data, which are collected to RIC standards will be stored in the Species Inventory (SPI) datasystem, housed within the Environment Inventory Branch of Ministry of Sustainable Resource Management. For more information visit the SPI website at http://www.elp.gov.bc.ca/rib/wis/spi/.

3.1.9 Data Analysis

You will find the data analysis section is at the end of this manual. However, it is essential that the frameworks, assumptions, and constraints of various statistical tests be considered during project planning. Please see Species Accounts and Survey Notes (Section 5), and the information in the survey specific methods (Section 3.3 to 3.10), under the heading Data analysis.

3.1.10 Survey Design Hierarchy

Raptor 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 call playback survey. A survey set up following this design will lend itself well to standard methods and RIC dataforms.

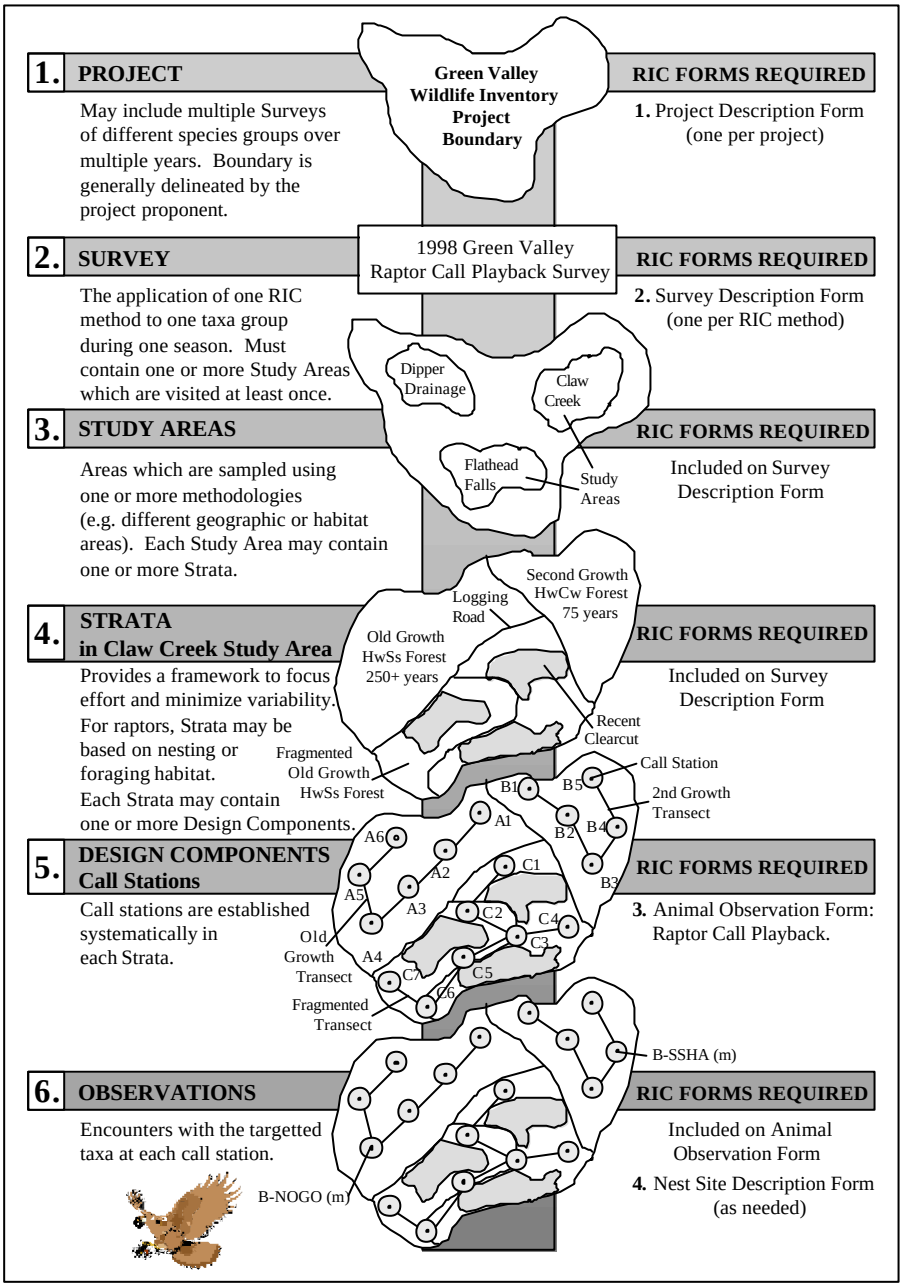

Figure 1. RIC species inventory survey design hierarchy with examples.

3.2 Inventory Surveys

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

Table 4. Types of inventory surveys, the dataforms needed, and the level of intensity of the survey.

Survey Type	Forms Needed	Intensity*
Raptor Aerial Block	• Wildlife Inventory Project Description Form • Wildlife Inventory Survey Description Form • Animal Observations Form- Raptor Aerial Block	• PN • RA • AA
Raptor Encounter Transect (aerial, boat, roadside, and foot)	• Wildlife Inventory Project Description Form • Wildlife Inventory Survey Description Form • Animal Observations Form- Raptor Encounter Transect	• PN • RA
Raptor Call Playback	• Wildlife Inventory Project Description Form • Wildlife Inventory Survey Description Form • Animal Observations Form- Raptor Call Playback	• PN • RA
Nest Site Description	• Animal Observations Form- Nest Site Description, is filled out only when a nest is located during the survey.	When nest is located.

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

3.2.1 Species-specific Inventory Survey Information

Sections 3.3 to 3.10 provide the general protocol for raptor species using these survey methods. Always review Section 5, Species Accounts and Survey Notes, for species-specific information about these methods for the species that interest you.

3.3 Call Playback Surveys

Raptors call to identify themselves, establish and defend territories and to attract mates. The use of call playback takes advantage of this knowledge by putting an "intruder" into an already claimed territory (Smith 1987). The response of the bird can be either behavioural (visual) and/or vocal which, allows the observer to record the presence of the bird. Use call playback for inconspicuous or nocturnal raptor species (e.g., owls and accipiters) known to respond to calls during the breeding season.

Call playback surveys are conducted by broadcasting calls at stations either along roadsides using vehicles, or in more remote areas while walking transects. In many cases birds will travel long distances to respond, thus playback itself is not useful for locating nests. However, it is very useful in association with nest searches in areas where birds respond. If the object of the survey is to find new nests and their location is required, follow Section 3.5, Ground Nest Search.

For determining presence/not detected it is possible to survey for a group of raptors at the same time by playing more than one species' call at a station. However, as it is not known what the effects are on the different species when more than one call is played, single-species inventories are still preferred. For determining relative abundance only one potential raptor species can be surveyed at a time using call playbacks. As well, a specific sampling design must be followed.

It is important to note that some raptor species have more than one call and they will respond to these calls differently, depending on the time of year. Sometimes raptors may not respond to playback in low prey years. It is also important to avoid playing calls during courtship, egg laying or incubation periods as this may disrupt successful breeding of raptors. See species accounts (Section 5) for more specific information and recommendations.

As can be seen in "species accounts" (Section 5) individual raptor and owl populations vary in density across the landscape, subsequently for many species a range of suitable call playback station distances are suggested. Depending on the type of survey planned (presence/ not detected or relative abundance) a more appropriate survey design may be obtained by pre-sampling the proposed project area to establish the probable species and densities likely to be encountered. If this pre-sampling visit indicates higher densities than can be accurately surveyed using the recommended distance, then adjust inter-station distance accordingly (record distance on field dataforms).

Office procedures

- Review the introductory manual No. 1, *Species Inventory Fundamentals* (RIC 1998).
- Obtain maps for Project and Study Area(s) (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). Any map that is used to record data must be referenced to NAD83.
- Outline the Project Area on a small to large-scale map (1:250 000 – 1:20 000).
- Determine Biogeoclimatic zones and subzones, Ecoregion, Ecosection, and Broad Ecosystem Units for the Project Area from maps.

- Delineate one to many Study Areas within this Project Area. Study Areas should be representative of the Project Area if conclusions are to be made about the Project Area. For example, this means if a system of stratification is used in the Sampling Design then strata within the Study Areas should represent relevant strata in the larger Project Area.
- Compile a list of all potential raptor species for the Study Area(s).
- Learn about possible species that may mimic your calls, and species with similar calls, in your area. For example, jays and other birds will mimic broadcast calls, but often give themselves away by adding a non-raptor like chirp at the end of the call. Surveyors should be able to discern their calls.
- Obtain or prepare quality recordings on a CD (preferred) or digital tape cassette of the raptor calls of interest (see Equipment section for instructions on how to prepare recordings).
- Due to the potential variation in call dialects, local recordings of raptor calls are preferable to general recordings.
- It is important to note that some raptor species have more than one call and they will respond to these calls differentially, depending on the time of year. Research the best call to use at each time of year or season and ensure all calls required are recorded.

Sampling design

The Design Component for this survey is (call playback) stations.

Presence/not detected

- Although a strict sampling design is not required, some type of systematic or stratified design should be employed so that effort is consistent, and equal between replicates of surveys (see *Species Inventory Fundamentals*, No. 1, RIC 1998).
- Ideally, the presence/not detected survey will be identical to one replicate of a relative abundance survey.

Relative abundance

- Stratify habitat based upon expected densities. Typically this is derived from an analysis of available habitat.
- Randomly choose strata in which to survey.
- Within each strata use systematic sampling. Transects should be a specified distance apart and so should the call playback stations along these transects (this requires an understanding of the territory size required by the raptor being surveyed). Transects may follow roads, trails, predetermined straight lines, contours or drainages.

Sampling effort

Presence/not detected

- Determining presence is straightforward if a raptor detection is made.
- Determining absence is much more difficult because of the uncertainty of whether the species is absent or just not found. The number of replicates required for a presence/not detected survey can be tested by replicating the call playback surveys many times in an area as part of relative abundance methods. Assuming survey independence, an approximation calculation of the number of surveys needed to detect the species present in an area can be made by plotting the proportion of surveys with positive results (Y-axis) against the number of surveys taken (X-axis). See Section 5 of *Species Inventory Fundamentals* manual (RIC 1998) for more details.

Relative abundance

- Sample effort should be determined by the use of power analysis packages (see Section 4.2 and Section 5 of *Species Inventory Fundamentals* (RIC 1998).
- Preliminary surveys would be most useful for input to power analysis.

Personnel

- Two workers are required; the crew leader should be a qualified biologist and possess raptor experience.
- Crew members should have prior experience in call playback surveys or they must be properly trained in the method. Excellent hearing is essential.

Equipment

- Maps
- Waterproof Notebook
- Compass
- Binoculars
- Flagging tape

Broadcasting Equipment

- High quality broadcast equipment. A portable megaphone attached via a mono cord to a walkman or disc player (preferred) is recommended (Hardy and Morrison 2000).
- This set-up is particularly useful for call playback surveys on foot as it is lighter and easier to pack than a portable stereo.
- The machine should be able to broadcast sounds over an area of 400 m; one technical description of a recommended player has a frequency of about 40 Hz to 12 kHz and power output of 1.2 watts at 1 kHz, with a volume output of 100-110 db at 1 m from the megaphone (Hardy and Morrison 2000).
- CDs (preferred) or digital tape cassettes of raptor calls of species of interest. Note that tape cassettes should be replaced periodically to ensure tape quality.
- Prepare multiple recordings on the call playback CD/cassette (at least 3).
- Each recording of calls should be the same duration (approximately 20-30 seconds). Thus, one recording is equal to as many calls of a particular raptor as can fit into 20 seconds, given the natural spacing between that raptor's vocalizations.
- When preparing recordings, ensure that the species' call is not cut off at an unnatural point in its call. It is best to make the recording slightly shorter/longer than 20 seconds as necessary to avoid this situation.
- Try to eliminate background noise on recordings.
- Prepare the CD/cassette so that it can be:
    - played continuously at a station by taping 30 seconds of silence after each recording (for a total of 2.5 minutes of recording per station); or
    - put on pause between recordings. Ensure that there is a long enough pause between recordings to indicate the end of one recording and the beginning of the next. CDs/cassettes prepared this way will eliminate excess noise from being heard between recordings as well as save batteries (by reducing broadcasting time and the amount of rewinding required for cassettes).

Field procedures - single species inventory

- The time of year for commencing call playback surveys can be determined from knowledge of when egg laying will occur (refer to Section 5, Species Accounts and Survey Notes).
- Call playback stations should be separated along a transect such that the distance covered is maximized, and duplication of called areas is minimized. This distance must be balanced with the ability to detect the raptor. Too great a distance between stations increases the likelihood of not detecting a raptor. For information from the literature, consult Species Accounts and Survey Notes, Section 5.
- Note that severe safety hazards may necessitate sampling at periods alternate to optimal times or may cause station location to deviate slightly from those recommended. For example, rock fall and avalanche hazards may be present in steep terrain and so safety conditions must be considered in these areas especially during late winter, early spring, and following severe rainstorms at any time. Stations may need to be temporarily moved to an alternative safe position where auditory radius maintains survey coverage of the transect (van Woudenberg 1997 unpubl.).
- For raptor species that have more than one call, use the one most appropriate for the time of year that the survey is being conducted (e.g., alarm call versus begging call). Note that the type of call used may change during the survey season.

Upon arriving at each station

- Wait a minimum of 2 minutes upon arriving at a call playback station (Takats *et al*. 2001):
- Use this time to 'adjust ears' and to listen for spontaneous calling raptors (before recorded calls are broadcasted). Note the noise from running water (e.g., from nearby stream) may cause interference in hearing vocalizations (particularly owls) and should be avoided.
- Record location and weather conditions.
- Habitat data for the station may be collected at this time, on your route back after you have completed the stations on your transect, or on another day (providing stations can be re-located).
- If the targeted species is heard spontaneously calling do not broadcast any recorded calls for this species (go to *Raptor response* protocol).
- If a spontaneously calling raptor is heard that is not the targeted species:
- Record the detected species.
- Wait 1 minute (from the time the non-targeted species was detected), then begin broadcasting calls for the targeted species (see *Broadcasting calls* protocol). This may mean broadcasting calls for the targeted species while the non-targeted species is still calling (e.g., B-GHOW can go on and on).
- If broadcasting calls of the targeted species results in disturbance (continuous calling, mobbing action, etc.) to other raptor species, discontinue broadcasting calls at that station.
- Record on the dataform at what point the calling was discontinued (e.g. after broadcasting the first recording).
- Move on to the next station.

Broadcasting calls

- Broadcast one series of recorded calls for the targeted species (if a spontaneously calling raptor is heard, see above).
- For consistency, broadcast 3 recordings of calls (20 seconds each), with a 30 second listening interval following each recording. Thus, it will take a total of 2.5 minutes to broadcast a series at a station (e.g., 20/30, 20/30, and 20/30) and complete a call playback survey for a species at a station.
- Depending on how the CD/cassette has been prepared:
- Play the CD/cassette continuously at a station if the listening intervals (30 seconds of silence) were taped after each call recording. Note that if the CD/cassette has substantial background noise, the volume should be turned down during the 30 second listening-intervals.
- Press pause between call recordings, and use a stopwatch to time the 30 second listening-intervals if this silent period was not taped.
- Broadcast the first recording at 60^0 from the transect line (turn left or right), listen and watch for 30 seconds. Turn 120^0 (in the same direction as before) and repeat the procedure, then turn another 120^0 and repeat the procedure for the third time.
- Hold the megaphone at chest height while broadcasting recorded calls.
- Be aware of how far the sound of your recording is carrying. Louder is not necessarily better, as it may distort broadcast calls and lower detection rates. Remember, the louder the call, the further away that raptors will hear it; the further away a raptor is the less chance that you have of seeing or hearing its reaction.
- Ensure that all other persons are away from the megaphone during broadcasting as this can cause short-term loss of sensitivity and false "echo" calls.

Raptor response

- If call playback elicits a response by the <u>targeted</u> species (or a spontaneously calling raptor is heard):
- Do <u>not</u> continue to broadcast the recorded call as this may frighten the raptor and cause it to abandon or alter its territory. Also, response to call playback alters the time budget of the bird which may interfere with critical breeding behaviour (i.e., feeding, courtship, mating).
- Record the species and its approximate location (take a compass bearing).
- Response time is unknown for many species. Some species respond immediately while others only respond after a prolonged period. Note the time that the raptor responded and at what point during the broadcasting (e.g. during the second recording) it responded (optional). This information could be useful for methods assessment and future inventories.
- Move on to the next station or initiate a nest search if this is one of your project objectives (see Section 3.5).
- If call playback elicits a response by a <u>non-targeted</u> raptor species:
- <u>Continue</u> broadcasting calls for the targeted species.
- Record the species that responded and its approximate location (optional).
- Record the time and at what point during the broadcasting (e.g. during the second recording) that the non-targeted raptor species responded (optional).
- Note that if broadcasting calls of the targeted species results in disturbance (continuous calling, mobbing action, etc.) to other raptor species, discontinue broadcasting calls at that station.

- Record on the dataform at what point the broadcast series was discontinued and why.
- Wait for 5 minutes, listening and watching for a response by the targeted species.
- Move on to the next station.
- If no response is elicited after broadcasting the series of 3 call recordings:
- Wait for 5 minutes, listening and watching for a response.
- Move on to the next station.

For owls only:

- Repeat the broadcasting calls procedure up to 2 more times (e.g. broadcast a maximum of 3 series of calls), depending on species (see Section 5, Species Accounts and Survey Notes).
- Shorter stops may be preferred for owls that respond quickly, while longer stops may be preferred for slower responding owls (Francis and Bradstreet 1997). This may help to optimize the number of owls detected for the number of stations surveyed.
- Note that longer stops are only justified if they result in more owls being detected as increasing the length of stops often means reducing the number of stations surveyed in a night (Francis and Bradstreet 1997). However, some owls may not be detected if the stop duration is too short.
- Ensure to wait for 5 minutes, listening and watching for a response after each broadcasting series.
- This means up to 25 minutes could be spent at a station for a single-species owl survey.
- See above if a raptor response is elicited.

Completing a transect

- Continue the above procedures until the transect is complete, looking and listening for raptors and raptor sign between stations. At the last station, wait 5 minutes after the calls have been played, before ending the survey and leaving the area.
- Following each night of call surveying, raptor detections should be plotted on a master map.

Field procedures - modifications for a multi-species owl inventory
- for presence/not detected surveys only

- This method can not be used for Relative Abundance. A relative abundance inventory can only survey for one species at a time (i.e., only calls of one species/station can be broadcasted).
- It is not possible to obtain relative abundance with a multi-species call playback as it is not known what the effects are on the different species when more than one type of call is broadcasted.
- Fuller and Mosher (1981), caution that the behavior of a target raptor species responding to playback recordings may be inhibited by the presence of a larger competitor or predator within its territory.
- Limit the number of target species in a multi-species inventory. For each potential target species determine what information will be gained. Include only those species that are required to meet survey objectives. Consider the balance between the information that will be gained by adding another target species with the information that may be lost due to the increased difficulty to plan an optimal sampling design for multiple species (see below) or the potential difficulty to analyse the data collected.

- Although multi-species inventories can be used to determine presence/not detected of owls, single-species inventories are still preferred.
- Note that the greater the number of species being surveyed in a multi-species inventory, the greater the amount of time spent at each station (which may restrict the amount of area that can be covered in an evening if the number of crews are limited).
- The time of year for commencing call playback surveys can be determined from knowledge of when egg laying will occur (refer to Section 5, Species Accounts and Survey Notes). In general, larger species tend to lay eggs before smaller species. A word of caution is that this information is based on small sample sizes and should be used as a guide only.
- Determine optimal distance between calling stations. This can become problematic when multiple species are being surveyed at the same time.
- It is difficult to find an interstation distance that will minimize duplication of called areas and still maximize likelihood of detection, especially when different sized owls are being surveyed at the same time. The compromise reached is dependent on the species being surveyed.
- If possible only use multi-species inventories when targeting similar sized owls.
- Results based on owl inventory surveys done in Nimpkish Valley (Deal and Lamont 1996a unpubl.) recommend an interstation distance of 1000 m if only large owls are targeted and 800 m if only smaller owls are targeted.
- Terminology:
- Targeted species – refers to the species whose call is being broadcasted in attempt to elicit a response from that species.
- Focal taxa – a group of targeted species; referred to individually as a focal species or as targeted species #1, targeted species #2, targeted species #3, etc.
- Play calls in order from smallest to largest owls as calls of larger owls may decrease the responses of smaller owls.
- Follow the field procedures for a single species inventory up to and including the protocol for broadcasting calls.
- Listen and watch for a response for 5 minutes after broadcasting calls for targeted owl species #1 and before broadcasting the series of calls for the next targeted owl species (#2). This means that it will take approximately 7.5 minutes/species/station (2.5 minutes of calls plus 5 minutes listening).
- If no response is elicited:
- Broadcast and listen as above for subsequent focal taxa.
- Note that only 1 series of taped calls is broadcasted (e.g., 20/30, 20/30, and 20/30) per owl species in a multi-species inventory, even if no response is elicited.
- Once taped calls have been broadcasted for all of the focal taxa, wait 5 minutes, listening and watching for a response.
- Move on to the next station.
- If a response is elicited:
- Discontinue broadcasting the call that elicited the response, regardless of the species of raptor that responded.
- Record the species, its approximate location (take a compass bearing) and time of response (e.g. after broadcasting for targeted owl species #1, targeted owl species #2, etc.).

- Wait 1 minute, and then continue with call playback for the other focal taxa, applying the following guidelines:
    - If either targeted species #1 or a non-targeted species responded to the first series of call playbacks, broadcast calls for targeted species #2 next.
    - If the species that responded is from the focal taxa, but is not the targeted species, do not broadcast calls for this species. For example, if targeted species #2 responded to broadcasted calls for targeted species #1: the next broadcasted calls would be for targeted species #3, and then for targeted species #4, etc.
    - If a larger owl responds to a broadcasted call of a smaller owl, do not broadcast any more calls for any of the small owls. Skip to the first large owl species in the focal taxa group and begin broadcasts. For example, if broadcasted calls of a small owl (B- WSOW, targeted species #1), elicited a response from a large owl (B-BAOW, targeted species #4), then the next calls to be broadcasted would be for an even larger owl (B- GHOW, targeted species #5). The smaller owls: targeted species #2 (B- NPOW) and #3 (B-NSOW) would be skipped.
- If call playback of additional focal taxa results in mobbing or threatening behavior to other raptor species:,
    - Discontinue broadcasting calls at that station.
    - Record on the dataform at what point the broadcast series was discontinued (e.g. after broadcasting the first recording of targeted species #2) and why. This will be important in an evaluation of survey effort (e.g., to evaluate the total number of stations at which call playback for a particular species was conducted).
    - Wait 5 minutes, listening and watching for a response from any targeted species.
    - Move on to the next station.
- Once taped calls have been broadcasted for all of the focal taxa:
    - Wait 5 minutes, listening and watching for a response from any targeted species.
    - Move on to the next station.

Data analysis

Presence / Not detected

- List the species detected in a given Study Area, plot detections on a master map.
- Determine the amount of effort applied to detecting raptors on a species-by-species basis. For a multi-species inventory detection effort will not likely be the same for all species, as all calls may not have been played at all stations. For each species only stations that the species' call was played can be included in survey effort. Note that even following these guidelines, it is still not known how the "presence" of another species (e.g., other broadcasted calls) will effect the response of the previous/next targeted species.

Relative Abundance

- Determine the average number of responding birds of a given species per station per Study Area.

3.4 Foot Surveys

Foot surveys may be used to determine presence/not detected (possible) of inconspicuous breeding raptors such as Short-eared Owls and Barn Owls, that may not respond to broadcast calls.

The major disadvantage of foot surveys is that large areas can not be covered. This method, especially in coniferous stands, is slow and time consuming and probably will never result in an accurate census (Swengel and Swengel 1987). Intensively searching an entire area may give a very accurate count however, the results can not be viewed as general and are unlikely to apply elsewhere. Thus, instead of intensively searching a large area, it is recommended that the habitat be stratified based on density estimates and habitat quality (low, medium or high). Once, habitat is stratified, randomly select smaller sample areas and run transects through this area.

After a raptor has been heard and/or seen, a nest search may be conducted if the objective of the survey is to find new nests. When conducting foot surveys during the breeding season, care should be given as to the approximate timing of nest visits (see Section 3.5, Ground Nest Search).

Office procedures

- Review the introductory manual No. 1, *Species Inventory Fundamentals* (RIC 1998).
- Obtain maps for Project and Study Area(s) (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). Any map that is used to record data must be referenced to NAD83.
- Outline the Project Area on a small to large-scale map (1:250 000 – 1:20 000).
- Determine Biogeoclimatic zones and subzones, Ecoregion, Ecosection, and Broad Ecosystem Units for the Project Area from maps.
- Delineate one to many Study Areas within this Project Area. Study areas should be representative of the Project Area if conclusions are to be made about the Project Area. For example, this means if a system of stratification is used in the Sampling Design then strata within the Study Areas should represent relevant strata in the larger Project Area.
- Compile a list of all potential raptor species for the Study Area.

Sampling design

The Design Component for this survey is a transect.

Presence/not detected

- Although a strict sampling design is not required, systematic sampling using transects is recommended so that effort can be replicated.
- Ideally, the presence/not detected survey will be identical to one replicate of a relative abundance survey.

Relative abundance

- Stratify habitat based upon expected densities.
- Randomly choose strata in which to survey.

- Within each strata use systematic sampling. Transects should be a specified distance apart and so should the stations along these transects. Transects may follow roads, trails, predetermined straightlines, contours or drainages.

Sampling effort

Presence/not detected

- Determining presence is straightforward if a raptor detection is made.
- Determining absence is much more difficult because of the uncertainty of whether the species is absent or just not found. It is difficult to determine whether absence can be concluded from foot surveys for detection relies on the reaction of nesting birds in an area. A crude method to determine the number of transects to ensure detection would be to replicate a foot survey effort many times as part of relative abundance methods and use the methods described in *Species Inventory Fundamentals* (Section 5, RIC 1998).

Relative abundance

- Sampling effort will best be determined by first doing some preliminary sampling.
- It is difficult to determine whether repeatable, precise data from foot surveys is possible to obtain for nesting birds in an area. However, it is doubtful that sample sizes would be adequate to allow estimation of nesting densities with a line transect method. Furthermore, if sample sizes are small with these surveys, it may be difficult to gain sufficient statistical power with any statistical tests that may be needed.
- See *Species Inventory Fundamentals* (Appendix G, RIC 1998), for many easy-to-use packages that are available to aid in the determination of sample sizes for trend analysis and comparison between areas.

Personnel

- Two workers are required; the crew leader should be a qualified biologist and possess raptor experience.
- Excellent hearing is essential.

Equipment

- Maps
- Waterproof Notebook
- Compass
- Binoculars
- Flagging tape

Field procedures

- Review the information in Conducting surveys on foot vs other transportation, Section 3.1.6.
- Conduct foot surveys during the breeding season, but take care to avoid unnecessary disturbance during courtship, egg laying or incubation periods as this may disrupt successful breeding of raptors (refer to Section 5, Species Accounts and Survey Notes).
- Consult the Species Accounts and Survey Notes, Section 5, for the appropriate time of day to conduct foot surveys depending on the species of interest.

- Walk transects slowly at a speed of between 0.5 - 2 km/hr, looking and listening for raptors en route.
- Separate listening stations as appropriate to survey target taxa (see Species Accounts and Survey Notes, Section 5).
- Wait a minimum of 2 minutes upon arriving at a listen station (Takats *et al.* 2001):
- Use this time to 'adjust ears' and to listen for spontaneous calling raptors. Note the noise from running water (e.g., from nearby stream) may cause interference in hearing vocalizations (particularly owls) and should be avoided.
- Record location and weather conditions.
- Wait for 5 minutes, listening and watching.
- For all raptors heard and/or seen, record relevant information such as species, sex, age, type of response, and its approximate location (take a compass bearing).
- If a nest search is warranted, follow protocols outlined in the , Ground Nest Search, Section 3.5.
- After listening and watching for 5 minutes, move on to the next station.
- Continue the above procedures until the transect is complete.

Data analysis
Presence / Not detected

- List the species detected in a given Study Area.
- Following each survey, plot raptor detections on a master map.

3.5 Ground Nest Search

Nest searches are used to supplement call playback, foot surveys, and roadside surveys to verify presence/not detected of breeding raptors. For example, after raptors have been heard and/or seen, searches are used to look for nests, cavity trees, roost sites, fecal wash, prey remains or any other sign of raptors inhabiting an area. As nest searches are not an inventory method on their own, they do not need to follow a strict sampling design. The success of nest searches is highly dependent upon observer effort, skill level and ability (Smith 1987).

Before conducting a nest search:

Confirm that the objectives of the study require that nests be located. This is important to consider due to the amount of time that it will take to locate nests, and the potential disturbance that it will cause to the birds.

Each species reacts differently to intruders at the nest site: some by calling, attacking, leaving, sitting tight, etc. Be aware that the presence of human intruders, particularly in the egg-laying and incubation stages may cause serious disturbance or nest failure. For these reasons, surveyors should take the following general precautions:

- When conducting a nest search during the breeding season, care should be given as to the approximate timing of nest visits. Try not to visit the nest sites early in the nest season. Site tenacity is weakest during the courtship and egg laying period, and is likely strongest once chicks are approximately seven days old. However, when the object of the survey is to find new nests (as opposed to checking historic nests) it is necessary to relax this constraint. When a nest is found, remain for as short a time as possible to record the necessary data.
- If approaching a cliff site do so from the most visible avenue, to prevent startling birds.

Be aware that polygamy sometimes occurs, and has been documented in species as diverse as Northern Harriers, Northern Saw-whet Owls, Boreal Owls, and Red-tailed Hawks. With polygamous species, one male may be maintaining two or more nests within a territory; therefore, be careful to observe and identify flight directions of the male.

Also be aware that birds often reuse nests or build new nests near old sites. However, nests that have failed in previous years may not be reused. Once nests are located, surveyors can use density estimates or spacing to establish where the next closest nest might be.

Search effort

- Return to an area and repeat a search up to three times before concluding that a nest is not there. Timing of these visits should be designed to cover the range of expected breeding dates of target taxa and include time periods when birds are most vocal or visible (see individual species accounts, Section 5).

Field procedures

- Review the information in Conducting surveys on foot vs other transportation, Section 3.1.6.
- If a nest search is going to be initiated, take a compass bearing in the direction a response was detected. This will aid in narrowing nest site location.

- If the response is visual, note whether the raptor is carrying prey. If so, take a compass bearing in the direction it is flying as it may be delivering food to its young at the nest.
- If a response (visual or vocal) was elicited during a call playback survey, do not continue playing the call when doing a nest search as this may frighten the bird and cause it to abandon or alter its territory. Also, response to call playback alters the time budget of the bird which may interfere with critical breeding behaviour (i.e., feeding, courtship, mating).
- Move in the direction of the response (toward the source of the call or in the direction the bird flew).
- If searching for nests after a detection - search within a radius of 300-400 m of the detection point.
- When searching for a nest, do not follow a strict sampling design but 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 clues by systematically combing the forest floor back and forth. Surveyors should separate themselves by approximately 10 m, depending on the terrain and visibility, to increase detection efficiency.
- Nests found may be inactive or fail later in the season. The observer must know how to 'read' behaviour of birds at a nest to determine its status. For example, some birds perch or forage closer to nests, while other species may not be around or displaying with humans present.
- In close proximity to active nests, there will be fecal wash that resembles splattered whitewash, moulted feathers from the incubating adults, the pluckings of prey, and ejected pellets.
- Once whitewash, pellets or prey pluckings have been detected, search the trees for nests.
- New nests can sometimes be distinguished from old nests because they have white ends of freshly broken sticks and daylight passing through (in old nests, leaves and other debris gather over the winter preventing daylight from passing through). Be aware though that it may be difficult to tell whether a nest is old or new as several raptors will build on old nests year after year causing the bottom layers of the nest to be compacted, while the top, newer layers are not.
- For cavity nesting species 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, leave the area immediately to minimize disturbance.
- Record nest site data attributes on the Nest Site Description Dataform.

3.6 Roadside Surveys

Roads and secondary trails are used as transect routes along which a vehicle is driven at low speed in one direction while at least two observers scan the countryside for perched and soaring raptors (Kochert 1986). It is a good method for comparing long-term trends and for covering large areas.

Roadside surveys can be used to inventory conspicuous raptors during the breeding season. Many conspicuous raptor species scavenge along highways. As well, during migration periods, passerine birds may concentrate activity near roadsides (as roadsides often are the first to become snow), which may attract many diurnal raptors during the breeding season (Table 2). American Kestrels, Northern Harriers and Rough-legged Hawks can also be inventoried using roadside surveys during the non-breeding season (Table 2).

Roadside surveys can be used to inventory a few inconspicuous raptors such as Short-eared Owls and Barn Owls in the breeding season and Snowy Owls during the non-breeding season (Table 1). These three species use open habitat and will therefore be visible (conspicuous) during roadside surveys at the appropriate time of day (i.e., they are all crepuscular and can bee seen just before sunset or just before sunrise).

For presence/not detected (possible) all that is required is that the raptor be sighted and identified. To determine relative abundance, an encounter transect method should be employed and the number of raptors seen along the transect route (number of raptors/km) be recorded.

After a raptor has been detected during a roadside survey, a nest search may be conducted if the object of the survey is to find new nests (see Section 3.5, Ground Nest Search).

Office procedures

- Review the introductory manual No. 1, *Species Inventory Fundamentals* (RIC 1998).
- Obtain maps for Project and Study Area(s) (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). Any map that is used to record data must be referenced to NAD83.
- Outline the Project Area on a small to large-scale map (1:250 000 – 1:20 000).
- Determine Biogeoclimatic zones and subzones, Ecoregion, Ecosection, and Broad Ecosystem Units for the Project Area and Study Areas from maps.
- Delineate one to many Study Areas within this Project Area. Study areas should be representative of the Project Area if conclusions are to be made about the Project Area. For example, this means if a system of stratification is used in the Sampling Design then strata within the Study Areas should represent relevant strata in the larger Project Area.
- Compile a list which includes all potential raptors for the Study Area.
- For each Study Area, identify on maps potential roads or trails that could be used as survey transects to try and locate raptors. Roads with high car volume should be excluded because of potential danger.

Sampling design

- Stratify area by habitat or based on expected densities of raptors (low, medium or high). Note that roads with telephone poles, power lines, fences or other artificial perching sites should be placed into the high strata because these objects tend to concentrate raptors.

- Randomly choose strata in which to conduct surveys.
  - If habitat or strata based inference is an objective, then equal survey effort between strata is recommended.
  - If detection of rare species is the objective then surveying strata with an expected high density is preferred.
- The Design Component for this survey is transects. Select roads (transects) to sample from each of the stratum of interest. These should be selected as randomly as possible, but in reality this likely can not be achieved and in many studies this criterion is ignored (see Andersen *et al.* 1985).

Presence/not detected

- For presence/not detected all raptor species observed are recorded regardless of their distance from transect line (there is no fixed-width).

Relative abundance

- A line transect would be ideal for this work, however, to estimate detection functions at least 40-60 observations are needed in each transect sample (Buckland *et al.* 1993). It is doubtful that this type of sample size can be obtained for raptors without very long transect lengths. Preliminary surveys should be conducted to determine likely sample sizes, and if possible line transect methods should be incorporated.
- If line transects are not possible, then a modified fixed-width transect (contingent on raptor species being detected) should be used. Perpendicular sighting distance (from the transect line) of raptors should always be recorded to estimate the strip width for different raptor species. (New advances in laser rangefinders may help in the estimation of distances of raptors from the transect line.) It is important to remember that an inherent assumption with this method is that there is a constant probability of detection of raptor species each time the survey is replicated.
- It is important to consider raptor detectability in different habitats, so if a fixed-width transect is being run, the width of these transects can be adjusted (Kochert 1986, Fuller and Mosher 1987). Road transect counts are most appropriate for sampling raptor populations in open vegetation (Millsap and LeFranc 1988).

Sampling effort

- If habitat or strata based inference is an objective, then equal survey effort between strata is recommended. If detection of rare species is the objective then surveying strata with an expected high density is preferred over surveying areas with lower expected density.
- To keep sampling effort similar between surveys, all surveys should be run at the same time of day, under similar weather conditions, at similar speeds and similar distance. Crews should be rotated evenly between transect routes and Study Areas to minimize observer bias in the data.

Presence/not detected

- Conduct at least one roadside survey, completely covering the area of interest during the breeding or non-breeding season (depending on raptor species).

Relative abundance

- Refer to the manual, *Species Inventory Fundamentals* (Sections 2.5 and 5, RIC 1998), to determine sample effort required to calculate relative abundance using this type of survey method.

Personnel

- A minimum of two people are required for roadside surveys.
- Crew members must have a valid Class 5 drivers license.
- The crew leader should be a qualified biologist with excellent raptor identification skills. Other crew member(s) should also have excellent raptor identification skills.

Equipment

- Vehicle that provides good vision to surrounding countryside. It should have extensive windows and ride high enough above the road surface so that the observers can see into open fields without their vision being prohibited by bushes at the field's edge.
- 7-10x binoculars for each observer
- 1 spotting scope (minimum 20x) per crew
- Maps
- Pencils
- Compass

Field procedures

- The time of day the survey is conducted will depend on the species of interest. Some raptors are better seen while soaring in thermals (later in morning/afternoon).
- Surveys may begin shortly after dawn (as soon as normal daylight conditions allow unrestricted visibility when compared to later in the day).
- Survey route, date, speed and weather conditions should be recorded for future replication.
- Set odometer to zero at transect initiation.
- Vehicle speed should not exceed 40 km/hr.
- When a raptor is detected, stop when safe to do so, and record:
- species, sex, relative age, and whether it is perched or flying.
- distance traveled along transect (from odometer).
- If a road double backs or contains hairpin turns it is easy to double count or miss raptors completely in the surrounding area. Decide ahead of time how you will count this section of road to minimize miscounts. For relative abundance surveys, adjustments to the distance traveled may have to be made as well, if the portion of road that double backs is significant.
- If a nest search is warranted, follow protocols outlined in Section 3.5, Ground Nest Search.

Data analysis

Presence/Not Detected

- List the species detected in a given Study Area.

Relative abundance

- Number of raptors seen/heard along transect. Calculate the number of raptors/km per stratum type.

3.7 Standwatches

Standwatches may be used to supplement call playback, foot and roadside surveys when determining presence/not detected (possible) of either conspicuous or inconspicuous raptors or their nest sites during the breeding season. As standwatches are not an inventory method on their own, they do not need to follow a strict sampling design. In general, standwatches require surveyors to position themselves at selected vantage points where suspected nesting habitat is searched for raptors rising out of the canopy.

Before conducting a standwatch:

- Identify sites and access routes to potential standwatch locations in your Study Area(s).
- Understand that standwatches are used to supplement other inventory techniques as deemed necessary. Standwatches are not used on their own since data collected may be difficult to interpret since most of the raptors will be detected while soaring and may not actually be from the Study Area.
- The duration of a standwatch and the number of standwatches performed will vary according to the surveyor and the success rate.
- Standwatches can be used as a reconnaissance approach to a Study Area followed by call playback, foot, or roadside surveys, and/or conducted during these inventory surveys.

Field procedures

- Only one person is required at a standwatch, but two workers are optimal. If more than one person is surveying, partition the standwatch slope so that each observer surveys a different area of the slope. It is recommended that vantage points face upslope as the small silhouette of a soaring bird is most visible against the sky.
- It is most useful for observers to survey without the aid of optics, however, when a bird is detected, use binoculars or a spotting scope to assist with raptor identification.
- When a raptor is identified, continue watching the bird until it enters the forest on the slope. Try to mark this location by referring to other landscape features around it and by taking a compass bearing for direction. Often raptors will enter into the canopy within their territory, which may be useful for locating a nest on foot.

3.8 Migration Surveys

This method is limited to presence/not detected unless it is done with a banding program.

During spring and fall migration, raptors become concentrated along specific flyways such as shorelines and mountain ridges at which time they can be counted much more easily then when they are dispersed during the breeding season. Depending on the species and season, anywhere from a handful to hundreds of raptors can be seen per day.

The accuracy of migration survey data to indicate population trends remains questionable. Hussel (1981) cites two main reasons for this:

1. difficulty with relating migrants to specific breeding and non-breeding populations; and
2. multiple factors other than population change which contribute to variability in migration counts (e.g., weather).

Solving the first problem requires banding of the raptors and hopefully recovering the band or sighting the banded birds on their breeding and/or non-breeding grounds. The second problem is resolved by identifying and separating the components that contribute variability in migration survey counts. Studies conducted by Hussel (1981), on migratory counts of small passerines, reported 27-63% (depending on the species) of the count variation was explained by year, date, site and weather variables.

In British Columbia only one informal fall hawk watch station has been established: in East Sooke Park on southern Vancouver Island. Other migration corridors in the province exist and are known but no formal monitoring stations have been established. Because censusing of breeding raptors over a large area is difficult and because funds will probably never be available to survey nesting populations of all species, hawk migration routes should be identified and monitoring stations set up.

Nocturnally migrating owls have also been successfully censused at hawk watch stations using an AN/PVS-3A night vision scope (Russel *et al.* 1991). On 25 nights at Cape May Point, New Jersey, 210 owls of the species Barn Owl, Northern Saw-whet Owl and Long-eared Owl were recorded migrating at night with most detections occurring within the first two hours after sunset.

To conduct migration surveys for raptors follow the standards established by the Hawk Migration Association of North America.

3.9 Aerial Surveys

Aerial surveys are efficient for searching large areas in a short period of time. During the breeding season aerial surveys can be used to locate nests of conspicuous raptors: Ospreys, Bald Eagles, Golden Eagles, Gyrfalcons, Peregrine Falcons and Prairie Falcons. Boat or foot surveys should be used at least in part of the census area as a correction factor and to verify nest site locations (see Munro 1988, Anthony *et al.* 1999). Aerial surveys can be supplemented with nest searches if the object of the survey is to find new nests (see Section 3.5). During the non-breeding season, aerial surveys may also be used for locating Osprey, Bald Eagle and Golden Eagle nests.

This method can be used to determine presence/not detected or abundance estimates if survey replicates are conducted. The estimation of absolute abundance is possible but only for conspicuous raptors during the nesting period and thus pertains only to the nesting population and does not count floaters or non-breeders.

Generally, active nest sites can be described as being:

- An occupied site - indicated by the presence of at least 1 adult, or eggs or young, during any of the survey flights
- A productive site - a nest where a minimum of 1 chick is present and is assumed to have fledged at the time of the productivity surveys. Productivity is defined as the mean number of known or assumed young fledged per occupied site.

Full definitions to describe occupancy and activities at nesting areas can be found in Poole and Bromley (1988), Postupalsky (1974), Postupalsky (1983) and Steenhof (1987).

Office procedures

- Review the introductory manual No. 1, *Species Inventory Fundamentals* (RIC 1998).
- Obtain maps for Project and Study Area(s) (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). Any map that is used to record data must be referenced to NAD83.
- Outline the Project Area on a small to large-scale map (1:250 000 – 1:20 000).
- Determine Biogeoclimatic zones and subzones, Ecoregion, Ecosection, and Broad Ecosystem Units for the Project Area from maps.
- Delineate one to many Study Areas within this Project Area. Study areas should be representative of the Project Area if conclusions are to be made about the Project Area. For example, this means if a system of stratification is used in the Sampling Design then strata within the Study Areas should represent relevant strata in the larger Project Area.
- Obtain 1:5 000 air photo maps for use in identifying flight lines.

Sampling design

- Stratify area by habitat or based on expected densities of raptors (low, medium or high). Randomly choose strata in which to conduct surveys.
    - If habitat or strata based inference is an objective, then equal survey effort between strata is recommended.

    - If detection of rare species is the objective then surveying strata with an expected high density is preferred.
- Delineate quadrats within the strata to be surveyed (a quadrat can include the whole stratum or just part of it). The Design Component for this survey is quadrats. Determine Biogeoclimatic zones and subzones, Ecoregion, Ecosection, and Broad Ecosystem Units for quadrats.
- In terms of optimal quadrat size, Krebs (1989, p.67) suggests methods to determine optimal quadrat size, or nested quadrats, for species dependent on what assumptions can be made about spatial dispersion and other factors. Krebs (1989) states that there is no single quadrat shape, size or number that is universally recommended.
- Plan flight routes within each quadrat to cover the area. Flying transects within quadrats is preferable to concentric circles from a statistical perspective. Transects should also provide a more uniform coverage of each quadrat.

Sampling effort

- Note that forestry plans should treat occupied and productive nests with equal significance as occupied and unproductive nests; thus, the additional effort required to determine productivity has limited benefits. A survey in Vanderhoof (Poole 1998 Unpubl. Rep.) that examined Bald Eagle and Osprey nest site occupancy and productivity reported that from the perspective of stand/site level management to minimize conflicts near nests, the occupancy flights in May are more important than the productivity surveys.

Presence/not detected

- If habitat or strata based inference is an objective, then equal survey effort between strata is recommended. If detection of rare species is the objective then surveying strata with an expected high density is preferred.
- If birds are sitting on nests, then one survey will probably provide presence/not detected information, especially if helicopter noise is sufficient to flush cliff-nesting raptors (this assumption depends on whether birds are on nests at the time of survey).
- Search time, search area, and search routes should always be detailed so that efforts can be replicated in future surveys.

Relative Abundance and Absolute Abundance

- Set up sampling in a way that will improve survey precision and subsequent statistical power.
- Variance is almost always proportional to mean count in quadrat counts.
- To appraise survey precision, calculate the coefficient of variation (standard deviation of replicated counts divided by mean of replicated counts). If this is done, it is found that survey precision is usually lower in the lower density (i.e., lower population abundance) strata.
- In general, survey precision as reflected by the coefficient of variation will be proportional to $1/A$ where A is the absolute abundance when quadrat or line transect counts are employed (Seber 1982, Gerrodette 1987, Krebs 1989, p.177).
- Krebs (1989, p.216) discusses how to allocate sample sizes in stratified sampling and in particular how to determine what fraction of samples to put in what strata.
- Sample effort should be evaluated in terms of project objectives using power analysis packages as described in Section 4 and *Species Inventory Fundamentals* manual (Section 5 and Appendix G, RIC 1998). Preliminary survey data will help design studies in terms of optimal sample effort.

- *Absolute Abundance:* It is suggested that absolute abundance estimates be replicated over the course of a breeding season to ensure that all breeding birds are counted. Some raptors such as falcons will "sit tight" on nests during the incubation phase, and not be at nests at all times after the nestlings have hatched. Therefore, replicated efforts that correspond to knowledge about nest chronology will help ensure the thoroughness of surveys.

Personnel

- A pilot with previous raptor aerial survey experience.
- Crew leader should be a qualified biologist with experience in aerial raptor surveying.
- Other crew members should have previous experience in aerial raptor surveys or be properly trained.

Equipment

- Aircraft
- Aircraft should be fitted with bubble windows enabling better visibility for observers
- Fixed-wing aircraft are sufficient for surveying tree nesting conspicuous raptors
- Helicopters are recommended for surveys in canyons and cliff sites. Helicopters are more slow-moving and highly maneuverable and therefore efficient for finding raptor nests compared to fixed-wing aircrafts. This should be considered in the objectives, survey design and budget of the project.
- Intercom (with spare batteries) and headsets
- Low power binoculars are recommended to minimize the effects of vibration (7x to 8x is best, probably no more than 10x)
- Topographic maps (sufficient to cover identified Study Area)
- Expandable file folders for map storage and dataforms
- Clipboards
- Coloured pencils, number 2 lead pencils, large eraser

Field procedures

Timing – nonbreeding season

Aerial surveys can be used to locate inactive nests in the non-breeding season. It may be easier to do this earlier in the year in areas where there are deciduous trees, as nests are often difficult to detect after the leaves flush due to the foliage density.

Timing – breeding season

- Usually aerial surveys are conducted to determine the presence or obtain an abundance estimate of active nests.
- Note that nests in aspen are particularly visible in early spring before leaf-out, and nests from previous years (often closely spaced) can alert ground or air surveyors to the fact that the area is used.
- Try and avoid surveying during inclement weather as to minimize risk to eggs or young in the nest and to allow for the best visibility for observers.

Presence/not detected

- Conduct surveys when birds are sitting on nests. This will provide presence/not detected information, especially if helicopter noise is sufficient to flush cliff-nesting raptors.
- If an occupied site is found then one survey of the Study Area will be enough.

Abundance

- Attempt to time the first flight late enough in the nesting season to decrease the potential for nest abandonment, yet still obtain a reasonable estimate of total active nests.
- If determining productivity is a goal then conduct subsequent flights to determine nesting success and productivity of previously surveyed nests when chicks should be present and assumed to have fledged. Surveys should include flights in late June to confirm late nestling survival (Witt 1996).
- Surveys designed to census more than one species (e.g. Bald Eagles and Ospreys) may compromise data collected on one or the other species, resulting in lowered estimates of density, site occupancy and productivity. Ideally, surveys will only census one species at a time.
- Since spring phenology varies among years, optimal survey timing also varies on a year to year basis.
- One method of refining survey timing would be to monitor several bald eagle and osprey nest sites on a proposed study area in the spring that are easily accessible from the ground or boat. This would enable an estimate of the dates of initiation of incubation, hatch and fledging, to ensure optimal timing of occupancy (early in the incubation period) and productivity (in the mid to latter part of the nestling period) surveys (Fraser *et al.* 1983).
- In populations that do not nest synchronously, it may be necessary to conduct more than one count of large chicks to more accurately estimate population productivity.

General

- Conduct surveys from 2 hours after sunrise to 2 hours before sunset to avoid contrasting and confusing shadows.
- A survey should last no more than 7 hours per day with a one-hour break period in the middle of the day.

Flight

- Before conducting the search, the observers should lightly trace the planned routes on maps. Flying transects within quadrats is the preferred technique to flying concentric circles.
- During the survey the navigator must chart the actual path flown on the map (this may differ from the planned routes) for later documentation.
- Low flights over potential nest sites should be avoided during courtship, egg laying or early incubation.
- Flights should be conducted at a minimum of 50 m above the nest height and between 30-130 km/h (Elliot *et al.* 1998, Anthony *et al.* 1999, Bowman and Schempf 1999, Jacobson and Hodges 1999, McIntyre and Adams 1999). Fixed wing and helicopter speeds differ but should be kept within this range. For species-specific variations in survey flight speed and altitude recommendations see Section 5, Species Accounts and Survey Notes.
- For cliffs, outcrops and high soil banks (preferred nesting habitat for a number of raptors) approach the Study Area along a path visible to the bird, permitting an incubating or brooding adult to leave unhurried.

- When an active nest is encountered, try to maintain a safe distance from the nest to minimize the risk of nest abandonment due to disturbance from the helicopter.

Observations

- The pilot may assist observers in locating birds/nests if s/he is comfortable doing so.
- Actively search all potential nesting habitat (rather than stare fixedly into a predetermined space).
- Record all raptor or nest observations directly on 1:20,000 maps or orthophotos. If raptors are at high density, tape-recorders can be used to record data.
- If a raptor or its nest is observed:
- Record plumage and behaviour of birds observed if known. This will be useful for interpreting breeding status.
- Record nest and site information on Nest Description Form (*Species Inventory Fundamentals No. 1 [Forms]*). This will include information such as location, whether the nest is active or inactive, nest condition, how many chicks or eggs are in the active nests (if possible); tree species and estimated distance from the top of the tree.
- Photograph each nest tree encountered (optional). It is best to take photos from all 4 cardinal directions to be able to examine tree structure and to assist in locating the nest tree in the future.
- Record the distance flown so that the number of raptors or active nests per km may be calculated.
- Transfer data from maps or tape-recorders to dataforms.

Supplementary Surveys

- For supplementary surveys refer to protocol outlined in the Boat, Foot, and Nest Survey sections (see Sections 3.10, 3.4, and 3.5, respectively).

Data analysis

Presence/Not Detected

- List the raptor species detected in a given Study Area. Indicate whether detections were based on active nest and/or bird observations.

Relative and Absolute Abundance

- Data only refers to the “abundance of breeding birds” as opposed to all birds. This is because estimation of abundance pertains only to the nesting population of raptors and does not count floaters or non-breeders. Thus it will always be negatively biased.
- The average density of occupied (active) nests for the project area in km^2 (area from quadrats).
- Lineal nesting density: number of occupied nests found per 100 km of shoreline. This is calculated based on the length of shoreline in major lakes (perimeter measurement) and rivers (lineal measurement) surveyed.

3.10 Boat Surveys

Boat surveys may be used to supplement aerial surveys in determining nest site locations of some conspicuous raptor species. Boat surveys follow water courses and survey the surrounding shoreline habitat with a look and see approach. Thus, the drawback to this method is that usually only the immediate shoreline is censused. For this reason, boat surveys are limited to censusing raptors which nest adjacent to the shoreline in trees (Bald Eagles, Ospreys, and Peregrine Falcons) or on cliffs in river canyons (Peregrine Falcons, Gyrfalcons, and Golden Eagles). During the non-breeding season, boat surveys may be used for locating Osprey, Bald Eagle and Golden Eagle nests.

Office procedures

- Review the introductory manual No. 1, *Species Inventory Fundamental* (RIC 1998).
- Obtain maps for Project and Study Area(s) (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). Any map that is used to record data must be referenced to NAD83.
- Outline the Project Area on a small to large-scale map (1:250 000 – 1:20 000).
- Determine Biogeoclimatic zones and subzones, Ecoregion, Ecosection, and Broad Ecosystem Units for the Project Area from maps.
- Delineate one to many Study Areas within this Project Area. Study areas should be representative of the Project Area if conclusions are to be made about the Project Area. For example, this means if a system of stratification is used in the Sampling Design then strata within the Study Areas should represent relevant strata in the larger Project Area.
- Compile a list which includes all potential raptors for the Study Area.
- Obtain 1:5 000 air photo maps for Study Area (if available). Identify on maps, potential cliffs where nests/birds may be located and the survey route (transect).

Sampling design

If using boat surveys as a supplement:

- If using boat surveys to determine a correction factor or to verify nest site locations as a supplement to an aerial survey, choose survey routes (transects) in areas where quadrats were flown. The Design Component for this survey is transects.

For stand-alone boat surveys:

- Stratify area by habitat or based on expected densities of raptors (low, medium or high). Randomly choose strata in which to conduct surveys.
    - If habitat or strata based inference is an objective, then equal survey effort between strata is recommended.
    - If detection of rare species is the objective then surveying strata with an expected high density is preferred.

General

- Choose survey transects that follow potential shoreline habitat for nesting raptors.

Sampling effort

Presence/not detected (for stand-alone boat surveys)

- If habitat or strata based inference is an objective, then equal survey effort between strata is recommended. If detection of rare species is the objective then surveying strata with an expected high density is preferred over surveying areas with lower expected density.
- Due to low detectability of raptors it is preferable to conduct survey more than once.
- It should be possible to determine presence but not necessarily absence by conducting one boat survey completely covering the area of interest during the breeding season, when adults are sitting on nests.
- Keep detailed notes on time spent observing, weather, and other factors that influence sightability to ensure that survey efforts are kept consistent.

Relative abundance

- Boat surveys are probably not as rigorous as aerial surveys for determination of relative abundance, since potential raptor habitat is surveyed less uniformly, and raptors are less likely to flush from areas with no aircraft noise. For this reason, boat surveys will probably need to be replicated frequently if they are to be used for relative abundance measurement.
- Power analysis packages, as described in Section 4 and in *Species Inventory Fundamentals* manual (Section 5, RIC 1998) will help in determination of optimal sample effort.
- Detailed notes on time spent observing, weather, and other factors that influence sightability should be taken to ensure that survey efforts are true replicates.

Personnel

- Boat operator must have the Small Boat Training Certification.
- The crew leader should be a qualified biologist with boating and raptor experience.
- Crew members should have some raptor experience.

Equipment

- Boat - sufficiently large enough to carry two to three workers, with a motor size of at least 20 horsepower. The boat must meet the minimum standards as contained in the Canadian Coast Guard Safe Boating Guide. This handbook is available free of charge from Transport Canada, Canada Customs and most marine dealers.
- Life Jackets for each crew member and operator
- Two-way Radios
- Topographic maps
- Waterproof map holders
- Binoculars of 7-10x for each crew member
- Spotting scope of 20x mounted on to a gun stock
- A noise making device such as a megaphone (used to startle birds off of the nest ledge)

Field procedures

- Follow the water courses (transects) to survey the surrounding shoreline habitat using a look and see approach in combination with various tactics to startle birds from their nests.

- Navigate the boat along transects to potential nest sites and turn off the motor if safe to do so.
- Scan cliffs (or tree tops) for signs of raptor activity. On cliff faces fecal wash is a tell-tale sign of raptor presence.
- As some raptors will ignore passing boats and may be missed in the census, periodically get out of the boat (if possible) and walk towards the nest cliffs; attempt to alert the birds to your presence (e.g., talking, and other noise makers).
- Boat surveys for Peregrine Falcons have been supplemented with loud noises (megaphones) around potential eyries to startle the birds off of their nests and make for easy detection (Munro 1988). When preparing a noise blast, have observers looking without aid of optics at the potential nest site. Once the noise has been made watch for any flushing birds.
- If a raptor is spotted:
- quickly view through the binoculars for species identification, age (plumage) and sex (if possible), and
- estimate the height of the raptor nest.
- For relative abundance
- record linear distance travelled along each transect so that the number of raptors/km can be calculated as a measure of effort.
- Keep detailed notes on time spent observing, weather, and other factors that influence sightability to ensure that survey efforts are true replicates.
- Transfer data from mapsheets to dataforms after boat surveys are complete.

Data analysis

Presence/Not Detected

- List the species detected in a given Study Area.

Relative abundance

- Number of raptors seen/heard along transect. Calculate number of raptors/km per stratum.

4. DATA ANALYSIS

4.1 Presence/not detected

The presence/not detected and relative abundance methods are nearly identical for aerial surveys, boat surveys, roadside surveys, and call playback surveys. If relative abundance surveys are replicated then a simple graph of species detected as a function of number of surveys will give an approximation of the efficiency of a single survey. This relationship can be analyzed (using regression analysis) to estimate approximate sample effort needed to detect species (with some restrictive assumptions). Techniques for determination of sample size for presence/not detected are outlined in *Species Inventory Fundamentals* manual (Section 5, RIC 1998).

4.2 Relative Abundance

It is important that the main assumptions of relative abundance surveys are clearly stated. The main assumptions are:

1. Identical or statistically comparable methods are used when comparison between areas or monitoring trends in one area over time is an objective of inventory effort.
2. Environmental, biological, and sampling factors are kept as constant as possible to minimize differences in survey bias and precision between surveys.
3. Surveys are independent; one survey does not influence another.

If these assumptions are met then each replicate survey should show (on average) the same relative bias allowing calculation of trends and comparison between areas. A great number of methods are proposed for relative abundance estimation. It is important that biologists understand that these methods are not interchangeable and therefore studies should be designed with consistent methods across areas and through time.

The quantification of sampling intensity and effort is fundamental to the use of indices and relative abundance measures. This way the assumption of equal bias of surveys between areas and over time can be met. In addition, the usefulness of indices depends on the precision of estimates. It is strongly recommend that power analysis procedures be integrated into the study design of all these techniques. As described in *Species Inventory Fundamentals* manual (Appendix G, RIC 1998), programs such as MONITOR, POWER AND PRECISION, and NQUERY are user friendly, and can easily be used in an adaptive fashion to calculate sample sizes needed for the desired analysis questions.

It is important to remember that each of the relative abundance techniques proposed will have unique features that affect sample bias and sample precision. Therefore, power analysis and statistical analysis should be done for each method individually. If studies are designed appropriately the following general analysis methods can be used (Table 5).

Table 5. RIC objectives and analysis methods for relative abundance data

Objective	Analysis method[1]	Programs[2]
• Trends in abundance over time	• Sample methods • Regression techniques • Power analysis	• Generic statistical packages • MONITOR
• Comparison in abundance between areas	• ANOVA-type methods • Power analysis	• Generic statistical packages • Power analysis software
• Determine whether habitat modifications have altered population size	• ANOVA type methods • Power analysis	• Generic statistical packages, RT • Power analysis software

[1]See *Species Inventory Fundamentals* manual (Section 5, RIC 1998) for more details on analysis techniques.
[2]See *Species Inventory Fundamentals* manual (Appendix G, RIC 1998) for more detail on software packages.

Appropriate analysis of strata: If comparison of areas and detection of trends is an objective of efforts, then each strata should be analyzed separately or as different factors in an ANOVA rather than pooling strata which may differ markedly in terms of counts obtained. A key assumption of parametric methods is similarity of samples in terms of variance, and also a normal distribution of counts. Therefore, a sample design that groups similar habitat areas and densities into strata is best for these tests. If low density strata are combined with high density strata, a highly non-normal distribution of counts would result which would make analysis using parametric methods more difficult.

Difficulties with count data: One inherent problem with count data is that it is rarely normally distributed making the applicability of parametric methods with raw data risky, especially if sample sizes are low. Before data are used in parametric tests the assumptions of normality, equal variances, and independent samples should be investigated.

Trend analysis: The basic method for the determination of trends is linear regression. There are a variety of refinements to linear regression techniques that can be used with data dependent on sampling assumptions and other characteristics of the data.

Comparison between areas: A variety of statistical methods can be used to compare areas if surveys are conducted concurrently. If surveys are conducted non-concurrently (such as in different years) then the results might be biased by population fluctuations and the variance among years is confounded with the variance among areas.

Habitat based inference: Logistic regression or similar methods can be used to describe habitat associations but this approach requires that habitat units be the primary sample unit as opposed to population units.

4.3 Absolute Abundance

Inferences about recruitment, and other life history parameters might be made indirectly by the determination of the number of breeding pairs in absolute abundance studies. However, banding and nest observation would be needed to estimate life history parameters accurately. Otherwise, the statistical techniques described in the relative abundance section pertain to analysis of absolute abundance data.

5. SPECIES ACCOUNTS & SURVEY NOTES

5.1 Introduction

The following sections provide some introductory life history characteristics of raptors, which are relevant to surveying these birds. To be effective, the techniques described will require repeated practice in the field.

Each page in these species accounts is designed to provide a relatively quick reference to those details directly related to finding the bird, or some feature related to the bird, rather than identification alone. For identification purposes, references to the birds in some of the more common identification and life-history handbooks[1] (with page numbers) are provided below the species name and code.

The species account section includes a species description, information on the species diet, breeding, and preferred habitat[2] within breeding and non-breeding areas of the province. The next section contains species-specific survey notes including information on how to locate nests and the possible risks to species and surveyor. Although many details are given here, it is recommended that a thorough literature search be undertaken for the species or species group that is to be inventoried. Citations given in the text of this document will give a broad base to the literature review but are not exhaustive.

Information was obtained from the field guides and life-history handbooks listed below as well as Cannings *et al.* (1987), Ehrlich *et al*. (1988) and Campbell *et al*. (1990).

[1]Field guides and life-history handbooks listed by abbreviations:

BoBC = The Birds of British Columbia, Vol. II Nonpasserines (Campbell *et al*. 1990).

BH = The Birder's Handbook (Ehrlich *et al*. 1988).

NGS = National Geographic Society Field Guide to the Birds of North America (Scott, ed. 1983).

PWB = Peterson Field Guides Western Birds (Peterson 1990).

HAWK = Peterson Field Guides Hawks (Clark and Wheeler 1987).

PGNAR = A Photographic Guide to North American Raptors (Wheeler and Clark 1996).

[2] Ecoprovince abbreviations used in habitat section:

Coast and Mountains - CAM; Georgia Depression - GED; Southern Interior - SOI; Southern Interior Mountains - SIM; Central Interior CEI; Sub-boreal Interior - SBI; Northern Boreal Mountains - NBM; Taiga Plains -TAP; Boreal Plains - BOP.

5.2 Turkey Vulture and Osprey

5.2.1 Turkey Vulture B-TUVU *Cathartes aura*

BoBC–8; BH–216; NGS–182; PWB–182; HAWK–15; PGNAR–1

Species Description

Plumage: The Turkey Vulture is black overall, with light grey to silver flight feathers. Feathering in the neck area often appears iridescent. The head is red and naked and the legs are pinkish. The two-toned underwing of this bird is distinctive; silvery flight feathers may appear white against the black underwing coverts.

Immature: Young have a dark beak and a dark grey fuzzy head, which turns first pink, then red.

Flight: This long narrow bird flies almost entirely by soaring or glidingwith wings held in a strong dihedral (Kirk and Mossman 1998). The tail appears long and slim. In flight the bird may appear to be rocking or teetering on its wings.

Distinguishing Features: Though the Turkey Vulture is nearly eagle size, its diminutive head and slim tail are distinctive, as is the V-shaped flight silhouette and two-toned underwing.

Voice: Normally silent, but may grunt or hiss when disturbed.

Habitat

In British Columbia, the Turkey Vulture tends to breed as a solitary pair, often in isolated locations (such as remote cliffs, caves and forests) along the southern inner coast of the province and in the Okanagan Valley. The Turkey Vulture is distributed across the extreme southern part of the province, and is most abundant in the Georgia Depression (ecoprovinces: GED, SOI).

The Turkey Vulture is a rare winter resident. In winter, the southern tip of Vancouver Island is a staging area for migrating Turkey Vultures, which gather there in the hundreds in tall conifers. It is most often seen soaring in the air over bluffs, cliffs, and open country.

Diet

The Turkey Vulture eats carrion of any kind.

Locating Nests

Nest sites are often reused and most sites in British Columbia are known. These sites and other potential nesting habitats can be surveyed using spotting scopes early in the breeding season (April to May) when the display flights of the birds are at their peak. Egg laying is from early April to late June and young are at the nest from early May to early September. Nests are found in areas with rocky outcrops and cliffs with protected crannies, sometimes in mixed forest. Most nests in British Columbia and throughout its range in North America have been found in caves or crevices in rock cliffs (Kirk and Mossman 1998). Occasionally, tree nests in a suitable snag have been used and one tree nest was found in British Columbia in a mixed forest of Douglas-fir, Garry oak, and arbutus (Campbell *et al.* 1990). Nests have been

found on the ground and up to 34 m high in cliffs.

Survey Notes

The RIC recommended methods for surveying the Turkey Vulture are roadside surveys during the breeding season and migration surveys during the non-breeding season. Migration in British Columbia peaks in early September and goes until late October (Campbell *et al.* 1990).

Like other soaring raptors, the Turkey Vulture may remain perched in early morning until the air warms. Surveys should take into consideration appropriate weather and time of day for best viewing soaring birds. That is, soaring occurs as the land is warmed by the sun, creating thermals of rising warm air. On most clear days, this will occur from mid-morning onwards. The Turkey Vulture performs conspicuous aerial and ground displays prior to the onset of breeding. These display flights take place in the nesting area. During incubation, adults become inconspicuous; there is very little display activity observed during the first seven weeks of nesting (Davis 1983).

5.2.2 Osprey B-OSPR *Pandion haliaetus*

BoBC–10; BH–242; NGS–200; PWB–184; HAWK–21; PGNAR–9

Species Description

Plumage: The Osprey has dark brown upper parts and is white below with black markings on the wing linings at the wrists. The head is white with a dark eye stripe and crown. Females often display a 'necklace' of dark streaking on the breast.

Immature: Juveniles are similar to adults, but display more streaking on underparts, and pale feather edges on the back.

Flight: Large (Raven-sized) birds with long, narrow wings that have a pronounced crook at the wrist, giving birds a 'gull-like' look in flight. The Osprey often soars with wings raised at the elbow and drooped at the tips. In flight, the head appears small.

Distinguishing Features: The dark wrist patches and eye stripes of this bird are good field marks.

Voice: The most common call, used by both sexes, is described as *w-cherk w-cherk w-cherk*, and alarm calls are a single-syllable *piu piu piu* uttered in rapid sequences (Beebe 1974), or *kip kip kip kiweek kiweek*, or a whistling *kyew, kyew, kyew.*

Habitat

The Osprey is almost always found near water. In coastal areas it is found in lagoons, inlets and bays, and elsewhere near lakes, rivers and sloughs. The Osprey is widely distributed throughout British Columbia, most often breeding south of latitude 56º N (Campbell *et al.* 1990), (ecoprovinces: CAM, GED, SOI, SIM, CEI, SBI, NBM, BOP).

In non-breeding seasons it is present in low numbers in the southern parts of province; associated with open bodies of water (ecoprovinces: CAM, GED, SOI).

Diet

The Osprey eats fish, which it captures by plunging into the water and grasping the fish with its talons.

Locating Nests

Nests are generally large, obvious structures of twigs, sticks and branches, which are added to year after year. They are built near the tops of trees (most often dead trees) near water, and in trees on wooded islands, but also on cliff ledges or boulders. Nests are also often situated atop human structures in and near lakes and rivers, such as pilings, power poles, wharves and navigation lights. The Osprey sometimes reuses nests for many consecutive years. This bird often indicates an active nesting area, as it is very vocal near nest sites, particularly during courtship. Flight displays occur in early spring when the Osprey returns to nest sites and consists of dives, plunges, and fish carrying and hovering while calling. Egg laying is from mid-April to early July and young are at the nest from late May to early September.

Osprey are distinct from others raptors by their ability to accept artificial nest platforms. This is a widely accepted practice throughout North America. If recommendations for artificial platforms are deemed necessary, Ewins (1994) (a construction manual for artificial platforms) and Witt (1997) may be considered for potential platform designs. If platforms are present in the study area(s) and need to be considered in the survey design, Witt (1997) has conducted surveys, which incorporated this into the survey design and in the statistical analysis.

Survey Notes

The RIC recommended methods for surveying the Osprey are aerial and boat surveys for nests during the breeding and non-breeding season and migration surveys during the non-breeding season.

Aerial surveys

- When surveying for ospreys stratification of quadrats based on expected raptor densities is often based on the number of kilometres of shoreline within each quadrat (Grier 1977, Hodges *et al.* 1984).
- Fly survey routes at speeds between 30-80 km/hr within 100 m of the shoreline and 50-200 m above the treetops.
- Helicopter flights should be flown a minimum of 50 m above the nest and should be terminated if birds are becoming agitated. Confirmation of nest occupancy can be determined on a later flight during the nestling stage when young are visible from a greater distance.
- If a nest site is not seen to be occupied during the time the aerial survey is taking place, the origin of a nest site can be determined primarily by the location of the nest in the tree and the size and shape of the nest. Bald eagle nests are typically larger and cone-shaped, and are located below the crown; Osprey nests are typically smaller and rounder, and are located at the top of the tree (Mathisen 1968).

5.3 Eagles

5.3.1 Common ID Problems: Eagles

Immature Bald Eagles and Golden Eagles are commonly misidentified and their ranges frequently overlap, particularly during periods of migration. Refer to Table 6 below for the most diagnostic features to use in the field to identify these species. Note that the Bald Eagle has five recognizably different plumage patterns that are associated with age classes (Table 7).

Table 6. Diagnostic features to use to identify eagles in the field.

	Head Projection	Plumage
Bald Eagle	Head projects in front of the wings more than half the length of the tail.	Underneath white feathers found on the body and under wing coverts.
Immature Bald Eagle		Un-feathered lower tarsi.
Golden Eagle	Head projects in front of the wings less than half the length of the tail.	Underneath white/grey feathers only found in a blotch under the primaries. Completely feathered lower tarsi, unlike above.
Immature Golden Eagle		Distinguished from above by a distinct white tail with a broad black band and white markings on the wing at the base of the inner primaries and outer secondaries.

Table 7. Bald Eagle plumage patterns that are associated with age classes.

Classes	Age	Plumage Characteristics
Juvenile	1 year	Overall dark brown, dark belly (often tawny), some white paneling on underwings. Dark bill and cere, tail longer and wider than adults.
Basic 1	2 years	Overall dark brown inverted light coloured “triangle shaped” area in the centre of the back. White paneling on underwings, large white areas on belly. Rough edge on trailing edge of wing. Dark eyes, beak and cere.
Basic 2	3 years	Same as BASIC 1. With yellowish bill and cere. Smooth trailing edge of wing.
Basic 3	4 years	Similar to adult but dark streaking on head, often with a dark eyestripe. Immature tail with white mottling.
Adult 1st	5 years	Characteristic dark body with white head and tail. May have eyestripe, may have dark band on tip of tail. Some whitish feathers still visible underneath.

5.3.2 Bald Eagle B-BAEA *Haliaeetus leucocephalus*

BoBC–14; BH–220; NGS–184; PWB–180; HAWK–81; PGNAR–116

Species Description

Plumage: The adult is chocolate brown with a white head and tail. The legs are orange yellow.

Immature: Young are dark brown with highly variable white mottling. They have longer tails and wider wings than adults. They have a dusky head and tail and a dark bill. The body, wings, and tail of juveniles are marked with dirty white. All non-adult plumage has white breast spotting and white diagonal lines on the underwing.

Flight: As with the Golden Eagle its great size and long wings set it apart from all other raptors. The proportionately large head of the Bald Eagle protrudes beyond the body more than half of the tail length. The tail is short, and the wings appear uniformly wide, almost rectangular. The Bald Eagle soars with flat wings, and flies with slow, powerful wingbeats. It is usually associated with water.

Distinguishing Features: The large head and bill of the Bald Eagle are distinctive in flight.

Voice: Makes harsh, squeaky chitters and screams.

Habitat

The Bald Eagle is usually associated with aquatic environments including seashores, lakes, rivers and marshes. Migration occurs along seacoasts and river valleys, and large aggregations of birds occur in fall and winter (ecoprovinces: CAM, GED, SOI, SIM). It can be found in salmon spawning areas and near areas of surface-feeding fish on the ocean in summer.

Dense populations of eagles nest on the Queen Charlotte and Gulf Islands, however, they do breed throughout the rest of the province (Campbell *et al.* 1990), (ecoprovinces: CAM, GED, SOI, SIM, CEI, SBI, TAP, NBM, BOP).

Diet

The Bald Eagle has a varied diet that includes fish and waterfowl. It also scavenges kills from other birds and fishing boats, and this opportunist will eat any available carrion.

Locating Nests

Nests are massive, cup shaped platforms, constructed of dead sticks and branches placed in the crotch or crown of the tree near the trunk. They are lined with grass, moss, bark, or conifer boughs. Nests are primarily found in coniferous forests near water. Large trees are important for nesting and roosting birds. Most nest sites have an unobstructed view of the surrounding landscape. Coastal nest sites are typically in live or dead trees including Douglas-fir, western red cedar, western hemlock, lodgepole pine, and black cottonwood. Interior nests have been found in black cottonwood, trembling aspen, and balsam poplar (Campbell *et al.* 1990, Buehler 2000). The Bald Eagle also occasionally nests on cliff ledges, and it has been known to nest on the ground on islands without trees.

Local residents and wildlife clubs often know of nest sites, so they should be contacted about nest locations before an extensive survey is conducted. For example, the Conservation Data Centre has maps of many Bald Eagle nests. If no prior knowledge is available, look for nests in the larger trees close (< 200 m) to water. Eagle pairs will evenly distribute along lakes, rivers or shoreline if nest sites and available food permit. As nest sites are approached, eagles will indicate a nest is near by circling and uttering a weak, gull-like alarm call. Egg laying is from early February to late June and young are at the nest from early April to early September.

Risks

The Bald Eagle is very sensitive to human activity. An eagle disturbed in feeding areas tends to leave and not return for several hours after human disturbance ceases (Stalmaster and Newman 1978). It is also easily disturbed in nesting areas, and will sometimes abandon nests disturbed at egg stage, or move to a new location in succeeding years.

Survey Notes

The RIC recommended methods for surveying the Bald Eagle are aerial surveys for nests and boat surveys during the breeding season, and migration surveys during the non-breeding season.

Aerial surveys

- When surveying for eagles stratification of quadrats based on expected raptor densities is often based on the number of kilometres of shoreline within each quadrat (Grier 1977, Hodges *et al.* 1984).
- Fly the survey route at speeds between 60 and 100 km/hr within 100 m of the shoreline and 20-100 m above the treetops (Bowman and Schrempf 1999, Jacobson and Hodges 1999).
- Helicopter flights should be flown a minimum of 50 m above the nest and should be terminated if birds are becoming agitated. Confirmation of nest occupancy can be determined on a later flight during the nestling stage when young are visible from a greater distance.
- If a nest site is not seen to be occupied during the time the aerial survey is taking place, the origin of a nest site can be determined primarily by the location of the nest in the tree and the size and shape of the nest. Bald eagle nests are typically larger and cone-shaped, and are located below the crown; Osprey nests are typically smaller and rounder, and are located at the top of the tree (Mathisen 1968).
- Surveys should be conducted at least twice throughout the breeding season to ensure breeding success for a nest or nesting territory (Elliot *et al.* 1998, Gende *et al.* 1998, Anthony *et al.* 1999). First flights range from late March in the Georgia Basin to late April early May in the northern areas of the province. Second flights should be timed to count nestlings 5-8 weeks old before they fledge but when survivorship is higher (Elliot *et al.* 1998, Gende *et al.* 1998, Anthony *et al.* 1999).
- For verifying survey results detection rates applicable for coastal British Columbia can be found in Bowman and Schempf (1999).

Boat surveys

- Look for the white heads of adult birds standing out like a beacon from the dark forest foliage. Sightings of birds perched regularly in the same location over a number of days (March to April) often indicate an active territory or nest.
- Boat surveys can be conducted simultaneously with aerial surveys to help determine detection rates making survey results more precise.

5.3.3 Golden Eagle B-GOEA *Aquila chrysaetos*

BoBC–44; BH–218; NGS–184; PWB–180; HAWK–88; PGNAR–123

Species Description

Plumage: The adult Golden Eagle is evenly dark below, occasionally with a slight lightening at the base of the tail. The crown and nape are golden and the tail is slightly banded grey and brown.

Immature: Young seen from below have white markings on the wing at the base of the inner primaries and outer secondaries. They have a white tail with a broad dark terminal band.

Flight: Flat -winged gliding and soaring are characteristic of the Golden Eagle, though this bird sometimes soars with slightly upraised wings. Its great size and long wings set it apart from all other raptors except the similar sized Bald Eagle. In certain lights, the golden wash on the hind neck is discernible as the bird soars. The head of this bird projects less than one half the tail length. Flight displays occur in spring, and are mostly silent, sometimes accompanied by faint mewling cries.

Distinguishing Features: The head of the Golden Eagle projects less distance from the body than that of the Bald Eagle. The legs are feathered to the toes. The young Golden Eagle's sharply banded tail is distinctive. Young only rarely have white spotting on the body or wing coverts.

Voice: Typically silent, will occasionally make a yelping bark or *kya.*

Habitat

The Golden Eagle forages in a variety of open habitats from mountain slopes to valley and prairie pastures. In general, it is a bird of hilly country, found near open sloping terrain. In winter it moves to lower elevations. Migration is not well known. The Golden Eagle is found throughout the interior of the province, the Fraser Lowlands, and the east coast of Vancouver Island. Greatest numbers occur in the Northern Boreal Mountains ecoregion (ecoprovinces: CAM, GED, SOI, SIM, CEI, SBI, NBM, BOP).

Breeding takes place in mountainous areas, along deep river canyons, and on large coastal islands (Campbell *et al*. 1990), (ecoprovinces: CAM, GED, SOI, SIM, CEI, SBI, NBM, BOP).

Diet

The Golden Eagle preys upon mammals, including hares, ground squirrels and marmots. It will also scavenge dead animals, including road kills. This large raptor often hunts from a soaring position, using air currents and updrafts along sloped terrain.

Locating Nests

Nests are generally on cliff ledges, but also in trees, on bluffs and in caves. Tree nests have been found in Douglas-fir and ponderosa pine. Nests are large, built of thick branches and sticks and lined with green boughs, grasses, bark, and moss. The Golden Eagle is very shy of humans, and tends to sneak away from nesting territories rather than betray its presence (Beebe 1974). Therefore, the use of a spotting scope should be used to ascertain if a nest is present and active. Egg laying is from late March to early June and young are at the nest from early May to late August. Nests and nest sites are regularly reused and since good sites may contain several old nests, local wildlife organisations should be contacted before surveying new areas. Cliff nests will be streaked with whitewash. In places where whitewash accumulates, there is often growth of distinctive orange lichen, which can serve as a nest or perch site marker for this and many other cliff-nesting species.

Survey Notes

The RIC recommended methods for surveying the Golden Eagle are aerial surveys for nests, boat surveys during the breeding and non-breeding season, and migration surveys during the non-breeding season.

Despite their large size, the Golden Eagle is typically found only in more remote habitats (mountain/tundra) and therefore populations may go unnoticed even when they are relatively abundant within a region. Within a region their population density and productivity may both be relate to the abundance of prey, and consequently to cycles in prey density. Flight displays near nest areas are frequently seen in the spring, these displays are mostly silent, but occasionally are accompanied by faint mewling cries.

Aerial surveys

- Aerial surveys are more effective for estimating nesting populations than extrapolating based on numbers of adults seen soaring from below. Long-occupied territories may contain several old nests.
- When surveying for eagles stratification of quadrats based on expected raptor densities is often based on the number of kilometres of shoreline within each quadrat (Grier 1977, Hodges *et al.* 1984).
- Surveys should be conducted at least twice throughout the breeding season to ensure breeding success for a nest or nesting territory (McIntyre and Adams 1999). The first should be conducted before hatching and after laying in late April/early May. The second should be conducted when chicks are >51 days old but before fledging in late July/early August.
- Surveys should be flown at 30-40 km/hr with periodic hovering and a minimum of 65 m should be maintained between the helicopter and nest structures (McIntyre and Adams 1999). Flights should be terminated if the birds become agitated. Confirmation of nest occupancy can be determined on a later flight during the nestling stage when young are visible from a greater distance.

5.3.4 Northern Harrier B-NOHA *Circus cyaneus*

BoBC–22; BH–226; NGS–188; PWB–170; HAWK–35; PGNAR–28

Species Description

Plumage: The adult male and female Northern Harrier are strikingly contrasting in plumage marking and size. The adult male is grey above, and mostly white below, with black wingtips. The female is brown above and whitish below, with brown streaking. Both sexes have a white rump patch. Females are noticeably larger than males.

Immature: Juveniles resemble females but are rich rufous brown in colour below and streaked only on the breast. In their second year males will have the characteristic basic plumage of mature male birds, but will also have many scattered immature rufous feathers especially on the back.

Flight: A medium sized hawk, the Northern Harrier has a slim body, and the wings and tail are long and narrow. Wings are held above the body in flight (dihedral). Northern Harriers glide buoyantly and unsteadily, and hunt with a slow, quartering flight. These birds generally perch and fly low to the ground, rarely soaring.

Distinguishing Features: The white rump patch is distinctive. This bird has an owl-like facial disk - the dark head of the female appears hooded. The dark wingtips of the male are distinctive when the bird is seen flying overhead.

Voice: Nest alarm call is a rapid, nasal, *ke ke ke ke ke.*

Habitat

The Northern Harrier frequents almost any type of open territory. It uses marshes, fields, grasslands, and meadows. It will also use human-altered habitats like airports, agricultural fields and golf courses. The Northern Harrier is widely distributed throughout British Columbia. In winter, large numbers can be found in the Fraser Lowlands. During the spring and fall, migrating birds can be seen flying above all types of habitat (ecoprovinces: CAM, GED, SOI, SIM).

The Northern Harrier nests in a variety of habitats including savannahs, sloughs, marshes, open fields and burns (ecoprovinces: CAM, GED, SOI, SIM, CEI, NBM, BOP).

Diet

Voles and mice are the main food of the Northern Harrier but it will also take other small mammals and birds.

Locating Nests

The Northern Harrier courtship displays can be seen over nest areas in April and May, with both birds are circling over the nest area. Two birds at a site are indicative of a breeding territory. Egg laying is from mid-April to early July and young are at the nest from mid-May to early August. Perch sites are low to the ground: stumps, fence posts, hummocks or low trees. Pellets can be seen at the base of these sites in occupied territories.

Nests are found on the ground in the open, often in areas of bulrush and cattails. The nests are concealed by shrubs, reeds, or grasses and are often on a raised hummock surrounded by water (Campbell *et al.* 1990). The location of Northern Harrier nests requires careful observation of the female's behaviour. Nests are best located in the early nestling period, mid-May to mid-June. Females will fly off the nest to preen in the very early morning. Once the chicks have hatched, prey deliveries are key to locating the nest. The male will fly in to the nest area with food. The female Northern Harrier flies off the nest to meet the male, and the transfer of prey items takes place in the air. The female then returns to the nest. These activities are best observed from afar, when birds are unaware of the viewer's presence. Once the general nest area is ascertained, it is a matter or walking along a sight line or bearing towards it. Alternatively if hand held radio transmitters are available, then the observer who has pinpointed the nest location can walk another observer in to the nest site. This is best accomplished when the female is sitting; if both birds are circling and calling in the air the nest will be difficult to find. Otherwise, walk in to the suspected location until the female flushes (often not until the surveyor is a metre or less from the nest itself). In later stages of nesting, chicks will 'run' from the nest to hide in nearby vegetation. The Northern Harrier will chase off other predators who stray into the nest area.

Risks

The Northern Harrier rarely, but occasionally, hits humans when approaching nests. Ground-nesting species are particularly vulnerable to predation. Time spent by humans in the nest area must be kept at a minimum, as calling and diving Northern Harriers may alert predators to nest location.

Survey Notes

The RIC recommended methods for surveying the Northern Harrier are roadside surveys during the breeding and non-breeding season and migration surveys during the non-breeding season.

5.4 Accipiters

5.4.1 Common ID Problems: Accipters

From central British Columbia south to the United States border there is the possibility of encountering all three species of accipiter, and further north both Northern Goshawks and Sharp-shinned Hawks can be present in the same area. It is therefore important to know the characteristics that will distinguish between these very similar looking species.

Sharp-shinned Hawk versus Cooper's Hawk

The Sharp-shinned Hawk is the smallest accipiter found in British Columbia, but females are comparable in size to male Cooper's Hawks. Both adults and juveniles of each species have very similar plumage patterns, and the subtle differences between them are often difficult to discern in field.

In flight or perched the Sharp-shinned Hawk has angular corners to the tail, while the Cooper's Hawk has rounded corners. With experience, it becomes apparent that the extension of the head in front of the wings in the Cooper's Hawk is noticeably further than that of the Sharp-shinned Hawk.

Northern Goshawk versus Cooper's Hawk

This bird is larger than Cooper's Hawk and the plumage of the adults is distinctive with a light grey breast, a slate grey back and a white eyestripe which contrasts with their dark crown.

Accipiters in Flight

In flight all three birds have very similar shapes, which makes it difficult to identify the birds when seen high in the sky, where no reference to scale can be gained. In this situation one of the key aids to identification is the appearance of the flight itself.

Accipiter Species	Flight
Sharp-shinned Hawk	Buoyant, rapid flight.
Cooper's Hawk	Heavier, slightly slower flight.
Northern Goshawk	Fast, powerful, minimal wing flapping.

5.4.2 Sharp-shinned Hawk B-SSHA *Accipiter striatus*

BoBC–24; BH–226; NGS–190; PWB–172; HAWK–38; PGNAR–32

Species Description

Plumage: The adult Sharp-shinned Hawk is dark blue grey above. Its white underparts are barred with rufous or cinnamon. The crown of the head is slate or dusky grey, blending into the back. The undertail coverts are white. Straight dark bands with a thin white terminal band cross the tail. Females are separably larger. For a similar sized species refer to the Merlin description.

Immature: Young are brownish above, with minimal white mottling. The underparts are streaked with tear-shaped reddish brown markings.

Flight: The Sharp-shinned Hawk is the most buoyant, fast flying of the accipiters. Like the others it flies with several quick wingbeats and a glide. Sharp-shinned hawks have the typical long tail and rounded wings of an accipiter, but although they are the smallest, they are also the most robust of the family. Thus in flight they have a chunky appearance.

Distinguishing Features: The tail of the Sharp-shinned Hawk can be distinguished from that of the remarkably similar Cooper's Hawk because the Sharp-shinned Hawk's tail is square or notched at the tip when folded, and even when fanned shows the presence of 'corners'. When gliding, the head of the Sharp-shinned Hawk does not extend far beyond the wrists.

Voice: Alarm is a high, shrill *kik kik kik kik*. It is similar to that of the Northern Goshawk, only much higher in pitch.

Habitat

The Sharp-shinned Hawk is primarily found in semi-open and forested areas, most commonly frequenting dense immature stands with an open understory. Breeding is more common at higher elevations, and also near water sources, including creeks, bogs, and lakes. This species is widely distributed throughout British Columbia, breeding throughout the province (ecoprovinces CAM, GED, SOI, SIM, CEI, TAP, NBM, BOP).

Wintering areas are along the southwestern coast of Vancouver Island, the Fraser Lowlands and the Okanagan valley (Campbell *et al.* 1990). The Sharp-shinned Hawk is very common during migration (ecoprovinces: CAM, GED, SOI, CEI).

Diet

The Sharp-shinned Hawk preys primarily on small passerine birds and some small mammals. The alarm calls and mobbing action given by such birds often indicates that a Sharp-shinned Hawk is in the area. During its nesting period it takes a high proportion of its diet in passerine nestlings from open cup nests and fledglings (Bildstein and Meyer 2000).

Locating Nests

Generally the habitat is indicative of the nesting area of this particular accipiter. Ground searches of the area should then be conducted to locate plucking sites, which are commonly

found on low-lying logs or stumps, scattered around the nest area. Another sign is whitewash streaks, which although similar within the accipiter group, are smaller for Sharp-shinned Hawks. Nests are built of small twigs and are up to 30 cm in diameter. Nests are usually well concealed near the base of the canopy and placed next to the trunk of a tree, usually less than 6 m from the ground. However, on Vancouver Island nests have been observed as high as 30 m above ground (E. McClaren pers. obs.). The species' secretive nature and dense vegetation of its nesting habitat make it difficult to find and study during the breeding season (Bildstein and Meyer 2000). Egg laying ranges from late May to early July and young are at the nest from June to mid-August.

Risks

Disturbance of breeding birds should be kept to a minimum, therefore limit searching for nests until after the young have hatched.

Survey Notes

The RIC recommended method for surveying Sharp-shinned Hawks is call playback during the breeding season. Additionally, standwatches may be used to supplement call playback surveys and to aid with locating nests during the breeding season. Migration surveys can be used during the non-breeding season, when the bird is best seen and large numbers of individuals concentrate along major migratory corridors and bottlenecks (Bildstein and Meyer 2000).

Call playback surveys

- Although playback has been recommended as a survey method for Sharp-shinned Hawks, not all birds will respond. (Do not use for relative abundance).
- Timing
  - It is important to note that some raptor species have more than one call and they will respond to these calls differentially, depending on the time of year.
  - Conduct surveys from daybreak to sunset.
- Interstation Distance
  - Distance between call playback stations suggested by Mosher *et al.* (1990) for Sharp-shinned Hawks is 0.8 km.

5.4.3 Cooper's Hawk B-COHA *Accipiter cooperii*

BoBC–26; BH–228; NGS–190; PWB–172; HAWK–41; PGNAR–35

Plumage: The Cooper's Hawk is dark blue-grey above. The white underparts are barred with fine rufous markings. The tail is crossed by straight dark bands and has a broad white terminal band. The blackish crown of this bird contrasts with its pale nape and grey back.

Immature: Young are brownish above, often spotted with white on the back, and creamy below, with brown streaks. They are distinct from those of the Sharp-shinned because this streaking is neat and fine, and restricted to the chest area.

Flight: The Cooper's Hawk is crow-sized. Its shape is characterized by short, rounded wings and a very long rounded tail. In flight, the head of the bird protrudes well ahead of the wings. It flies with the typical five-flaps-and-a-glide flight of the accipiter (Beebe 1974). Wing beats

are slower than Sharp-shinned Hawks, and flight movements appear almost stiff. Cooper's Hawks will also soar frequently, particularly in the early part of the breeding season. When hunting, this hawk flies beneath the tree canopy, close to the ground, but may be seen flying above the canopy when carrying prey.

Distinguishing Features: The best field marks for the Cooper's Hawk are the rounded tail, dark crown, and the broad white terminal band on the tail. This bird is larger than the Sharp-shinned Hawk and smaller than the Northern Goshawk, however this is often very difficult to distinguish when the bird is seen in the field.

Voice: Alarm call is a harsh, raspy *cac cac cac cac*.

Habitat

The Cooper's Hawk uses a wide range of habitat, but are usually found in mixed deciduous/coniferous forests. It is relatively tolerant of human disturbances and habitat fragmentation; it breeds in urban settings such as parks and golf courses, and in winter is sometimes found in gardens, particularly in the vicinity of bird feeders. The Cooper's Hawk is found breeding throughout the southern half of British Columbia, including Vancouver Island (ecoprovinces: CAM, GED, SOI, SIM, CEI).

In winter, many of the birds move south but some birds overwinter in the southern part of the province. The Cooper's Hawk is observed most often on southern Vancouver Island, the Fraser Lowlands and the Okanagan in mixed habitats (ecoprovinces: CAM, GED, SOI, SIM).

Diet

The Cooper's Hawk primarily preys on passerines, but will take any birds ranging in size from chickadees up to pheasants and mallards (Beebe 1974).

Locating Nests

Courtship displays begin from mid-April to early May, and on sunny days both male and female birds can be seen soaring and diving over the nest area, with both sexes often flying with slow, exagerated wing beats, and fanned undertail coverts (Rosenfield and Bielefeldt 1993). These displays are brief; the birds then drop into the trees (Beebe 1974). Nest building or repair also takes place during this period. Egg laying is from late April to late July and young are at the nest from early June to late August.

The Cooper's Hawk generally nests in the same area each year, and sometimes in the same nest. Preferred nest areas often contain several old nests. Nests in deciduous trees are most easily identified before leaf-out. Most nests that have been located in British Columbia are in coniferous trees, but the top three species are Douglas-fir, birch, and black cottonwood (Campbell *et al.* 1990). Nest heights are generally 8–15 m, and nests are often in a tree crotch close to the trunk. Nests are made of twigs and are flat-topped with a shallow cup, and can be distinguished from other hawk nests because they are often lined with bark flakes (Craighead and Craighead 1969). Many breeding Cooper's Hawks are inconspicuous, neither vocalizing nor behaving aggressively in human presence. Instead, they will sometimes silently leave the nest vicinity when it is approached (Rosenfield and Bielefeldt 1993). Plucking sites are usually within site of the nest, usually on a large horizontal limb or on a low stump or leaning

log. Listening for the alarm calls of its avian prey can also indicate the possible presence of these hawks.

See below for use of the dawn vocalization technique in locating nests during the pre-incubation stage (Stewart *et al.* 1996). Rosenfield *et al.* (1985) found broadcasting conspecific calls useful for eliciting responses and as an aid in finding nests of breeding Cooper's Hawks. They found that broadcasts during pre-incubation (from the time of arrival at nesting areas until egg-laying) and post-incubation (nestling to fledgling period) were more likely to elicit a response and thus lead to the discovery of a nest than broadcasts during incubation. This is likely due to the fact that males spend more time away from the nest and females are reluctant to leave or call from the nest during incubation (Rosenfield *et al.* 1988).

Risks

The Cooper's Hawk can be pugnacious at the nest, and some individuals will occaisionally strike at human intruders.

Survey Notes

The RIC recommended method for surveying the Cooper's Hawk is call playback during the breeding season. Migration surveys can be used during the non-breeding season. As well, dawn vocalization surveys are effective at locating nest sites in small, accessible forest patches during courtship and for determining reoccupancy of known breeding areas and locating alternative nest sites within these sites (Stewart *et al.* 1996).

Call playback surveys

- Rosenfield *et al.* (1988) found broadcasting conspecific calls useful for eliciting responses during pre-incubation (from the time of arrival at nesting areas until egg-laying) and post-incubation (nestling to fledgling period) than during incubation. This is likely due to the fact that males spend more time away from the nest and females are reluctant to leave or call from the nest during incubation (Rosenfield *et al.* 1988).
- Timing
- It is important to note that some raptor species have more than one call and they will respond to these calls differentially, depending on the time of year.
- Cooper's Hawks are vocal near nests particularly in the pre-incubation stage (Rosenfield and Bielefeldt 1991). During this stage, vocalizations and nest-building activities are most pronounced at dawn (Rosenfield and Bielefeldt 1993).
- Conduct surveys from daybreak to sunset.
- Interstation Distance
- Distance between call playback stations suggested by Mosher *et al.* (1990) for Cooper's Hawk is 0.8 km.
- For intensive presence/not detected surveys Mosher and Fuller (1996) suggest stations be placed about 0.5 km apart (i.e., it is not critical that stations are independent of each other).
- Repeat surveys every 5-10 days because breeding chronology varies among pairs and there is a relatively low probability of detection (Mosher and Fuller 1996).
- Mosher and Fuller (1996) found that a relationship existed between the number of Cooper's Hawk responses to Great Horned Owl calls and the number of Cooper's Hawk

pairs present and thus were able to obtain relative abundance estimates for Cooper's Hawks.

Dawn vocalization surveys

- Stewart *et al.* (1996) found this technique to be effective in detecting territorial and breeding Cooper's hawks in urban areas where nest sites were in small isolated woodlands (e.g. parks, golf courses), where hawks were habituated to the presence of humans; and where nests were concealed in tall coniferous trees.
- Cooper's Hawks are vocal near nests particularly in the pre-incubation stage (Rosenfield and Bielefeldt 1991). During this stage, vocalisations and nest-building activities are most pronounced at dawn (Rosenfield and Bielefeldt 1993). With ideal weather (e.g. no wind or rain), and low noise (e.g., traffic), Stewart *et al.* (1996) reported these calls were audible at distances of up to 150 m.
- Stewart *et al.* (1996) took advantage of this conspicuous behaviour and surveyed for Cooper's Hawks nesting in the Victoria area during the first 30–90 minutes of daylight. Using this 'dawn vocalisation technique' they found Cooper's Hawks to be readily detectable with vocalizations being most pronounced from late March through early April and decreasing as egg laying approached in late April. Earlier surveys were useful to detect single and paired birds, but repeated visits were required to confirm nesting. When a breeding pair was detected, surveyors watched for nest building activity to locate the actual nest tree.

5.4.4 Northern GoshawkB-NOGO *Accipiter gentilis*

BoBC–28; BH–228; NGS–190; PWB–172; HAWK–43; PGNAR–38

Species Description

Plumage: The back and upperwing coverts of the Northern Goshawk are slate blue in colour. The head is black with a thick white eye stripe. Underparts are pale blue-grey with fine grey barring. The tail is dark grey with indistinct dark banding. The undertail coverts are white and fluffy. Females are larger, darker and have coarser barring on the underparts.

Immature: Young are brown above, with buffy underparts heavily streaked, particularly on the flanks and undertail coverts. The cream-coloured stripe over the eye is distinctive. The tail has wavy brown streaks and ends in a narrow white band. When perched near to or on the ground their general appearance and size is very similar to the female Northern Harrier, but the Northern Harrier has a distinctive facial disc and lacks the Northern Goshawk's eye stripe.

Flight: This is the largest accipiter (Raven-sized). It flies with powerful, stiff wingbeats. The Northern Goshawk soars on level wings, sometimes appearing buteo or harrier like. Their tapered wings are long for an accipiter. The tip of the tail is wedge-shaped when folded.

Distinguishing Features: The pale grey breast, large size and pronounced white eye stripe of the Northern Goshawk are distinctive.

Voice: Alarm call is a loud, high pitched, non-raspy *ki ki ki ki ki.*

Habitat

The Northern Goshawk generally nests in dense coniferous mature forest (though sometimes in aspen groves), which can be described as mossy and dark, with little undergrowth and ample low flying room. The Northern Goshawk often uses areas of dense forest near open waterways or glades, which allow access to nest area and travel routes to hunting areas (ecoprovinces: CAM, GED, SOI, SIM, CEI, NBM, BOP).

Year round Northern Goshawks reside in habitat similar to breeding habitat (ecoprovinces: CAM, GED, SOI, SIM, CEI, SBI, NBM, TAP), however they may use a greater variety of habitats for hunting during the winter when prey levels are lower (i.e. alpine areas, estuaries, farm fields, sagebrush). The Northern Goshawk is widely distributed throughout British Columbia, yet are seen much less often than other raptors because it does not generally soar or circle above the forest canopy.

Diet

The Northern Goshawk appears to be an opportunistic hunter feeding on medium-sized birds and mammals including: jays, thrushes, crows, snowshoe hare, ground squirrel, red squirrel, grouse, and (at higher elevations) ptarmigan. Early in the nesting period, the female broods while the male hunts; later both birds hunt. The male returns to the nest with food, flying low along an access route to the nest area and then in a direct line to the nest.

Locating Nests

Egg laying is from early April to mid-July and young are at the nest from late May to late August. Nests are made of sticks and are placed in crotches near the trunk. In deciduous trees, the nest is often at the base of the crown (Siders and Kennedy 1996). In conifers, the nest is usually located next to the trunk at the base of the crown. Nests in aspen are particularly visible in early spring before leaf-out, and nests from previous years (often closely spaced) can alert ground or air surveyors to the fact that the area is used by Northern Goshawks, who may return to breed.

If a bird responds to playback, the area from which the bird called or the direction from which the bird flew towards the playback should be searched thoroughly. If you are close to the nest the birds will often fly around the area calling and may attack. The whitewash ‘streak’ of the Northern Goshawk is an identifying feature. The area around the nest site is decorated with long thin white streaks beneath perch sites and plucking sites. These plucking sites, where the birds dismember and eat their prey, are low branches, stumps, deadfall logs, or even mounds of earth. Visual searches of suspected nesting areas are aided by the presence of scattered feathers, pellets, and bones, especially hare and grouse feet. Pellets of Northern Goshawks can be distinguished from those of other accipiters by their size (about 5 cm x 2 cm), and from those of other raptors by their location under dense forest canopy.

Risks

The Northern Goshawk can be pugnacious at the nest, and some individuals will strike at human intruders.

Survey Notes

The RIC recommended method for surveying the Northern Goshawk is call playback during the breeding season. Migration surveys can be used during the non-breeding season. Aerial surveys of deciduous habitats before leafout are also used to locate potential goshawk nest sites.

Northern Goshawk populations are known to be tied in with the snowshoe hare cycle, and "invasions" of this species are seen periodically on a 1–2 year lag with peak hare populations. During this time the Northern Goshawk is seen in large numbers south of their usual range and on migration surveys (Mueller *et al.* 1977).

Call playback surveys

- Utilise information from anecdotal Northern Goshawk sightings by local residents and forestry workers. Catalogue these sightings for potential follow-up surveys at the beginning of the field season and for use in establishing potential Northern Goshawk areas.
- Dense patches of forest can be surveyed by using playback on nearby hills, ridges, or eskers as playback often causes an adult Northern Goshawk to fly up and perch above the nest site, where its 'silver' breast will be clearly visible from a nearby vantage point. Northern Goshawks will respond with greater speed and frequency to conspecific playback than to Great Horned Owl hooting playback.
- Timing
- Conduct playback surveys through the nestling and post-fledgling periods (dates may vary with latitude). The likelihood of locating active nest sites is greater during the nestling period because adults respond closer to their nest sites whereas juvenile responses during the post-fledgling period may be at great distances from active nest sites.
- Conduct surveys from daybreak to sunset. Kimmel and Yahner (1990) tested the influence of time of day on detection rates using the alarm call and reported no influence of time of day. However, if using the juvenile begging call it may be more effective broadcasted in the early morning, which is the 'peak hunger' time for nesting females and chicks.
- Interstation Distance
- Transects should be spaced 400 m apart.
- Distance between call playback stations should be 400 m (Kennedy and Stahleker 1993) when the objective is to cover as large an area as possible. In denser, coastal forests, spacing transects and broadcast stations 200-m apart may elicit higher detection rates if the survey objective is to conduct intensive surveys of an area of interest (McClaren 2001).
- It is important to note that the Northern Goshawk has more than one call and will respond to these calls differentially, depending on the time of year.
- Note that playing calls during incubation may result in addled eggs and goshawks are less responsive to calls during this time. It is ideal to determine the breeding chronology for a specific area before broadcasting calls.
- Use the alarm call during the nestling period (May 15 to July 1) as it elicits the highest detection rates from Northern Goshawk adults. Broadcasting using the alarm call was tested on Vancouver Island and resulted in a 60% detection rate (McClaren 2001).

- Use the begging call during the fledgling dependency period (July 1 to August 31), as this call elicits the highest detection rates from juveniles, as well, adults are less responsive to the alarm call during this time. Broadcasting using the juvenile begging call was tested on Vancouver Island and resulted in a 75% detection rate during the fledgling-dependency period (McClaren 2001).
- If your project objective is to thoroughly survey an area (i.e. proposed cutblocks; known territories for alternative nest sites) then you may want to consider surveying the area using both calls (each at the appropriate time of year). On Vancouver Island, crews have often had detections when using the begging call during the second survey even though no adults were detected during earlier surveys in the same area. These surveys also allow the crew to document whether young fledged in an area, however, it is often more difficult to locate the nest during this time period (E. McClaren, pers. comm.).
- Surveyors must be vigilant and scan in all directions as a response to call playback may merely be a silent bird gliding in for a closer look. Emphasis should be on quality of the call stations, not quantity to achieve accurate detection results. Some researchers have reported that the most valuable part of call playbacks may be that it forces surveyors to walk through a stand and systematically stop and listen every few hundred metres. This has resulted in the detection of many nests, particularly after the young have fledged; a time at which they become very vocal, frequently emitting begging calls independent of call playback responses.
- Northern Goshawks should be surveyed over several years to determine presence/not detected in suitable habitat (Doyle and Smith 1994) because their breeding cycle may fluctuate with that of prey and they may not call or respond to call playback in every year.

Standwatches

- Standwatches have been used often as a supplemental survey technique for detecting Northern Goshawks.
- Preliminary results indicate that standwatch surveys are more successful at detecting Northern Goshawks in the pre-nesting season (during a period which coincides with high levels of courtship activity) (Chytyk *et al.* 1997) and post-fledgling (E. McClaren, pers. comm.) periods than during the incubation and nestling phases.
- Conducting call playback surveys and nest searches in conjunction with pre-nesting standwatch detections (after strong territorial behavior or goshawks carrying prey are observed) will likely be necessary as follow-up techniques to locate active nest trees.
- If standwatches are to be conducted, select days when weather conditions may be expected to encourage display activity above the canopy (warm and dry), and days when birds are readily seen and heard (not cloudy, rainy or windy conditions), (F.Doyle pers. comm.).

5.5 Buteos

5.5.1 Common Identification Problems

Red-tailed Hawk and Rough-legged Hawk

These two species of buteo overlap in distribution throughout British Columbia in the spring and fall months as Rough-legged Hawks migrate to and from their breeding grounds in northern Canada. Both species have multiple variations in both body and wing plumage patterns, which can overlap 100 % with each other. Howver, they do have typical plumage patterns individual to the species, which are discussed in the species identification notes below (Table 8).

Table 8. Diagnostic features to use to identify Rough-legged Hawks from Red-tailed Hawks in the field.

Species	Tail	Legs	Wings and Flight
Rough-legged Hawk	Broad black band	Feathered legs	Long wings, buoyant flight, occasionally hovers
Red-tailed Hawk	Black band is small, faint or absent	No feathers on legs	Shorter wings, heavier flight, rarely hovers

5.5.2 Broad-winged Hawk B-BWHA *Buteo platypterus*

BoBC–30; BH–230; NGS–192; PWB–176; HAWK–56; PGNAR–56

Species Description

Plumage: The upperparts of the Broad-winged Hawk are a uniform dark-brown in colour. Underparts are white with rusty barring. Underwings are white with dark tips forming a dark border around the wing. The tail is black, banded with several white bands, the last white band being wide and distinct. A rare dark morph of this hawk breeds in Alberta and may be seen in British Columbia. This bird has a dark brown head, body and underwing coverts, and the same dark band on the trailing edges of silvery flight wings. The tail is similar to that of the light morph.

Immature: Young typically have a black facial whisker stripe. Their underparts are cream with dark blotches. The tail banding is indistinct, but the dark-bordered underwings are characteristic. Its tail is shorter than that of juvenile and immature accipiters, and it lacks their white eye stripes.

Flight: This crow-sized hawk is much smaller and stockier than other buteos. The wings are broad, but very pointed for a buteo. Active flight is with strong, stiff wingbeats. The Broad-winged Hawk soars and glides on flat wings and does not hover. It often perches low to the ground.

Distinguishing Features: The black wing borders and thick white tail band are the best field marks for the Broad-winged Hawk, apart from its small size.

Voice: Call is a thin, shrill, descending whistle: *pee-teee*.

Habitat

The Broad-winged Hawk inhabits deciduous woodlands of trembling aspen and birch. It nests in continuous deciduous or mixed forest with clearings, and nearby water. In recent years, the Broad-winged Hawk has established itself in the Peace Lowland area of British Columbia, particularly near Fort St. John (Campbell *et al.* 1990), (ecoprovince: BOP). Breeding has recently been recorded in this region of the province (Fraser *et al.*1999).

The Broad-winged Hawk is rare, but regular fall migrants are seen on extreme southern Vancouver Island. The Broad-winged Hawk migrates to southern United States, Central and South America.

Diet

The Broad-winged Hawk perch-hunts for insects, voles, amphibians and small birds.

Locating Nests

Nests are located most often in the first main crotch of deciduous trees or on a platform of horizontal branches against the trunk of a conifer, usually in the lower third of the canopy. Prior to incubation, active nests can be identified by the presence of fresh conifer sprigs (Goodrich *et al.* 1996). Nests can be located by the use of standwatches to indicate the regular presence of birds, and then searching of suitable nest sites. Before leaf-out, a survey of stands may reveal the presence of old nests, these are sometimes reused, and any stand that has a nest is also more likely to be used by the hawks in subsequent years. Another technique that may help locate specific nests in areas where pairs of hawks are known to breed is the use of call playback. In 14 of 90 instances, breeding Broad-winged Hawks responded to call playback, usually by vocalising and flying low towards surveyors (Balding and Dibble 1984, Mosher *et al.* 1990).

Survey Notes

The RIC recommended method for surveying the Broad-winged Hawk is migration surveys during the non-breeding season.

Territorial Broad-winged Hawks give a plaintive whistle (*peee uum*) while making occasional soaring flights above the forest canopy. These calls are given from the nest and in flight throughout the year. The Broad-winged Hawk will defend the nest site against other hawks.

5.5.3 Swainson's Hawk B-SWHA *Buteo swainsoni*

BoBC–32; BH–234; NGS–194; PWB–174; HAWK–61; PGNAR–63

Species Description

Plumage: The plumage of the Swainson's Hawk is extremely variable which makes it difficult to distinguish from other species. The upperparts of the adult are a smooth dark brown in colour. The **light morph** has a white throat patch above a dark brown breast band or bib. The underparts are otherwise whitish. Light wing linings contrast with dark barred flight

feathers, which are darkest at their tips. The **dark morph** has wings that are dark throughout, including the flight feathers, and a narrowly banded tail. The tail is slightly lighter towards the base; combined with uppertail coverts, the base of the tail may appear whitish, especially in flight. Intermediate colorations of the Swainson's Hawk include a reddish plumage. The legs are half feathered versus the fully feathered Ferruginous and Rough-legged Hawks (England *et al*. 1997).

Immature: Young have white spotting on upperparts, and often a white rump band. The light morph young have a dark whisker streak and whitish eyebrows. They show less contrast between wing lining and flight feathers than adults.

Flight: The Swainson's Hawk has long tapering to pointed wings (not as extreme as those seen in falcons). It hunts from posts and low trees, and soars over open areas. The flight is teetering and vulture-like, with wings held above the horizontal in a V shape and in a dihedral during soaring (England *et al*. 1997).

Distinguishing Features: A buteo about the size of a Northern Harrier, with a slim appearance and only three notched primary feathers as opposed to the four or five of other buteos. The long wings of this hawk, with their distinctive pointed tips, are a good field mark. The dark steely grey of the flight feathers is also a key to identification, as is the white undertail coverts in the dark morph. The Swainson's Hawk lacks the Red-tailed Hawk's pale mottling on the shoulders.

Voice: Makes a shrill, plaintive whistle - *kreeeeer* - that is higher-pitched than the Red-tailed Hawk's and fades off toward the end.

Habitat

Generally a bird of open country, the Swainson's Hawk inhabits grasslands and rangelands, burns and clear cuts. It breeds in open mixed forests and groves near such areas, throughout the Thompson-Okanagan plateau and has been noted in the Bulkley Basin Ecosection (F. Doyle pers. obs.) (ecoprovinces: CAM, CEI, SOI, Campbell *et al.* 1990). This migratory bird is found mainly in the southern and central interior of British Columbia, and winters predominantly on the Pampas in Argentina.

Diet

The Swainson's Hawk feeds mostly on small mammals, birds and reptiles during the breeding season and on large invertebrates, especially dragonflies and grasshoppers at other times (England *et al.* 1997). It hunts from perches such as utility poles or fence posts. It forages in open grassland, shrub steppe and agricultural areas. Most prey is captured on the ground, but is sometimes chases down insects on the run or with short leaps (England *et al.* 1997).

Locating Nests

As with many of the hawks, nests can be located by surveying wood lots for old nests prior to leaf-out. These nests or wood lots will often be re-used by a pair of birds however, England *et al.* (1997) found that more than 50% of nests were freshly built. After leaf-out or in areas of coniferous trees, standwatches and roadside surveys can be used to detect the presence of birds in the area, a concentration of activity often indicating a nest site. Nest sites in British

Columbia are usually in upland areas of foothills and valleys (Campbell *et al.* 1990). These hawks often reuse nests, building large stick structures in both conifers (often ponderosa pine) and deciduous trees like cottonwood and aspen. The nest appears more flimsy or ragged than that of other Buteo's. It can be any height but is usually near the top of the tree within the crown on a small limb (England *et al.* 1997). The Swainson's Hawk is a fairly silent bird. When disturbed on nest sites, it makes a call similar to that of the screech of the Red-tailed Hawk, but less raucous. Young birds have a sustained wailing cry during the latter part of the nestling period and prior to leaving the nest. Sprigs of greenery in nests indicate active sites. Egg laying is from early May to early July and young are at the nest from early June to mid-August.

Survey Notes

The RIC recommended methods for surveying the Swainson's Hawk are roadside surveys and standwatches during the breeding season and migration surveys during the non-breeding season.

The Swainson's Hawk is a relatively non-aggressive, even gregarious bird in interactions with other Swainson's Hawks, sometimes even hunting in a group (Beebe 1974 and England *et al.* 1997).

5.5.4 Red-tailed Hawk B-RTHA *Buteo jamaicensis*

BoBC–34; BH–232; NGS–194; PWB–174; HAWK–69; PGNAR–82

Species Description

Plumage: The plumage of this commonly seen hawk is extremely variable. In British Columbia the plumage patterns of the Red-tailed Hawk range from the classic light morph bird to the very dark "Harlan's Hawk", with many inter-gradations in between. The **light morph** Red-tailed Hawk adults display a bellyband of dark streaks on whitish underparts or a rufous wash over the entire belly. A dark bar on the leading edge of the underwing contrasts with pale wing linings. There is also often a dark carpal patch or 'comma'. Primaries and secondaries are often crossed with narrow dark bars. The tail is reddish above, pale red underneath, with a narrow black subterminal band. The undertail appears reddish, particularly in strong light. The **dark morph** Harlan's Hawk, subspecies *harlani,* is common in British Columbia, particularly in northern parts of the province. This is a brown or blackish bird with a dusky-white or mottled greyish tail, and diffuse black terminal band. There may be white streaking on the dark breast and back. The silvery flight feathers contrast with dark coverts. The upperparts of the Red-tailed Hawks range in colour from grey brown to dark brown or rufous.

Immature: Young tend to look more slender than adults, with longer wings and tails. All immatures have grey-brown tails, many with narrow blackish bands. They are heavily brown-streaked and spotted on the underparts.

Flight: The Red-tailed Hawk is a large, stocky, usually dark-headed buteo. The wings are broad and faintly rounded. This hawk is commonly observed soaring, or hunting from a perch overlooking an open area. It often soars with wings in a slight dihedral and glides on flat wings.

Distinguishing Features: The spotted breast band, dark shoulder markings, dark carpal marks (also present on Rough-legged Hawks), and pale inner primaries of light morph are all good field marks for the Red-tailed Hawk, but are not present on all birds. The white-mottled or barred tail of the Harlan's or the rufous tail of others is also distinctive.

Voice: Call is often heard — a harsh, raspy, descending *keeeeer*, or *tseeeer*.

Habitat

The Red-tailed Hawk can be found breeding throughout the province in any habitat which provides mature trees big enough to support a nest (ecoprovinces: CAM, GED, SOI, SIM, CEI, BOP). Nest sites can be a single tree in an open area or a tree in the centre of a large stand.

In winter, most birds migrate south, but some birds over-winter in the Fraser Lowlands, and throughout much of southern British Columbia (ecoprovinces: CAM, GED, SOI, SIM).

Diet

The Red-tailed Hawk is an opportunistic generalist, typically taking smaller mammals and birds.

Locating Nests

These birds build a large stick nest 50-cm in diameter, located in the crown of deciduous or coniferous tree. They are often on the edge of a forest stand and usually in a tree with good all round visibility. In deciduous habitat, aerial or ground transects can be used before leaf out to locate old nest sites. These nests may be reused, or a new nest may be built in the same stand. Birds will often be seen perching in tall trees (offering a good all round view of the area) adjacent to the nest site. In sunlight, the breast of the bird can be easily observed through binoculars, and in this way, observers can locate nests by scanning an area using a vantage point.

Early in the breeding period, both birds will display high in the sky, over the top of the nest area, circling and making short dives towards the nest site. Repeated calls of the Red-tailed Hawk's distinctive raspy screech will often alert surveyors to the presence of a nest site in the area. Egg laying is from late February to late June and young are at the nest from early April to early August. The best time to search for Red-tailed Hawk nests is after the eggs are hatched. During egg stage females will often sit quietly on nests, even when the observer passes close by. After chicks have hatched, adult birds become very vocal in the presence of human intruders. However, birds will try to draw intruders away from the nest by circling away from it. Look for a large stick nest decorated with whitewash, feathers or white chicks. The female's begging call is also a clue, and later in the nesting period so are the calls of the hungry chicks. If the birds are giving alarm calls, the female is typically already off the nest and subsequently the nest will be difficult to locate. If the general location of the nest is known, it is best to return to the nest area later. At this time, the nest may be located by quietly moving in, then locating the nest as the female flushes and typically calls as she takes flight. It should be noted that once a nest has been subject to human disturbance (trying to locate the nest etc.), the birds will often begin screaming when the observer is a kilometre or more from the nest. It is therefore recommended that as much information as possible about the nest area be obtained by non-intrusive means (interspecific interactions, display etc.), to

successfully locate the nest and to minimise disturbance. It is helpful to watch for territorial disputes between Red-tailed Hawks and ravens, eagles etc. These disputes are typically followed by display flights over the nest. Also look for males carrying prey across roadways, taking note of how high they are flying and in which direction; low direct flight indicates the nest may be nearby.

Risks

The Red-tailed Hawk is very susceptible to disturbance when the birds are incubating eggs or have very young chicks. The eggs and young are vulnerable to dying of overheating or hypothermia when they are left exposed while the female defends the nest.

Survey Notes

The RIC recommended methods for surveying the Red-tailed Hawk are roadside surveys during the breeding season and migration surveys during the non-breeding season.

5.5.5 Ferruginous Hawk B-FEHA *Buteo regalis*

BoBC–38; BH–236; NGS–196; PWB–176; HAWK–74; PGNAR–100

Species Description

Plumage: The Ferruginous Hawk has a rusty back and shoulders, pale head, and a white tail washed with pale rust. Most birds are **light morph**, with the reddish brown shoulders and back and mainly white underparts with contrasting dark-chestnut feathered thighs. The tail is unbanded plain white or greyish, sometimes with a reddish tip. The rare **dark morph** is similar to the dark Rough-legged Hawk, but the pale tail does not have dark banding.

Immature: Young are dark-brown above with some white spotting. They have white underparts and white-feathered legs — thus they do not exhibit the distinctive dark V on the belly in flight.

Flight: This is the largest buteo, with long, tapered wings and large head and chest. The dark V formed by the rusty feathered legs against the white underparts is a good field mark. Also a whitish primary patch on the upperwing often flashes in flight. They are sluggish when taking flight, which is characterized by slow, strong wingbeats, like a small eagle. They soar and circle with slightly up tilted wings, and they alight and roost on the ground more so than other hawks.

Distinguishing Features: On the light morph Ferruginous Hawk the brown thighs are feathered to the toes; in flight, giving adult hawks a distinctive dark V shape on the belly.

Voice: Less vocal than other buteos. Alarm call is a sharp, descending *kree-a-aah.*

Habitat

The Ferruginous Hawk has been only very rarely recorded in British Columbia, most often in late spring and early summer (Campbell *et al.* 1990). Small numbers migrate through British Columbia. They have been seen in the central southern interior of the province, mainly in the Okanagan and Nicola regions of the Thompson-Okanagan plateau (ecoprovince: SOI). There

is only one winter record for British Columbia. The Ferruginous Hawk winters from the southwestern USA to central Mexico (Campbell *et al.* 1990).

Ferruginous Hawks inhabit almost exclusively, open country with scattered trees and rock bluffs. They use grasslands, rangelands, and agricultural fields. There is only one confirmed breeding record for this species in British Columbia.

Diet

The Ferruginous Hawk feeds on lagomorphs and large rodents: rabbits, hares, marmots, gophers and ground squirrels.

Locating Nests

Nests are commonly found in isolated trees in grassland; though these hawks prefer elevated sites, they will also nest on the ground, usually on slight rises or bluffs. One British Columbia nest was 14 m above ground in a ponderosa pine (Campbell *et al.* 1990). The nests of these hawks are very large, and made up of large dry sticks. Unlike other hawks, the Ferruginous Hawk rarely uses green sprigs to line the nest. If the presence of birds in an area is confirmed, repeated sightings of individuals in the same location is a good indication that the nest is close by. Both male and female Ferruginous Hawks share incubation, but gradually the male spends more time perching and patrolling near the nest site (Powers 1981). These generally silent hawks are vocal during the breeding season, giving alarm calls from the nest when humans approach. Calling also accompanies flight-displays (Bechard and Schmutz 1995). The alarm call (*kaah kaah*) is quieter and lower pitched than that of other hawks, and is described as gull-like and plaintive.

Risks

The Ferruginous Hawk is very sensitive to human disturbance, and even one visit to a nest site before or during egg laying can result in abandonment of the nest (Jensen 1995).

Survey Notes

The RIC recommended method for surveying the Ferruginous Hawk is the roadside survey in the breeding season. This search for territories is best in early April during the 3 weeks of territory establishment by northern populations (Olendorff 1993, Zelenak 1996, Zelenak and Rotella 1997).

The Ferruginous Hawk is wary of humans, and it often roosts on the ground, rendering it inconspicuous. However, the white belly of light-morph birds reflects sunlight, making even ground-perching birds quite visible (Bechard and Schmutz 1995). These hawks will defend territories against other birds of the same species, and frequent aggressive interactions can be seen in such cases.

5.5.6 Rough-legged Hawk B-RLHA *Buteo lagopus*

BoBC–40; BH–234; NGS–196; PWB–176; HAWK–77; PGNAR–108

Species Description

Plumage: The plumage of the Rough-legged Hawk is extremely variable, with many intergradations. Most birds are the classic **light morph**. These birds are brownish or greyish above, with buff feather edgings. The pale head contrasts with the dark back and dark bellyband. The breast is cream or buff with scattered brownish spots and a dark brown bellyband. There is often a pale, unmarked U between the breast and bellyband. In flight, the wing lining shows whitish with dark brown spotting and very dark carpal patches. The tail is white at the base, sometimes with dark spotting or incomplete bars, and a broad, black subterminal band. Legs are feathered to the toes. **Dark morph** birds vary from dark brown to black above and below, though black wrist patches are often still visible. These birds lack the extensive white at the base of the tail, but from below show much white at base of flight feathers. The tail may have multiple dark bands, but still shows the broad dark subterminal band.

Immature: Young are similar to adults, but have more black on the belly and show small white patches of the base of upperwing primaries. The tail has a single broad brown tail band.

Flight: This is a large buteo with long wings. It is an open country hawk that often hovers on rapidly beating wings when hunting. When gliding or soaring, wings are held above the horizontal.

Distinguishing Features: The long white tail of the Rough-legged Hawk, with its broad dark subterminal band is key to identification. The dark belly and carpal patches of the light morph birds are also distinctive. The wings are longer than those of the Red-tailed Hawk, with whom it is often confused. The feathered legs are a good field mark.

Voice: Makes a squealing or mewing screech - *kee-we-uk* - that ends on a lower note.

Habitat

The Rough-legged Hawk frequents flat, open areas, with sparse ground cover. It can be seen in grasslands, marshes, fields and meadows. The Rough-legged Hawk perches in the open, often in prominent locations low to the ground. It migrates singly or in small flocks. In winter it can be found anywhere in the southern half of province and many of these hawks winter in the Fraser Lowlands (Campbell *et al.* 1990), (ecoprovinces: CAM, GED, SOI, SIM, CEI, SBI, BOP). The Rough-legged Hawk breeds outside of the province on the tundra, or in open coniferous forests.

Diet

The Rough-legged Hawk feeds on lemmings, voles, mice and shrews.

Survey Notes

The RIC recommended methods for surveying the Rough-legged Hawk are roadside surveys during the breeding and non-breeding season, as well as migration surveys during the non-breeding season.

The Rough-legged Hawk is generally a silent bird when not breeding. In winter ranges it is non-aggressive, sharing territory with other hawks and transient birds. Populations appear to fluctuate in association with the lemming cycle in the far north (Beebe 1974). No birds are recorded breeding in British Columbia.

5.6 Falcons

5.6.1 Common ID Problems: American Kestrel and Merlin

The American Kestrel and the Merlin are similar-sized falcons whose ranges overlap in many parts of British Columbia. Both will perch on telephone wires, posts, and trees in open areas of farmland, grassland, and meadow.

The main features to consider when identifying these small falcons are the following:

1. The American Kestrel has very distinctive black moustache markings on the face. The Merlin's markings are indistinct, washed out with grey. Thus the facial pattern is much less striking.

2. The tail of the American Kestrel is rufous with multiple fine black barring on the female and one thick black terminal band on the male. The Merlins have a dark tail with a whitish terminal band and several light grey bands.

3. As most of the Merlins in British Columbia are the dark *suckleyi* subspecies, their overall appearance is much darker than that of the American Kestrel. American Kestrels are the only small hawks with rufous backs. Males in flight (particularly on bright days) display a distinctive series of white dots on the trailing edge of the wing.

5.6.2 American Kestrel B-AMKE *Falco sparvarius*

BoBC–48; BH–244; NGS–202; PWB–186; HAWK–96; PGNAR–130

Species Description

Plumage: The American Kestrel is the smallest and most colourful of British Columbia's falcons. It has a grey head with a rufous crown patch, white cheeks and two black moustache marks. The male's crown and upperwing coverts are blue grey, and the back is rufous with narrow black barring. The black primaries are spotted with white. The tail is reddish with a wide black subterminal band. The underparts are buff with variable black spotting. Females are reddish brown above with black barring. Their underparts are buff blotched with brown. The reddish brown tail has narrow dark brown banding.

Immature: Young are similar to adults. Juvenile males have heavily streaked breasts and completely barred backs and tails.

Flight: Typical of falcons, it has long pointed wings that are visible when the bird is in flight. It soars on flat wings and will often hover on rapidly beating wings. In flight, this bird appears paler than the similar-sized Merlin. The American Kestrel sits erect, perching on poles, posts, wires and snags. It often dips or pumps its tails when perched.

Distinguishing Features: No other small hawk has the rufous back and tail of the American Kestrel. The white cheeks and moustache are distinctive. The male in flight often displays a row of translucent white dots on the trailing edges of his wings. The similar-sized Sharp-shinned Hawk has rounded wings, and both it and the Merlin have darker grey or brown backs and tails.

Voice: Alarm is a rapid *killy killy killy*.

Habitat

The American Kestrel uses semi-open or open habitat throughout the province. It can be found in burned and cleared areas of forest and in any open habitat from sea level to tree line throughout the province (ecoprovinces: CAM, GED, SOI, SIM, CEI, SBI, NBM, BOP).

The American Kestrel is largely migratory. Some areas such as the Fraser Lowlands and the Southern Interior have overwintering populations (ecoprovinces: CAM, GED, SOI, SIM).

Diet

The American Kestrel preys upon large insects, voles, and occasionally small birds.

Locating Nests

The American Kestrel nests in cavities, usually those made by the larger woodpeckers (Flicker and Pileated), as well as natural cavities. It will also readily use nest boxes. Regular sighting of a female or a pair of birds at the same locale over a number of weeks indicates a nest site is near. Pellets and whitewash splatters will be found beneath favourite perches. Another common sign of a nearby nest site is the American Kestrel mobbing other predators such as eagles, hawks and corvids who have strayed near their nest. Location of the actual nest site should take place after hatching to avoid nest disturbance that may result in nests being abandoned. The nest can be located by observation of perching females or pairs from a blind until a flight to the nest hole is observed. Active nests can also be located by inspecting suitable holes for down feathers around the outer edge. An active nest cavity will not have spider webs across its opening. Often, small flies will be seen flying in and out of the hole. Tapping on the tree may induce the bird to look out of the nest hole. Intruders in the nest area often cause birds to give alarm calls and flight display. Territorial flights consist of rapid wing beats, wing tips pointed downwards. Egg laying is from the first of April to mid-June and young are at the nest from early May to the end of August.

Survey Notes

The RIC recommended methods for surveying the American Kestrel are roadside surveys during the breeding and non-breeding season and migration surveys during the non-breeding season.

Roadside surveys

- Conduct roadside surveys in the early morning to locate pairs of birds and individual female American Kestrels.
- These birds will reliably perch in the highest snag adjacent to the nest hole particularly in the few hours around sunrise in the pre-egg laying and laying period.
- Repeated observations of perching females and pairs in the same area over several mornings are a good indication of a nearby nest.

5.6.3 Merlin B-MERL *Falco columbarius*

BoBC–50; BH–246; NGS–202; PWB–186; HAWK–100; PGNAR–136

Species Description

Plumage: The adult male Merlin is charcoal grey to dark brown above. The dark grey crown is streaked with black. The tail is dark with several faint greyish bands and a whitish terminal band. Underparts are buff with brown streaking. Females are similar in appearance, but dark brown or black above, and heavily streaked with brown below. Most Merlins found in British Columbia are "Black Merlins" of the subspecies *suckleyi,* but some are the paler "Prairie Merlin", subspecies *richardsoni*.

Immature: Immature plumage is similar to that of the adult female.

Flight: The Merlin does not hover. Its flight is direct, with quick wing beats, flicking the wing tips backward at the end of each stroke. Merlins soar on flat wings with tails slightly fanned. In flight, the bird appears stocky and angular.

Distinguishing Features: The Merlin is slightly larger than the American Kestrel, and lacks that bird's bold moustache marks. The dark underwings and broad dark bands on the tail are distinctive. Its stocky size and large head sets the Merlin apart from the Sharp-shinned Hawk (Beebe 1974).

Voice: Alarm call is a rapid, high-pitched *ki ki ki ki.*

Habitat

Though the Merlin may be found in almost any area of the province, it prefers open areas. During migration it uses seacoasts, river valleys and lakeshores. In winter it inhabits lowlands, valley bottoms, farmlands, marshes, parks, and residential areas in the southern portions of the province (ecoprovinces: CAM, GED, SOI, SIM, CEI, BOP).

The Merlin breeds most often in woodlands bordering open areas or waterways. It is widely distributed throughout British Columbia and is found breeding from the timberline to sea level, from southern British Columbia and up through the interior of the province (Campbell *et al.* 1990), (ecoprovinces: CAM, GED, SOI, SIM, CEI, SBI, NBM, BOP).

Diet

The Merlin preys on small birds, which they capture in short, dashing flights.

Locating Nests

Most nests are those abandoned by crows or magpies, as well as ravens, jays, and woodpeckers. The Merlin will attack potential predators near the nest site, which it guards by perching in tall trees nearby. It will attack crows, ravens and other raptors, climbing to great heights to intercept and harass them. Males often react to humans as far as 800 m from the nest (Craighead and Craighead 1940), and their increasing agitation as the nest site is approached, aids in its detection (Beebe 1974). However, females are likely to 'sit tight' on the nest during incubation and brooding, and pairs nesting in urban areas show little reaction to humans. During incubation, the male hunts, brings food to the female, and calls. The

female takes prey and leaves the nest to eat it, while the male incubates until she returns and calls. During the nestling stage, the female will fly off the nest to take food from the male away from the site (Sodhi *et al*. 1993). Egg laying is from mid-April to early July and young are at the nest from mid-May to mid-August.

Survey Notes

The RIC recommended method for surveying the Merlin is call playback during the breeding season. Migration surveys can be used during the non-breeding season.

Call playback surveys

The most common call of the Merlin is described as *ki-ki-kee*, and accompanies courtship displays as well as territorial and aggressive encounters.

- Paul James (pers. comm.) recommends call playback surveys be done prior to incubation for Merlins.
- Conduct surveys from daybreak to sunset.
- It is important to note that some raptor species have more than one call and they will respond to these calls differentially, depending on the time of year.

5.6.4 Peregrine Falcon B-PEFA *Falco peregrinus*

BoBC–54; BH–246; NGS–204; PWB–186; HAWK–107; PGNAR–149

Species Description

Plumage: The crown and nape of the Peregrine Falcon are black, with a black wedge extending well below the eye, forming a distinctive black helmet, or hood. The adult is slate-backed, pale below, with bars and spots. It displays a gleaming white throat. The *anatum* subspecies has a pale rufous wash on the chest.

Immature: Young are dark brownish above, with heavily streaked underparts. The immatures of the subspecies *pealei*, found on the Queen Charlotte Islands, could be mistaken for Gyrfalcons.

Flight: This bird is slightly larger than the Prairie Falcon and has the pointed wings, narrow tail, and quick pigeon-like wingbeats of the typical falcon. It soars on flat wings. The Peregrine Falcon appears uniformly dark in flight.

Distinguishing Features: Other falcons lack the bold facial markings of the Peregrine Falcon. The heavy moustache is particularly distinctive.

Voice: Usually silent but a variety of wails and cries can be heard during the breeding season. Alarm call of the adult birds is a grating *kree-aak*, *kree-aak* or *ki ki ki* (Beebe 1974).

Habitat

The Peregrine Falcon uses open habitats that support large populations of suitable birds as prey. For breeding populations it needs the presence of suitable nest sites, which are typically on cliffs and occasionally in abandoned tree nests of other species (ecoprovinces: CAM, GED, SOI, CEI, BOP). On the coast they inhabit beaches, tidal flats, islands, lagoons and marshes (in close proximity to breeding colonies of seabirds). In the interior it uses lake shores, and river mouths and valleys. These birds have also taken to nesting on human-made structures and forage on pigeons (Johnstone 1999).

In winter the Peregrine Falcon uses human altered habitat like golf courses, parks, farmlands, airports and cities. Small numbers of birds winter in the southern interior (ecoprovinces: CAM, GED, SOI).

Diet

The Peregrine Falcon feeds on shorebirds, waterfowl, and other small or medium-sized birds. They strike, kill and often capture these on the wing in spectacular dives and aerial chases. The Peregrine Falcon often hunts at dawn and dusk, as well as during the day.

Locating Nests

Nests are placed on any flat surface on a cliff, bluff or in the abandoned nest of another species. In more recent developments, birds have also taken to nesting on human-made structures, and several cities in North America have pairs of birds nesting on skyscrapers. Locating active nest areas can be aided by conducting standwatches in suitable nest areas. The prolonged and spectacular flight displays take place when birds return to nesting territories. These courtship flights involve both birds swooping, chasing and calling, particularly on windy days (Beebe 1974). Courtship displays end when eggs are laid. Egg laying is from late March to early July and young are at the nest from the first of May to late July.

Because nest locations usually occur in areas where the prey base is high, both sexes can be found at or near the nest site throughout the breeding period. Females are mostly silent and difficult to disturb during incubation and the early nestling period, and will tolerate or ignore approaching humans (Beebe 1974). From this period on, Peregrine Falcons are noisy and demonstrative. The large fluffy white chicks of the Peregrine Falcon are quite visible in nest aeries. Young also have a loud wailing call given when adult birds come into sight. The presence of active aeries is often indicated by whitewash splattered beneath the nest and below favourite perch sites of the adults.

Survey Notes

The RIC recommended methods for surveying the Peregrine Falcon are aerial surveys for nests, and boat surveys in the breeding season. Migration surveys can be used in the non-breeding season.

Most surveys for the Peregrine Falcon are conducted from the air or by boat (Fyfe *et al.* 1976), where cliff ledges are checked for the presence of nests and birds. Many nest sites are re-used and are known to local wildlife organisations, and they should be contacted before surveying any new areas.

Aerial surveys

- When surveying for cliff-nesting falcons stratification of quadrats based on expected raptor densities is often based on the number of kilometres of shoreline within each quadrat (Grier 1977, Hodges *et al*. 1984).
- Falcons often sit with their feet under or between their eggs/young, and if startled may accidentally eject them when vacating the nest. Helicopter flights should be flown a minimum of 50 m above the nest and should be terminated if birds are becoming agitated. Confirmation of nest occupancy can be determined on a later flight during the nestling stage when young are visible from a greater distance.
- Two surveys should be conducted during April and May to determine nest occupancy, with minimal disturbance, and again in late May to July to determine number of young late in nestling stage (Wilson *et al*. 2000).

Boat surveys

- Peregrine Falcons are likely to flush only from nest areas during certain times in their nesting chronology, which are during incubation and early nestling period.
- At other times they will flush only if there are loud noises or substantial disturbance occurs near their aeries (e.g., aircraft noise). Boat surveys for Peregrine Falcons have been supplemented with loud noises (megaphones) around potential aeries to startle the birds off of their nests and make for easy detection (Munro 1988).

5.6.5 Gyrfalcon B-GYRF *Falco rusticolus*

BoBC–58; BH–248; NGS–204; PWB–184; HAWK–111; PGNAR–145

Species Description

Plumage: There is considerable variation in the colouring of the Gyrfalcon. Upperparts range from white with streaking to uniform black or dark brown with pale feather edges. Typically underparts of adults are lighter than upperparts and have streaked breasts and spotted bellies. Most birds are grey or brownish. Gyrfalcons are more uniformly coloured than other falcons.

Immature: Young are similar to adults but are more heavily streaked on the underparts.

Flight: The Gyrfalcon shows broader, less pointed wings and a longer tail than other falcons. The tail is wide and noticeably tapered. It is the largest and most powerful falcon, and flies with slow, deep wing beats. Gyrfalcons soar and glide on level wings. In grey and dark morphs, the underwing is two-toned.

Distinguishing Features: The very large size (Raven-sized), paler head (with no obvious dark hood and moustaches) and more uniform coloration distinguish the Gyrfalcon from the Peregrine Falcon. For a similar species, see Northern Goshawk.

Voice: Call is similar to that of the Peregrine Falcon but louder and harsher.

Habitat

In winter, the Gyrfalcon is found in open country wherever food is plentiful. It uses tidal flats, lake shores, marshes, golf courses, wet fields, ponds and river mouths. During the summer the bird is associated with open tundra and areas above tree line. The presence of breeding

birds is closely linked to the abundance of food supply. It breeds in the northwestern part of the province (Campbell *et al*. 1990), (ecoprovince: NB).

The Gyrfalcon is widespread in western British Columbia in winter (Campbell *et al*. 1990), except on the Queen Charlotte Islands. Periodic invasions occur in the southern parts of the province when northern ptarmigan populations crash (ecoprovinces: CAM, SOI, GED).

Diet

Birds make up the most part of the Gyrfalcon's diet. In the breeding range, ptarmigan is the principle prey, and populations appear to cycle in relation to its availability (Clum and Cade 1994). In southern areas in winter, the Gyrfalcon preys upon shorebirds, waterfowl and gulls.

Locating Nests

No nest is built. The eggs are laid on flat ledges or abandoned nests of other large cliff nesting species. Nests are typically on cliffs, rock outcrops and river bluffs. Most nest sites found in British Columbia are on bare cliff ledges or in unused Golden Eagle nests, and are protected by overhangs (Campbell *et al*. 1990). For signs of active nests, look for Gyrfalcons performing aerial displays near nest sites during the egg laying period, as well as the presence of fresh whitewash on cliff faces. Egg laying is from the first of April to the first of June and young are at the nest from the first of May til mid-July. The birds will give a *kak* call in the nest vicinity, and both sexes will chase and strike avian intruders during breeding. They have killed Ravens, Rough-legged Hawks and Peregrine Falcons in this way (Clum and Cade 1994).

Risks

The Gyrfalcon is not particularly aggressive to human intruders at nest sites, often flying away and circling silently. It has been shown to be disturbed by helicopters flying lower than 600 m above the nest site, and are often less likely to re-use such sites (Clum and Cade 1994).

Survey Notes

The RIC recommended methods for surveying the Gyrfalcon are aerial surveys for nests and boat surveys in the breeding season.

The Gyrfalcon is most readily surveyed on its breeding range when an annual survey of known nest sites will give an index of abundance. As with Golden Eagles, nest sites are frequently re-used, and are often known by local wildlife organisations. These organisations should therefore be contacted before surveying new areas.

Aerial surveys

- When surveying for cliff nesting falcons stratification of quadrats based on expected raptor densities is often based on the number of kilometres of cliff/bluff edge within each quadrat (Grier 1977, Hodges *et al*. 1984).
- Falcons often sit with their feet under or between their eggs/young, and if startled may accidentally eject them when vacating the nest.
- Gryfalcons has been shown to be disturbed by helicopters flying lower than 600 m above the nest site, and are often less likely to re-use such sites (Clum and Cade 1994), so

disturbance should be kept to a minimum. Helicopter flights should be terminated if birds become agitated. Confirmation of nest occupancy can be determined on a later flight during the nestling stage when young are visible from a greater distance.

5.6.6 Prairie Falcon B-PRFA *Falco mexicanus*

BoBC–60; BH–246; NGS–204; PWB–186; HAWK–114; PGNAR–141

Species Description

Plumage: The Prairie Falcon is a large (crow-sized) pale falcon. The moustache mark is narrow and indistinct. The long tail has faint banding. The back feathers of the adult are dark brown with light brown bars and edges. The whitish underparts are faintly spotted or barred in adults. Wing tips don't reach tail tip when perched (Steenhof *et al.* 1998).

Immature: The back of the young lacks the light brown barring like that found with adults and so appears darker. The underparts are more heavily streaked.

Flight: The dark triangular patches on the inner core area of the Prairie Falcon's otherwise the pale underwing is distinctive in flight. It has a slimmer build than the Peregrine Falcon.

Distinguishing Features: The head of the Prairie Falcon is square or blocky. It is similar to the Peregrine Falcon in appearance, but is paler, sandier in colour, and the facial markings are less distinctive. A white area between the eye and the dark ear patch are diagnostic.

Voice: Alarm call is a yelping *kik kik kik*. As part of a ledge display at potential nest sites, at food transfers, aggressive interactions and mostly during courtship, both sexes emit a characteristic *Eechup* call, also known as *chup* or *kiduchip* (Steenhof *et al.* 1998).

Habitat

The Prairie Falcon is a bird of arid plains and desert landscapes, wherever cliffs or bluffs are present for nesting sites. It uses dry, open country: shrub-steppe desert, sagebrush plains, grasslands, mixed shrub and grasslands, and alpine tundra. The Prairie Falcon is found throughout the central and southern interior of British Columbia, and occasionally elsewhere in the province, including the south coast (ecoprovinces: CAM, GED, SOI).

It appears to breed only in the south-central interior, but may be expanding their range (Campbell *et al.* 1990), (ecoprovinces: SOI, CEI).

Diet

Ground squirrels are a key prey item during the breeding season. Birds, particularly the Horned Lark, Western Meadowlark, and Mourning Dove, are secondary in the Prairie Falcon's diet in the breeding season but relied on in winter (Steenhof *et al.* 1998). This falcon does much of its hunting from perches, particularly in winter, and may use cliffs or hillocks, or utility poles and power-line towers as scanning stations (Beebe 1974). It also hunts by soaring or 'prospecting' and with low active flight (Phipps 1979). They (females more the males) cache prey in clumps of vegetation and in rocky areas within the nesting territory.

Locating Nests

Nesting territories include valleys (sometimes caves in the southern interior including the Okanagan and Nicola Valley) and river canyons with rocky cliffs, buttes, and escarpments. Cliffs used by nesting Prairie Falcons are relatively low to moderate in height. Nest sites are bare scrapes on such cliffs, usually with a protective overhang, and are often near water. Noisy aerial nest displays occur several weeks prior to egg laying, and seem to be stimulated by strong winds against the nest cliff (Beebe 1974). Egg laying is from early March to mid-May and young are at the nest from mid-May to early August. The Prairie Falcon nest site is marked by yellowish whitewash and prey remains beneath the nest and favourite perch sites. They are known to nest at higher densities than most other large North American falcons (Enderson 1964).

Risks

Studies of the Prairie Falcon on the Canadian Prairies found that many birds were aggressive in nest defence, making direct attacks on intruders, but an almost equal number were moderate or weak in their nest defence, merely calling or leaving the site (Fyfe *et al.* 1976). The Prairie Falcon rarely strikes humans, but is aggressive with raptors and will attack normally tolerated nearby Ravens when human presence agitates them (Beebe 1974).

Survey Notes

The RIC recommended methods for surveying the Prairie Falcon are aerial surveys for nests, boat surveys, and roadside surveys in the breeding season. Migration surveys can be used in the non-breeding season. Standwatches are also suitable for this species. Steenhof *et al.* (1998) surveyed by walking along canyon rim and observing from observation points along the bottom of the cliff; 1 in March/early April, 1 in May and 1 in June.

The Prairie Falcon is a noisy bird near its nest, and is vocal throughout the winter in interactions with other raptors.

Aerial surveys

- When surveying for cliff nesting falcons stratification of quadrats based on expected raptor densities is often based on the number of kilometres of cliff edge or canyon rim within each quadrat (Grier 1977, Hodges *et al.* 1984).
- Falcons often sit with their feet under or between their eggs/young, and if startled may accidentally eject them when vacating the nest. Helicopter flights should be flown a minimum of 50 m above the nest and should be terminated if birds are becoming agitated. Confirmation of nest occupancy can be determined on a later flight during the nestling stage when young are visible from a greater distance.
- Two surveys should be conducted with minimal disturbance during April and May to determine nest occupancy, and again in late May to July to determine number of young that are in the late nestling stage (see Wilson *et al.* 2000 for methods).

5.7 Owls

5.7.1 Barn Owl B-BNOW *Tyto alba*

BoBC–352; BH–288; NGS–238; PWB–198

Species Description

Appearance: The Barn Owl (crow-sized) has a white, heart-shaped (monkey-like) facial disk, and dark eyes. It is a medium-sized, slender-bodied owl with long legs. Both sexes have golden or rusty upper plumage. Their underparts are whitish or cinnamon and are unstreaked but are finely speckled with black. Juveniles are similar to adults.

Identification: The Barn Owl in flight has the typical owl-like large head and slow moth-like wingbeats. The heart-shaped, white face of this owl is distinctive. In flight, the pale, unstreaked breast is a good field mark. The bird is typically observed hunting near farm buildings and farmland at dusk and early in the morning.

Voice: Makes a shrill, rasping hiss — *kschh shiiish*.

Habitat

The Barn Owl prefers open country, especially agricultural areas or grasslands. Habitat use is restricted to open areas with available nest and roost sites. It is found in the Fraser lowlands and lower mainland to Hope, southeastern Vancouver Island, and in the southern interior (ecoprovinces: GED).

In the Fraser Lowlands the population is predominately resident. There are records for this species throughout the Okanagan Valley (ecoprovinces: GED, SOI). Populations are generally sedentary, though numbers fluctuate with prey cycles.

Diet

The Barn Owl feeds on small mammals, particularly voles. In British Columbia, *Microtus* voles make up most of the diet, followed by shrews (Campbell *et al.* 1987). During peak vole years, the Barn Owl breeds prolifically throughout the year. This species hunts at night, making low flights over open habitat.

Locating Nests

Egg laying and rearing young is year round, particularly when there are plenty of voles available. Roosting Barn Owls are generally well hidden, however they roost for long periods in the same places, thus leaving behind an accumulation of feces and pellets. Barn Owls flushed from roosts in daylight are often mobbed by corvids (Marti 1992).

The Barn Owl commonly roosts and nests in human-made structures such as barns, sheds, aircraft hangers and silos. Where they are available it will also use large natural tree cavities and suitable holes in cliffs. Most nests found in British Columbia were in human-made structures including nest-boxes (Campbell *et al.* 1990). No nest is built. The birds lay eggs on

any available flat surface, but down feathers and old pellets usually surround the nest area, with the eggs often lying on a layer of old pellets (Bunn *et al.* 1982).

Survey Notes

The RIC recommended methods for surveying the Barn Owl are call playback surveys or foot surveys during the breeding season and migration surveys during the non-breeding season.

- Conduct surveys between 0.5 hours after sundown and 0.5 hours before sunrise.
- Barn Owls call most frequently at and just after dusk. During the breeding season, the main periods of activity are just after sunset and just before sunrise. Advertising males call repeatedly and make display flights in and out of potential nest sites (Bunn *et al.* 1982).

5.7.2 Flammulated Owl B-FLOW *Otus flammeolus*

BoBC–356; BH–300; NGS–244; PWB–204

Species Description

Appearance: The Flammulated Owl is a small owl with dark eyes. It is grey and tawny reddish in colour, with inconspicuous ear tufts.

Voice: Song is a long series of notes: a mellow *hoot* or *hoo-hoot*, low in pitch for such a small owl, repeated steadily at 2–3 second intervals.

Habitat

The Flammulated Owl in British Columbia appears to be restricted to mountainous and valley-side areas of the interior, where mature Douglas-fir are dominant and ponderosa pine are present. Regenerating thickets are used for roosting. The highest densities of owls occur in tree stands aged 140–200+ years (Howie and Ritcey 1987, Groves *et al.* 1997). Breeding occurs in areas of well-spaced Douglas-fir with open understory on moderate to steep slopes. In British Columbia the Flammulated Owl breeds in the Thompson-Okanagan plateau area (ecoprovince: SOI). There are no valid winter records for this species in the province.

Diet

The main diet of the Flammulated Owl includes insects, primarily moths and beetles. All hunting is done at night.

Locating Nests

Nests are in tree cavities, usually in old woodpecker nests and have been found between 610 and 1210 m (sub-boreal/Douglas Fir Ponderosa Pine line) elevation, ranging from mature to mixed aged Douglas Fir and Ponderosa Pine stands (Campbell *et al.* 1990, Grove *et al.* 1997). The Flammulated Owl will also use nest boxes (Campbell *et al.* 1990). Egg laying is from mid-April to mid-July and young are at the nest from mid-May to mid-August.

Survey Notes

The RIC recommended method for surveying the Flammulated Owl is call playback during the breeding season.

Call playback surveys

Like many owls, Flammulated Owl populations are not evenly distributed throughout their British Columbia range, and are thus difficult to estimate (Campbell *et al.* 1990). As well, territorial occupancy can not be estimated from density estimates due to bias from the possibility of recording the same male at more than one station or recording surplus birds en route during migration (Woudenberg and Christie 1997).

- The hoarse, low-frequency notes of this species are often ventriloquial and difficult to locate, especially in variable habitat like that found in British Columbia (Woudenberg and Christie 1997). The impression given by this call is that of a larger owl calling from a distance (the vocal repertoire of the Flammulated Owl is similar to that of the Long-eared Owl), (McCallum 1994).
- Woudenberg and Christie (1997) found that mimicked calls by surveyors worked better than tape recordings during their surveys for Flammulated Owl in the southern interior of British Columbia. This technique should only be attempted by field crew that are experienced in owl calling and know the Flammulated owl call well.
- Timing:
  - Flammulated Owls are heard more often than seen. Males sing (typically from the crown of a mature tree) for hours on end early in the breeding season (and more sporadically later), and unmated males continue to sing throughout the summer. In British Columbia singing begins in early May (Cannings and Cannings 1982).
  - Male Flammulated Owls may give vocal response to call imitations. Call playback survey transects have been used in May, June and early July to elicit responses. Paired males may not respond later in the nesting period (Reynolds 1987).
  - Conduct surveys between 2200 and 0100 hours (Howie and Ritcey 1987, Johnson and Zwank 1990, Groves *et al.* 1997).
  - At the beginning of the breeding season the greatest calling intensity for the Flammulated Owl is during much of the evening, and then after nestling hatching singing is "later at night" (Reynolds and Linkhart 1987).
- Interstation Distance
  - Recommended distance between call playback stations for the Flammulated Owl is 0.5 km (Howie and Ritchie 1987).
- Stop Duration
  - Listening time at a station should follow the standard 5 minutes after broadcasting calls. Other surveys have waited longer (e.g.,Woudenberg and Christie 1997).

Locating Nests

Tree cavities used by the Flammulated Owl in British Columbia have generally been old Northern Flicker nests but other similar sized cavities will be used. Observations from a blind or by stealthily approaching calling birds, can be used in the spring to locate nests. During the nest selection process the male enters and calls from potential nest cavities within the territory, in the hope of attracting a mate. Later in the breeding season, frequent visits to the nest with food will take place most frequently one hour after sunset and one hour before sunrise. Dry, chitinous pellets are sometimes found nearby or in nest boxes.

Woudenberg and Christie (1997) took compass bearings to calling owls from playback stations and then used triangulation of the bearings to help identify areas used by calling owls and thus possible nest areas. Parallel transects 50 m apart through areas where owls were detected were surveyed in June and early July to try and find nest site locations. Confirmation of a nest site was made if a female Flammulated Owl was observed at a cavity entrance. Multiple surveys, starting when migrants arrive until nesting is underway, is also important to ensure that most calling males are detected so fewer nest sites are likely to be missed during nest surveys.

Risks

After fledging, both sexes will hoot and swoop close to human intruder's heads if the fledged young are approached (McCallum 1994).

5.7.3 Western Screech-Owl B-WSOW *Otus kennicotti*

BoBC–358; BH–296; NGS–242; PWB–200

Species Description

Appearance: The Western Screech-Owl is a small owl with conspicuous ear tufts (when raised) and yellow eyes. It is grey or brownish in colour. The underparts are marked with blackish streaks and thinner bars.

Voice: Two common calls. The first is a series of hollow whistles on one pitch, at first distinct building to a trill, then slurring together with the rhythm of a small ball bouncing progressing to a standstill (Tyler and Phillips 1978). The second is a short trill followed immediately by a longer trill.

Habitat

The Western Screech-Owl is found in many forest habitats, but prefers mixed forests near water. In the interior, these owls use deciduous woods near lakes and streams. It roosts in tree cavities, on branches, in nest boxes, and in cliff crevices. Breeding habitats include rivers, bogs, lakes, creeks, and marshes. It utilises orchards, parks and gardens. The Western Screech-Owl breeds on Vancouver Island, the Gulf Islands, the Fraser Lowlands and the southern Okanagan valley (ecoprovinces: CAM, GED, SOI), (Campbell *et al.* 1990).

The Western Screech-Owl occurs year round on Vancouver Island and the mainland coast through the Fraser Lowlands to Hope. It is also a likely resident on the northern coast and in the interior below 600-m elevation from the Kootenays south and throughout the Okanagan. It is essentially non-migratory, and can be found in the same habitats as breeding habitats (ecoprovinces: CAM, GED, SOI, SIM).

Diet

The Western Screech-Owl's diet includes a wide spectrum of prey including small birds and mammals, insects, and amphibians.

Locating Nests

Nests can be found in nest boxes, or in natural cavities or holes created by Pileated Woodpeckers and Northern Flickers. Most nests found in British Columbia have been between 3 and 4.5 m above ground, and many nest boxes have been used (Campbell *et al.* 1990). Male and female owls engage in a courtship duet in springtime soon after dark, from perches close to the nest cavity. Nests can be located by listening for these duets and walking in to this area during daytime to locate possible nest cavities. Egg laying is from late April to late July and young are at the nest from mid-May to mid-August.

Risks

The Western Screech-Owl is relatively passive at nest sites in the egg stage, but will attack humans during the nestling period when approached at night (Tyler and Phillips 1978).

Survey Notes

The RIC recommended method for surveying the Western Screech-Owl is call playback during the breeding season.

Call playback surveys

Screech-Owls appeared to accommodate themselves to playback, however, they responded with less frequency when surveyed repeatedly at short intervals (Smith *et al.* 1987). Phases of the moon show no affect on detection rate, however, a decrease in detection rate was seen with increasing wind speed, temperature and cloud cover (Hardy and Morrison 2000). Responses occur more rapidly in winter and owls take the longest to respond in spring (Carpenter 1987).

- Documented response rates to call playback for the closely related Eastern Screech-Owl is 91% (Smith *et al.* 1987).
- Timing
- Conduct surveys between 0.5 hours after sundown and 0.5 hours before sunrise. Hardy and Morrison (2000) started surveys within 0.5 hours after sundown and completed them in 4 hours. Greatest calling intensity for the Western Screech-Owl is anytime after dark, with the greatest response after midnight (D. Fraser, pers. comm.).
- In Idaho, male Western Screech-Owls appear to defend their territories year round and respond to playback calls (Herting and Belthoff 1997).
- It is recommended to do surveys 4-5 times per year between mid-March to late May (Hardy and Morrison 2000), mid-April to August in more northern regions.
- Interstation Distance
- Recommended distance between call playback stations for this inconspicuous owl species is 0.8 km (Hardy and Morrison 2000).

5.7.4 Great Horned Owl B-GHOW *Bubo virginianus*

BoBC–360; BH–292; NGS–238; PWB–200

Species Description

Appearance: The large size (46-63 cm), bulky shape, distinctive ear tufts and white throat patch or bib of this owl are distinctive. It is dark brown/grey brown, with heavy barring underneath. In flight, the Great Horned Owl approaches buteos in size. Like other owls, in flight it appears to have no neck and a large, stubby head.

Voice: Gives a series of 3-8 loud, deep hoots, the second and third often short and rapid. The pattern for males is *hoo, hoo-oo, hoo, hoo* (sounds like: *Who's awake? Me too*); for females *hoo, hoo-hoo-hoo, hoo-oo, hoo-oo*, uttered more rapidly, and in a higher pitch. It is only one of two North American owls to give multinote hoots (Houston *et al.* 1998). It also snaps or claps its bill vigorously when angry, disturbed, stresses or as a warning or aggressive sound (Houston *et al.* 1998).

Habitat

The Great Horned Owl is able to live in virtually all types of treed habitat from sea level to tree line. It has been found in British Columbian cities, usually near parks or golf courses with treed areas. It requires only a nest tree, perch sites, and hunting area. Hunting areas are typically relatively open, but often include scattered trees for perching (ecoprovinces: CAM, GED, BOP). It is less common at higher elevations, and populations appear to decrease northward through the province (Campbell *et al.* 1990).

It breeds throughout its range, except on the Queen Charlotte Islands (Campbell *et al.* 1990), (ecoprovinces: CAM, GED, SOI, SIM, CEI, SBI, NBM, TAP, BOP).

Diet

The main prey of the Great Horned Owl is hares and rabbits, particularly in the northern parts of its range. However, this species has a wider range of prey than that known for any other North American raptor (Johnsgard 1988). Mammals appear to be the preferred food, but when these are scarce, birds form a large part of the diet.

Locating Nests

Egg laying is from mid-February to late May and young are at the nest from late March to mid-September. Signs of a Great Horned Owl nest or roost site include the presence of whitewash blobs, prey remains, or pellets. Owls do not pluck their prey before eating it, instead swallowing bone and meat together. Therefore they do not leave plucked skeletal remains, as other predators do, but instead leave scattered appendages. The Great Horned Owl often uses a regular feeding roost, which may be on a stump, fallen log, or wide flat tree branch. These sites are littered with bones, feathers, fur, droppings, and pellets. Unbroken Great Horned Owl pellets are 5–10 cm in length and 3–4 cm in diameter. The pellets of this owl usually contain sizeable bone fragments, unlike those of hawks, whose digestion is more complete. The current spring's whitewash is easily distinguished from winter specimens, which will be crumbly blobs, formerly atop snow, or have been washed away by rain. The presence of fresh whitewash in several sites, large 'velvety' feathers, and pellets underneath

several roost sites indicates that Great Horned Owls are using the area regularly; a nest may be nearby.

Nests are generally in coniferous, sometimes deciduous trees, also rock cliffs and clay banks, and the tops of broken snags. On the coast, the most common nest sites are in broken-top snags. The Great Horned Owl does not build its own nests. It usually uses old nests of other large raptors or atop parasitic vegetative growths, or 'witches brooms'. Previously used nests utilised by the Great Horned Owl in British Columbia includes those of Red-tailed Hawks, crows, herons, eagles, ravens, and Northern Goshawks. Over half of recorded nests in British Columbia were at heights of between 7.6 and 14 m (Campbell *et al.* 1990). The home range may include open habitat including fields, wetlands, pastures or croplands (Houston *et al.* 1998).

In deciduous forests, the Great Horned Owl uses old nests of other species and these can be detected with the use of systematic searches from the air or ground in late winter. Rohner and Doyle (1992) have outlined a method of locating Great Horned Owl nests in the boreal forest that may also be applied to other locales, such as British Columbia's temperate rainforest. The first step involves an acoustic triangulation of the nesting area. By taking bearings of the hooting birds, the general locality of the nest can be ascertained. Males regularly roost in the immediate vicinity of the nesting female. They begin hooting in this area just after sunset, and again hoot in the nesting area about an hour before sunrise (Rohner and Doyle 1992). Females generally join in from the nest, with one or several hoots at the beginning and end of each activity period. The second step is a careful visual search of the probable nesting area. In areas where there are many witches brooms or old nest sites, the best distinguishing feature of an active nest is the presence of fresh down feathers at the edge of the nest or in nearby branches. These feathers are especially visible in sunlight, or when waving in a breeze. Both birds will hoot in the daytime when a nest is approached.

Risks

The Great Horned Owl varies in behaviour when the nest or young are disturbed. In general, this species is very aggressive and will attack intruders, particularly when the nest tree is climbed. Hooting and barking alert visitors to the fact that they are near a nest site. Both male and female owls will defend the nest, striking intruders with their talons. Caution must be taken, including wearing protective clothing and helmets. It is helpful to have a bystander to alert a tree climber when an owl is incoming; these owls often hoot just before they strike.

Health risks associated with handling Great Horned Owl pellets are minimal; the digestive process tends to kill harmful bacteria. However, although mice are uncommon prey, wearing gloves when handling pellets can lessen the risk of contracting Hantavirus.

Survey Notes

The RIC recommended method for surveying the Great Horned Owl is call playback during the breeding season.

Population densities of Great Horned Owls in the northern and interior parts of the province have been shown to parallel snowshoe hare cycles, with dispersal taking place during the hare population crash (Rohner 1996).

Call playback surveys

Great Horned Owls are known to respond to call imitations or playback. Documented response rates to call playback for Great Horned Owl is 75-85% (Springer 1978).

Call playback is not necessarily valuable for locating the nests of this species. These birds will fly large distances to respond from all parts of their home range, or may follow the surveyor from call playback station to call playback station. Great Horned Owls have been shown to cease calling and not respond to call playback during periods of low prey abundance (Doyle 2000).

- This technique is most effective in February and March, but these owls will also respond at other times of the year.
- Conduct surveys between 0.5 hours after sundown and 0.5 hours before sunrise. Greatest calling intensity for the Great Horned Owl is dawn and dusk (D. Fraser, F. Doyle pers. comm.), which corresponds to male and female calling duet and territorial calling (Rohner and Doyle 1992).
- Interstation Distance
    - Recommended distance between call playback stations for this owl species is 1 km (F. Doyle pers. obs. in Boreal Forest Yukon with a breeding pair every 2 km in peak prey years (Doyle 2000).

A call series, followed by the listening period, may be repeated up to a maximum of 3 times for this species. If birds are going to respond to playback it will typically be within 20 minutes of starting playback. (Rohner pers. comm.).

5.7.5 Snowy Owl B-SNOW *Nictea scandiaca*

BoBC–362; BH–296; NGS–240; PWB–198

Species Description

Appearance: The Snowy Owl is a large white owl with a rounded head and yellow eyes. It is bulky in stature. Most birds have variable black markings; adult males are markedly smaller and paler than females; females have more dark bars and spots, and juveniles are the most heavily marked with dark streaks.

Identification: This almost unmistakable owl will fly during the day or perch on drifts, posts, haystacks, etc. It does not have ear tufts or a large facial disk.

Voice: Usually silent outside of its breeding range.

Habitat

The Snowy Owl is a circumpolar species that lives and breeds in open tundra north of the tree-line. In British Columbia, they winter in southern portions of the province, and in years of population irruption (Parmelee 1992), it can also found in the northern and southern interior (ecoprovinces: CAM, GED, SOI, SIM, CEI, BOP). In British Columbia it is usually seen roosting or perching on the ground or on slight rises such as raised drifts, stumps, posts, and rocky headlands.

Principal wintering areas in the interior are the open country of the Peace Lowlands near Fort St. John and the northern Okanagan Valley near Vernon. Habitats in the Okanagan include grasslands, lake shores and alpine meadows (Campbell *et al.* 1990). Along the southern coast in the winter, the Snowy Owl is primarily found in open country. It is often seen in urban areas where it can be found in parks, marshes, and airports.

Diet

In coastal areas on southern Vancouver Island, the Snowy Owl feeds mainly on wintering waterfowl and small passerine birds (Guiget 1954). Waterfowl (grebes and ducks) also comprise most of the diet in the Fraser Delta area (Campbell *et al.* 1990). Reports from many other wintering areas in Canada, which would match more northern areas of British Columbia, show mice and voles as the main component of the winter diet. This owl is largely diurnal and hunts in all kinds of weather.

Survey Notes

The RIC recommended method for surveying the Snowy Owl is roadside survey during the non-breeding season.

Visits to the Fraser Delta area are useful for wintering bird counts. The Snowy Owl often remains at a commanding perch for long, uninterrupted spells. In flight, it suggests a buteo or harrier, with jerky, swaying movements caused by quick upstroke and slow down stroke of the wings (Parmelee 1992). Surveying the birds is easiest when there is no snow on the ground.

Risks

The Snowy Owl is known to attack viciously when approached in its breeding range, and has seriously wounded humans. In its wintering areas this owl is described as exhibiting anything from docility to skittishness. As with all raptors care should be taken when in close proximity to the birds. The Snowy Owl hisses when threatened (Parmelee 1992).

5.7.6 Northern Hawk Owl B-NHOW *Surnia ulula*

BoBC–362; BH–306; NGS–246; PWB–202

Species Description

Appearance: The upperparts of the Northern Hawk Owl are dark brown and spotted with white. The chest and abdomen are sharply brown-barred. The pale greyish facial disks are black-bordered, appearing like sideburns. This black border of the facial disk extends down on to the chest. The eyes and bill are yellow.

Identification: The Northern Hawk Owl is a medium-sized (pigeon-sized with a long tail), slender, hawk-like owl with pointed wings that often flies by day. It does not have ear tufts. Its long, rounded, tapered tail and falcon-like profile is distinctive. It is often seen perched high in a spruce tree, and is known to jerk its tail like a American Kestrel. The flight of the Northern Hawk Owl is low and swift, with rapid wing beats. It occasionally hovers. The flight pattern of this species (direct, quick flight often beneath canopy height) is surprisingly

like that of the accipiters, and a good view of the head is often needed to distinguish between them.

Voice: Alarm call is a rapid series of *kip kip kip* or *kleep kleep kleep* or a raspy *skree-e-e-e-e-yip*. Territory call of the male is a bubbling whistle *ululululululululul* that lasts up to 14 seconds. (Mikkola 1983).

Habitat

The Northern Hawk Owl uses semi-open and open areas for hunting, including fields, lake shores, and burns. Nesting habitat is fairly open coniferous and mixed forests, typically in boreal and sub-alpine forest areas, and most often in northern parts of the province (ecoprovinces: SOI, SIM, SBI, BOP).

During the non-breeding season, it is found throughout the province, east of the coast and mountains ecoprovince with highest densities occurring above 56 degrees latitude (ecoprovinces: CAM, GED, SOI, SIM, CEI, SBI, BOP).

Diet

The Northern Hawk Owl's summer diet consists primarily of voles. However, it will take a variety of prey including grouse, ptarmigan and both adult and juvenile hares in winter.

Locating Nests

Nests are located in the tops of broken snags, and occasionally in natural and woodpecker cavities. They do not add fresh material to the nest (Duncan 1998). The Northern Hawk Owl is widespread throughout the interior of British Columbia, but is rarely seen at the coast (Campbell *et al.* 1990). Birds will perch in an open location near the nest site and repeated sightings at the same location, particularly of pairs indicates that a nest site is near. Egg laying is from mid-April to the first of June and young are at the nest from late May to early August. Often when nests are at the top of a snag, the brooding owl's head can just be seen rounding off the usually jagged tops of snags. Nests can be located by watching hunting birds who will fly directly to the nest with prey. Take a compass bearing and follow. Birds will actively mob other predators when they are near the nest or recently fledged chicks. Northern Hawk Owls will leave pellets and whitewash under perch sites. They have been known to swoop and attack intruders, including people.

Risks

These birds will try to hit intruders to the nest, so suitable protection should be worn. In particular, birds will fly at the head and eyes so a full-face crash helmet and goggles are recommended.

Survey Notes

The RIC recommended method for surveying the Northern Hawk Owl is roadside surveys during the breeding season.

Roadside surveys

- Conduct surveys during the day as this owl is diurnal. There are no recommended calling times currently for this species.
- This species fluctuates in numbers often dramatically, and it is recommended that several years of surveys may be needed to ascertain its status in a particular area (Rohner *et al.* 1995).

5.7.7 Northern Pygmy-Owl B-NPOW *Glaucidium gnoma*

BoBC–366; BH–302; NGS–244; PWB–204

Species Description

Appearance: The Northern Pygmy-Owl is a very small owl (sparrow-sized) with no ear tufts. The upperparts are rusty or grey brown, spotted with buff white, particularly on the head and wings. It has sharp dark-brown streaks on white underparts. The long tail is dark brown with six or seven pale crossbars. The eyes are yellow. This owl has a distinctive black patch on either side of the hind neck — appearing like a second set of eyes.

Identification: The Northern Pygmy-Owl is often heard calling or seen flying during the day, but is most active at dawn and dusk. It is a favourite target for songbirds and can often be identified by the pack of mobbing birds surrounding it. The flight is straight and direct. When perched the tail is often held at a crooked angle (Tyler and Phillips 1978). The head of this owl is proportionately smaller than that of the Western Screech-Owl or Northern Saw-whet Owls.

Voice: Call is a single mellow whistle, *hoo*, repeated every 2 seconds (sounds like a submarine sonar to some). It also uses a rolling series of hollow *too-too-too-too-too-too-too-too-took-too-took* notes, the last three of these being emphatic.

Habitat

The Northern Pygmy-Owl prefers the edges of open coniferous forests or mixed woodlands, using logged areas, thickets, meadows, parks, farmlands and orchards. It also inhabits river and lakeshores. This diurnal owl is widely distributed in northwestern British Columbia and southwest Alaska, but appears to be a year-round resident only in southern parts of the province and rare elsewhere (ecoprovinces: CAM, GED, SOI, SIM, CEI, SBI).

The Northern Pygmy-Owl breeds on Vancouver Island (commoner on the west coast than the east), the mainland coast, as far north as Prince Rupert, and in the southern interior (ecoprovinces: CAM, GED, SOI).

Diet

The Northern Pygmy-Owl eats songbirds, even ones greater in size than the owl itself, often striking them in the air during steep dives. The Northern Pygmy-Owl also takes small mammals like mice and chipmunks, and insects. It is diurnal, feeding in early morning and late afternoon. It caches food during breeding and non-breeding seasons (Holt and Petersen 2000).

Locating Nests

Nests are in natural tree cavities, or those made by the smaller woodpeckers. Nest trees are often found on steep hillsides, slopes, or ravines near water. During courtship, the Northern Pygmy-Owl calls soon after dusk, where the female calls (a low trill) from a perch near the nest, and is joined by the male. In daytime, look for mobbing behaviour by small birds, in locations where owls had previously been heard. This often indicates the presence of the owl and a possible nest site. Egg laying is from mid-April to mid-June and young are at the nest from early June to late August.

Survey Notes

The RIC recommended method for surveying the Northern Pygmy-Owl is call playback during the breeding season.

This owl often perches on tree limbs quite inconspicuously, but also sits on top of treetops conspicuously. It often darts through the bushes like any other small bird and may not be recognised for what it is.

- Timing
  - Greatest calling intensity for the Northern Pygmy-Owl is at dawn and dusk, but it will call at night (D. Fraser, pers. comm.). This is the best time to conduct surveys.
  - The the Northern Pygmy-Owl shows a fairly uniform peak in detections one-half to four hours after sunset, (Deal and Lamont 1996a unpubl.)
- Interstation Distance
  - Recommended distance between call playback stations is 0.8 km (Deal and Lamont 1996s unpubl.).

5.7.8 Burrowing Owl B-BUOW *Athene cunicularia*

BoBC–368; BH–306; NGS–246; PWB–202

Species Description

Appearance: This is a small, round-headed, short-tailed, ground-dwelling owl. The Burrowing Owl is very long-legged, and its thin legs are mostly bare of feathers. The adult is sandy-brown in colour and is boldly speckled and barred, with white eyebrows and throat. Its yellow eyes appear large, and it has a poorly developed facial disk. Juveniles have a cream to buffy unbarred breast.

Identification: This open-country owl is often seen by day standing on the ground or on fence posts. It bows or bobs when agitated, and has a preference for running rather than flight.

Voice: A rapid, chattering *quick quick quick*. At night, the call is a mellow *co-hoo*, pitched higher than a mourning dove.

Habitat

The Burrowing Owl lives in loose colonies in open habitat. It frequents short-grass areas of agricultural lands, airports, golf courses, and coastal sand dunes. It has been found roosting in hollow logs, culverts and barns. In the interior of British Columbia, it lives in open areas of short-grass and sagebrush with rolling hills, plains, range lands and valley bottoms (Campbell

et al. 1990). The Burrowing Owl occurs mainly in the south Thompson and Okanagan in the interior of the province, and also rarely on the Fraser River Delta (ecoprovinces: GED, SOI). This migratory owl arrives in March and departs in September (Campbell *et al.* 1990), though some reintroduced owls have over-wintered in the Kamloops area (Dundas 1995).

The Burrowing Owl virtually disappeared from British Columbia in the late 1970s, and recent attempts have been made to reintroduce owls into the Okanagan (thirteen returned to area in 1992), combined with attempts to protect and extend suitable habitat (ecoprovinces: GED, SOI).

Diet

The Burrowing Owl is an opportunistic feeder, primarily eating arthropods, and occasionally small mammals and birds. It hunts by running, walking, and hopping over the ground, flying from a perch, or hovering and fly catching in the air (Haug *et al.* 1993).

Locating Nests

Nests can be located by watching suitable nest sites for activity, especially birds carrying food to holes. Nests are in ground burrows, either natural or those of burrowing mammals. Burrowing Owls will also use human-made burrows. Nests in British Columbia have included a marmot hole, a badger den, a striped skunk den, and an old drain pipe (Campbell *et al.* 1990). Egg laying is from late March to late May; and young are at the nest from early May to late September.

This species is Red Listed and no attempt should be made to inspect or locate nests without prior permission from the appropriate authorities.

Survey Notes

The RIC recommended method for surveying the Burrowing Owl is roadside surveys in the breeding season.

The Burrowing Owl is vocal during the breeding period, and in defence of nests. The male's primary song is described as *coo-coooo* (Haug *et al.* 1993). Haug and Didiuk (1993) used recordings of this song to elicit responses from territorial pairs. Songbirds will dive at and harass Burrowing Owls, thus giving away their location.

5.7.9 Spotted Owl B-SPOW *Strix occidentalis*

BoBC–372; BH–294; NGS–240; PWB–204

Species Description

Appearance: The Spotted Owl is a medium to large, dark-eyed owl with a puffy round head. It is chestnut brown, with round white spots on head, neck, back, and under-parts. It does not have the barring and streaking of the similar Barred Owl.

Voice: A series of 3 or 4 hesitant dog-like barks and cries. Vocalizations are loud and carry over great distance.

Habitat

South of Downton and Carpenter Lakes to Lillooet, eastern boundary follows the Fraser River from Lillooet to Lytton. South of Lytton its range extends east of the Fraser River to Manning Park. On the west it extends from Downton Lake to the Squamish River Valley and surrounding areas to the US border. Since surveys began in 1985 there have been over 60 occupied sites found. Survey results from 1992 to 2000 suggest a 6.85% annual decline in the number of occupied sites. Currently there are less than 30 occupied sites known (I. Blackburn pers. comm.).

The Spotted Owl inhabits a variety of dense forest habitats. Preferred habitat in British Columbia is Douglas-fir or Douglas-fir/western hemlock forests with varying amounts of western red cedar and amabilis fir. Such forests typically exhibit high canopy closure and multiple canopy layers, dominated by large diameter trees. Roost sites are in dense vegetation, and usually in cool, shady spots near streams. This owl casts pellets at roost sites in early evening during summer, and away from diurnal roost sites during the night in winter. The roost sites are often marked with extensive whitewash, pellets, or moulted feathers.

The Spotted Owl prefers to live and nest in mountainous areas, often in shady ravines near water. It is non-migratory; adults generally occupy the same home range year-round. It tends to nest in thick, multi-layered, older portions of forest with relatively high canopy closure. The majority of Spotted Owl pairs do not breed every year, and have been known not to breed for 5 or 6 years. However, they show a strong fidelity to breeding sites even when not nesting (Gutierrez *et al.* 1995).

Diet

The Spotted Owl mainly eats small and medium-sized mammals, primarily rodents. In British Columbia, Northern flying squirrels predominate, but other important prey includes deer mice, bushy-tailed woodrats, red tree voles, and red-backed voles.

Locating Nests

This species is Red listed and location of nests should only be done with appropriate permission. Nests are in broken-top trees and cavities, or platforms such as abandoned raptor nests, squirrel nests, or witches broom. Nests are often reused. Attempts to locate nests should be conducted between mid-March and early June. Egg laying is from mid-March to late June; and young are at the nest from late April to late July. Males, who roost near nest sites during the day are located with call playback surveys and then given a live mouse, the male will return to the nest with the mouse, revealing its location (Forsman 1983, Blackburn 1995, Franklin *et al.* 1996). Another method involves calling near the nest location to elicit a response from the female.

Risks

It is important for surveyors to note that stimulating owls to move around increases an owl's risk of predation. Further, bringing females off a nest increases risks for eggs and young. Therefore, surveys must be undertaken with caution.

The Spotted Owl has often attacked researchers capturing fledged young, especially near the nest. Both male and female parents strike at the head and upper body with talons. Goggles or a facemask should be worn when climbing a nest or when near fledged young.

Survey Notes

The RIC recommended method for surveying the Spotted Owl is call playback during the breeding season. For a full outline of survey methodology please refer to Blackburn and Lenihan 1995 and USDA 1988.

5.7.10 Barred Owl B-BAOW *Strix varia*

BoBC–374; BH–292; NGS–240; PWB–198

Species Description

Appearance: The Barred Owl is a medium to large, tuft-less, chunky-headed, dark-eyed owl. It is grey-brown with dark barring on the upper breast and dark streaking below.

Voice: More likely than other owls to be heard in the daytime. It gives a rhythmic series of loud hoots that sounds like *who-cooks-for-you, who-cooks-for-you-all*. Also it gives a drawn-out *hoo-ah*, sometimes preceded by agitated barking.

Habitat

This owl prefers deep forest habitats, both mixed and coniferous. Near human settlements it has been found near farmland, towns and parks, roosting in railroad bridges, balconies, awnings, and thickets. The Barred Owl is found through eastern and southern British Columbia, with one record from the north west part of the province. Northern populations are believed to be may be partially migratory while the southern populations are considered residents (ecoprovinces: CAM, GED, CEI, SOI, SIM).

Breeding usually takes place in mature forests near water, including lakeshores, swamps, and creek valleys. It breeds in coastal areas, and in the south-central part of the interior e.g., Kamloops, Okanagan; Campbell *et al.* 1990), (ecoprovinces: CAM, GED, CEI, SOI, SIM, CEI, SBI, NBM, TAP, BOP).

Diet

The Barred Owl eats mice and other small mammals, and will also capture amphibians like frogs and salamanders when these are available. It hunts at twilight and through the night, and is occasionally seen active on cloudy days Tyler and Phillips 1978).

Locating Nests

Nests are found in hollow tree tops or tree cavities south of 55 degrees latitude. Egg laying is from mid-March to late June; and young are at the nest from late April to late July.

Risks

The Barred Owl actively defends nest sites and young and will strike humans. There are records of lacerations, and at least one person losing an eye to a Barred Owl defending its nests.

Survey Notes

The RIC recommended method for surveying the Barred Owls is call playback during the breeding season.

Call playback surveys

- The Barred Owl is a very vocal bird. It shows a high response rate to vocal imitation or call playback during the breeding season, but shows a much lower response in other times of the year.
- Francis and Bradstreet (1997) found that the use of call playbacks increased Barred Owl detections by 50% in the first 2 minutes after playback.
- Documented response rates to call playback for Barred Owls is 82.4% (Bosakowski 1987).
- Timing:
  - Conduct surveys during the breeding season.
  - Surveys can be conducted during the day or during the night. Response by these birds appear to be equal during daylight hours as it is during the night, which makes it easier to survey them on rugged terrain (Bosakowski 1987).
  - Nocturnal surveys: conduct surveys between 0.5 hours after sundown and 0.5 hours before sunrise. Takats and Holroyd (1997) found no significant difference in response rate among 3 time intervals: 20:00-23:59, 00:00-03:59 and 03:59-07:59. Deal and Lamont (1996b unpubl.) found the peak of Barred Owl activity was between 1 to 2 hours after sunset during nocturnal surveys.
  - Daylight surveys: surveyors should attempt to remain hidden at stations as this owl may flush or remain secretive if aware of human presence.
- Stop Duration
  - Listen for 15 minutes after broadcasting a series of calls. It is important to allow more than the standard 5 minutes after broadcasting to allow time for this species to respond (pers. comm. D. Fraser, McGarigal and Fraser 1985, Deal and Lamont 1996a unpubl.). Surveyors believe that some Barred Owls fly in relatively close to the tape player without vocalizing, then wait several minutes (5 to 15) after the taped calls end to respond (Deal and Lamont 1996a unpubl.).
  - If a raptor responds, record the number of minutes the detection was made after the calls had been broadcasted. This can later be used to determine the optimal amount of time that a surveyor should wait after broadcasting calls. For example, Takats and Holroyd (1997) found that most of the owl calls in their study in Alberta were recorded in the first 7 minutes suggesting stops do not need to be longer.
  - The surveyor will need to determine whether the time to broadcast more than one call series per station is warranted.
- Interstation Distance
  - Barred Owl song is audible at up to an 800-m distance (Bosakowski 1987). Call playback often brings birds into view without any audible response.
  - Recommended distance between call playback stations is 1.6 km (Bosakowski 1987, Takats and Holroyd 1997). When interstation distance increased from 0.8 to 1.6 km, Francis and Bradstreet (1997) found no change in the number of Barred Owls that observers thought to be at more than one station. However, they did feel the variance associated with the judgement differences of observers to determine whether the same owl was being heard at the next station or not may have decreased.

5.7.11 Great Gray Owl B-GGOW *Strix nebulosa*

BoBC–376; BH–294; NGS–240; PWB–198

Species Description

Appearance: The largest of the North American owls. It has a heavily ringed dark facial disk and yellow eyes. It is dusky grey in colour, and striped lengthwise on the underparts. The Great Gray Owl has a noticeable black chin spot, and white throat patch. It does not have ear tufts.

Identification: The tail of the Great Gray Owl is long for an owl. It hunts in open fields or clearings from fence posts, trees, and other low perches. This bird is much larger than the similar Spotted or Barred Owls, both of which have brown eyes. The Great Horned Owl is of similar size, but it has distinctive long ear tufts and is brown in overall plumage colour.

Voice: A distinctive voice that is deep and booming but not far-reaching. The call is a series of deep, booming *whoo*'s. The territorial call of both sexes is a series of low, evenly spaced '*hoos*' in repetition. This call is used mostly during breeding near the nest.

Habitat

The Great Gray Owl is essentially sedentary, but winter irruptions occur into southern areas; possibly due to lack of prey, competition, deep snow or icy crusts. In the forest, this owl perches against tree trunks, its grey colour rendering it inconspicuous. It also perches on fence posts, telephone wires, and snags in rural areas. The Great Gray Owl is widespread throughout the interior of British Columbia, and is occasionally found in southwestern British Columbia in winter (Campbell *et al*. 1990), (ecoprovinces: GED, SOI, SIM, CEI, TAP, BOP).

It breeds in coniferous, deciduous, or mixed woodlands, usually in the vicinity of water, including marshes, lakes, muskegs, pastures and wet meadows (ecoprovinces: SOI, SIM, CEI, SBI, TAP, BOP).

Diet

The Great Gray Owl feeds on small mammals (voles, mice, young rabbits, and squirrels), and occasionally birds.

Locating Nests

As with most owls these birds do not build their own nests, but use abandoned nest of other species and any available flat surface in riparian and muskeg habitat. Many nests are in abandoned Northern Goshawk nests, witches brooms or the tops of large broken snags. Nest sites are often reused for several years. Daylight searches for nests are best conducted in early spring, when the snow is nearly gone and leaves are not yet out. Researchers should search an area intensively for old Northern Goshawk or Raven nests, or suitable snags, then return to check each possible nest for signs of Great Gray Owl activity. These signs could include whitewash, moulted owl feathers, begging chicks, or the presence of hooting, bill-snapping (territorial) adult owls (Nero 1980). Young chicks defecate in the nest; older chicks over the edge, leaving whitewash on the forest floor later in the breeding season. Egg laying is from late March to the middle of May and young are at the nest from late April to early August.

Risks

While often described as relatively 'tame', Great Gray Owl females are particularly savage in defending small nestlings (Nero 1980). Use a helmet and face mask when in nest vicinity; people have lost eyes.

Survey Notes

The RIC recommended method for surveying the Great Gray Owl is call playback during the breeding season.

The Great Gray Owl remains unseen in many years because, by its nature, it is retiring and fond of deep secluded woods and bogs. It is most conspicuous during the non-breeding season when it comes out of the deep woods to perch and hunt along the edges of clearings and roadways. Many people report that it will appear in windbreaks near roads and in rural areas in harsh winters. Following population increases or when food is scarce, it emerges from the forest in search of prey. Birds are often nomadic, and breeding populations fluctuate.

Most surveys of Great Gray Owls in Canada have been done opportunistically, and the researchers knew the owls were in the area and set out to find more information. Quinton (1988) would walk through suitable habitat in hopes of hearing the raspy screeching of begging immatures, or see an adult carrying a vole towards a nest. Nero (1980), studying in Manitoba, searched intensively in winter, spring and early summer to discover if Great Gray Owls were resident in an area. He reports hearing them call at night even in years when few owls were actually seen. Osborne (1987) surveyed for these owls in Alaska from a small aeroplane. He found that he could observe Great Gray Owls perched at meadow edges, or flushed from forest perches, but felt that the method was biased due to varying visibility and unpredictable individual reactions on the part of the owls.

Several studies have stressed the importance of 'plunge marks' as a clue to the winter habitat of owls. These holes are left as markers in the snow where Great Gray Owls have dived though the surface to capture rodents. Whether shallow or deep, plunge holes show distinctive crescent-shaped marks left by folded wings on initial impact. The bird also often leaves a tail impression and a fainter impression of spread primaries where it braced itself to lift out of the snow. Plunge holes have been used to identify feeding sites and presence of owls by observing roadside snowbanks when driving through owl country. This method is obviously limited by the frequency and depth of snowfall.

Call playback surveys

Some researchers found that Great Gray Owls would respond to call imitations, but not enough research has been done to fully assess this survey method. As is the case with other owls, Great Gray Owls may not respond to playback in low prey years.

- Conduct surveys between 0.5 hours after sundown and 0.5 hours before sunrise. Most frequent calling time for Great Gray Owls is a peak at 22:00 and a second peak at 01:00.
- Recommended distance between call stations for this species is 0.8 km (Duncan and Duncan 1997).
- Playback should be done over several years to determine the presence of Great Gray Owls.

- Playback is not recommended as a tool for finding owl nests because owls will respond from large distances over a wide home range and not from nest sites alone.

5.7.12 Long-eared Owl B-LEOW *Asio otus*

BoBC–380; BH–290; NGS–238; PWB–200

Species Description

Appearance: The Long-eared Owl is a medium-sized, slender owl with long, close-set ear tufts. It is brown/grey in colour and boldly streaked and barred on the underparts. The facial disk is rusty coloured. It is a nocturnal species that roosts in forest or thickets and hunts semi-open and open areas at night. Birds feeding young will also hunt in daylight hours. A similar species, the Short-eared Owl, is found hunting in similar habitat, but is seen hunting in daylight. The owl's flight is characterised by fast wing beats, interspersed with short glides.

Voice: Generally silent, except during the breeding season. The common call is one or more long, low, moaning *hooo*'s.

Habitat

The Long-eared Owl nests and roosts in dense forest and hunts in nearby open areas. It breeds in deciduous thickets of birch, willows, trembling aspen, hawthorn, and black cottonwood, usually near water and south of 55 degrees (ecoprovinces: GED, SOI, CEI, SBI). It prefers abandoned nests of crows, hawks and squirrels in small deciduous woodlands.

Though this species is said to roost in large groups in the winter, the only record of this in British Columbia is of six birds roosting together in the Okanagan (Cannings *et al.* 1987). It is found in a variety of habitats at low elevations and often associated with riparian zones. The Long-eared Owl is found throughout the southern third of British Columbia, with the centre of concentration in the Thompson-Okanagan plateau (ecoprovinces: GED, SOI, CEI).

Diet

Small mammals, especially *Microtus* voles, made up the majority of the diet of the Long-eared Owl in the Okanagan valley (Hooper and Nyhof 1986). This owl primarily hunts on the wing over open ground (Marks *et al.* 1994).

Locating Nests

Nests can be located by pinpointing the calling locations of the owl's first calls after sunset and last calls before sunrise. A detailed daytime search of that area should then be conducted to locate the nest. Most nests in British Columbia have been found in dense deciduous shrubs and trees including birch and willow. The Long-eared Owl nests in the old nests of other species. In British Columbia these are primarily crow nests, and sometimes those of the Black-billed Magpie. Most nests found in British Columbia were between 3.5 and 7.5 m above ground (Campbell *et al.* 1990).

The Long-eared Owls will use a 'broken-wing' act in an attempt to distract intruders from nestlings. When approached at roosts, it compresses feathers into a 'slenderized' position and elongates the body to resemble a long branch, but will assume a threatening posture, with fluffed feathers and raised wings, if the disguise fails Guiget 1970). Females on nests will

rarely flush until humans are within 2 m of the nest. Nest defence is weak during incubation and strongest when the young are 2–6 weeks old (Marks *et al.* 1994). Egg laying is from early March to early June and young are at the nest from early April to early August.

Risks

As is the case with all raptors, nests should not be disturbed, especially during the egg laying and incubation stages, or the nesting attempt may be abandoned. Observers should therefore leave the area if the birds are obviously being disturbed.

Survey Notes

The RIC recommended method for surveying the Long-eared Owl is call playback in the breeding season.

The Long-eared Owl has been surveyed during the winter by searching for favourable roosting sites in thickets and dense conifers. Because it tends to roost in the same area all winter long, pellets are found in concentration at these sites. Craighead and Craighead (1969) found that groups of Long-eared Owls would roost together and then scatter out to hunt in other open territories each evening.

Call playback surveys

Hooting Long-eared Owls studied in Finland were surveyed using the point-stop method as well as playback during March and April. Owlets begging calls can be heard at up to 500 m distance (Korpimaki and Norrdahl 1991). Adult Long-eared Owls have reportedly approached humans broadcasting calls of Barred Owl, Great Horned Owl and Northern Saw-whet Owl (Marks *et al.* 1994).

- Timing
  - Conduct surveys between 0.5 hours after sundown and 0.5 hours before sunrise.
  - Most calling is done in the breeding season, during which time wide ranges of noises are made by the owls. The advertising song of males can be heard up to 1 km and is given at night, beginning shortly after sunset (Marks *et al.* 1994). Territorial behaviour in the early breeding season comprises a set of acoustic signals and display flights by both the male and female (Voronetsky 1987).
  - The intensity of hooting and demonstrations on nesting territory rapidly decreases after egg laying. After about two weeks, male owls will generally not respond to other male's voices. However, females become more aggressive in response to playback of other female's voices during the nestling stage (Voronetsky 1987).
- Surveys in Alberta used an interstation distance of 1.6 km for this species (Takats *et al.* 2001).

5.7.13 Short-eared Owl B-SEOW *Asio flammeus*

BoBC–382; BH–290; NGS–238; PWB–200

Species Description

Appearance: This is a medium (almost crow-sized) owl with tawny brown, broadly streaked upperparts. The Short-eared Owl is boldly streaked on the breast and has a pale, lightly streaked belly. The dark facial disk emphasizes the yellow eyes.

Identification: This owl of open country is often active by day, particularly at dusk. It flies with erratic, flopping wingbeats and is typically found flying close to the ground, as it quarters an area while searching for prey. The large buffy wing patches on upperparts are visible in flight, and a distinct black patch below at the carpal joint. The complete lack of cross barring on the breast is distinctive. The Northern Harrier also has a wavering flight, but this hawk's conspicuous white rump patch identifies it to be other than the Short-eared owl.

Voice: Makes a raspy, high barking — a sneezy *kee-yow! Wow*!

Habitat

The Short-eared Owl inhabits open country with short vegetation grasslands, marshes, farmlands, tundra and forest clearings. This owl also uses human-altered habitats like golf courses and airports. It breeds in the central interior south of 54 degrees and on the southern mainland coast (ecoprovinces: GED, SOI, SIM, CEI, SBI, BOP). Most nests in British Columbia have been found in shrubby fields adjacent to agricultural areas, but also in airport fields, marshes and rangelands.

The Short-eared Owl is found throughout British Columbia in open habitats, though populations are nomadic and irregular, fluctuating with prey cycles (ecoprovinces: GED, SOI, SIM, CEI, SBI, BOP). The Fraser Delta is a main wintering area for this owl in British Columbia (Campbell *et al.* 1990). In the winter it can also be found in the south of the province near estuaries, sloughs, lakeshores, beaches and lagoons. The Short-eared Owl will roost in large communal groups in peak vole years, hidden in tall grass fields

Diet

The Short-eared Owl feeds almost entirely on small rodents, primarily voles, which it hunts in daylight as well as at night; most rodents are active at dusk and early evening. It hunts primarily on the wing. Foraging flights are described as buoyant and moth-like, with slow wing beats Holt and Leasure 1993).

Locating Nests

Nests are on the ground in large open areas and are usually placed at the base of grass clumps. The Short-eared Owl is most vocal around the nest. It will utter a bark-like '*keee-ow*' throughout the year, when intruded upon by humans (Holt and Leasure 1993). The male Short-eared Owl performs a conspicuous courtship flight over the nesting territory in early spring. These flights and the accompanying calls (*Voo-hoo-hoo-hoo-hoo*) have been used by surveyors as diagnostic features associated with nest sites. Nests are found by searching ground areas where Short-eared Owls have been seen 'sky dancing' and displaying above (Holt 1992). Later in the season, surveyors can listen for begging calls of owl chicks, which

can be heard at up to a distance of 200 m (Korpimaki and Norrdahl 1991). Females, however, rarely flush from the nest until humans are within a few metres of it (Holt and Leasure 1993). Egg laying is from late March to early July and young are at the nest from early April to mid-September.

Risks

The Long-eared Owl defends its nest, but rarely strikes humans. Ground-nesting species are particularly sensitive to human disturbance. Three out of four females flushed from nest by researchers apparently moved and re-nested a short distance away (Holt 1992).

Survey Notes

The RIC recommended methods for surveying the Short-eared Owl are roadside and foot surveys during the breeding season and migration surveys during the non-breeding season.

General

The Short-eared Owl sleeps and roosts primarily on the ground. Pellets left by roosting birds can be distinguished from those of the Northern Harrier because they are longer and show more bone content near the surface (Holt *et al.* 1987).

- The Short-eared Owl is crepuscular. Conduct surveys 0.5 hours prior to sunset until dark, and from the first light to 0.5 hours after sunrise.
- *kewww--owl* call given in response to human intruder in territory (Holt and Leasure 1993).

5.7.14 Boreal Owl B-BOOW *Aegolius funereus*

BoBC–386; BH–304; NGS–246; PWB–202

Species Description

Appearance: This is a small, earless owl with a large head and a pale yellow bill. The facial disks are framed with black. The forehead is dotted with white, and the white underparts are streaked with chocolate brown. Juveniles are dark brown with white eyebrows. Though rarely seen, Boreal Owls are usually discovered perched amid conifer branches, often standing motionless in an upright position near the trunk of the tree. Mobbing behaviour and alarm calls of passerine birds give some indication of a roosting owl.

Voice: Calls mainly in the breeding season, with a short rapid series of hollow *hoo* notes (staccato song). The sound is similar to that of water dripping, and is often confused with the winnowing call of a snipe.

Habitat

This owl is widespread through forested portions of the interior of the province, particularly in the north, and at higher elevations in the south. It is rarely recorded in coastal regions (Campbell *et al.* 1990), (ecoprovinces: CAM, SOI, SIM, CEI, SBI, BOP). Little is known about population densities in British Columbia; Boreal Owls population densities studied over two years in Alberta and Ontario were estimated at one bird/11 km^2 Bondrup-Nielsen

1978). Boreal Owls live and breed in boreal forest characterized by black and white spruce. In British Columbia they appear to prefer stands of mixed white spruce and trembling aspen in northern areas. In the central and southern interior, they have been found among Douglas-fir, lodgepole pine, and sub-alpine fir. Near Lillooet Lake they have used stands of Douglas-fir and western redcedar; near Kamloops, Engelmann spruce (Campbell *et al.* 1990). They roost near the boles of trees, at heights averaging about 6 m above ground. Roost sites are generally in dense conifer. This species is considered largely sedentary, though irruptions do occasionally occur. A shift in concentration of activity to lower elevations has also been recorded in winter. Movements seem to be more common in low prey years. Breeding period is not clearly defined in British Columbia with one record of nest eggs found in May and one record of young in June (Campbell *et al.* 1990). Egg laying has been recorded from late March to early June in the United States with a nestling period of 28-36 days (Hayward and Hayward 1993).

Diet

Boreal Owls feed by preference on small rodents, particularly voles. Smaller prey includes shrews and mice when available. Small birds, flying squirrels and insects also make up part of the diet.

Locating Nests

The Boreal Owl nests in tree cavities, typically old woodpecker nests, particularly those of the Northern Flicker and Pileated Woodpecker. Nests have been reported both in spruce and in trembling aspen. Nests or the location of the likely nest site can be found by walking in quietly to a calling bird. By using a spotlight, the singing male can often be seen calling from the nest hole. If the tree foliage is too dense, the tree can be flagged and a visual check can then be made of this and adjacent trees in daylight to locate possible nest sites. It should be noted that at this point you are surveying calling males, and a later check will be needed to see if the male successfully attracted a female to nest in that cavity. Presence of an owl in the cavity can often be confirmed by sharply rapping upon the trunk while watching the hole for a response; usually the protrusion of a disturbed female Boreal Owl. This technique, however, is not always useful, as females will not regularly flush during early stages of brooding. The presence of greyish down feathers around the rim of the hole and scattered whitewash at the base of surrounding trees is another more reliable clue.

The Boreal Owl casts pellets (one or two a day) from roost sites, and defecates from its perch a few times a day, often just before moving perches. Males only appear to display territorial behaviour in close proximity to the nest, and thus will not necessarily react to visitors within their home range.

These nest holes are known to fill with rotting prey remains, and the stench can be somewhat remarkable.

Survey Notes

The RIC recommended method for surveying the Boreal Owl is call playback during the breeding season.

Detectability for Boreal Owls is highly variable; they are almost impossible to locate during the day. When encountered at roost sites, the birds assume a long, thin posture against the tree trunk, narrowing the eyes to slits and erecting the facial disk into shallow 'horns'.

The best time for surveying is in the early spring, when males are singing the 'staccato song' near possible nest holes. This call resembles the winnowing noise of the common snipe, and is a trill of notes in a constant pitch. This call lasts one or two seconds, with about 12 pulsed notes per second, and is the only really loud vocalisation of this species. The unpaired male calls persistently for 20 minutes or more each night near possible nest holes, gradually increasing until his singing lasts most of the night. However, annual, seasonal, and nightly calling activity is highly variable. It is likely associated with changes in prey populations.

- Timing:
  - O'Connell (1987) found that the owls will respond to the 'staccato' song during most of the year, however, the best time for surveying may be in the early spring when males are singing.
  - Surveys should be done on moonlight nights, because the owls often approached without making a sound, therefore visual sightings are needed.
  - Conduct surveys between 0.5 hours after sundown and 0.5 hours before sunrise. Greatest calling intensity for the Boreal Owl is before midnight, but it can call anytime before dawn (Hayward and Hayward 1993).
- Stop Duration
  - The standard listening time of 5 minutes should be used after a call series is played.
  - Replies sometimes come after a delay of up to 15 minutes (O'Connell 1987).
  - In Ontario, Francis and Bradstreet (1997) found that many Boreal Owls responded spontaneously, however, call playback did increase response success. In the same study they also found that a prolonged final listening period was not efficient for this species as only a 30% increase in detections resulted from listening another 8 minutes after the initial 4 minutes of calls and listening period. They suggest keeping the stops short and doing more stations.
- Interstation Distance
  - Recommended distance between call playback stations for the Boreal owl is 0.7 and 0.8 km (Ryder et al. 1987, Palmer 1987).
  - Males can be heard calling from over 1.5-km distance on calm nights (Bondrup-Nielsen 1978).
- Surveyors must be trained to distinguish the owl's song from the winnowing of a snipe. Snipe will respond to playback of the Boreal Owl call.
- Conduct surveys over a minimum of three years because low vocal activity in two consecutive years is likely (Palmer 1987).

5.7.15 Northern Saw-whet Owl B-NSWO *Aegolius acadicus*

BoBC–388; BH–304; NGS–246; PWB–202

Species Description

Appearance: The Northern Saw-whet Owl is one of the smallest owls (robin-sized), without ear tufts. It is reddish brown above, and the underparts are white with blotchy rufous streaking. The facial disks are reddish and the bill is dark. Juveniles are dark reddish brown

with white eyebrows forming a V on the forehead. This owl is most often encountered as its hiding place and is revealed by an angry mob of scolding passerines.

Voice: A single, mellow, whistled note, repeated rapidly and monotonously. It also gives a raspy call.

Habitat

This owl is found in woodlands, dense forests, groves, and thickets of pure and mixed coniferous and deciduous trees. It also frequents tall shrubs often in association with lakeshores, wet bogs and marshes, hillsides and canyons, city parks, orchards, campgrounds and wooded residential areas. Northern Saw-whet Owls roost in dense tangles of branches as well as natural cavities and human-made structures like garages, barns, cabins, airport hangars, and stables. The breeding habitat in the western mountains overlaps that of the Flammulated Owl, and to some extent, that of Northern Pygmy-Owl. The Northern Saw-whet Owl frequently uses woodlands in second growth or transitional stages. Egg laying is from late February to early June and young are at the nest from early April to mid-August.

The Northern Saw-whet Owl is present year-round in its breeding range (ecoprovinces: CAM, GED, SOI, SIM, CEI, SBI, BOP). The Northern Saw-whet Owl is found on the Queen Charlotte Islands, southeastern Vancouver Island, and across the interior of British Columbia south of 51º latitude, and is very rarely found in northern British Columbia (numbers decrease rapidly north of Prince George). Considerable numbers move south as local spring and autumn migrants in southern British Columbia (Campbell *et al.* 1990).

Diet

The Northern Saw-whet Owl's main prey are small mammals, especially mice and voles. They forage along forest edges and openings, where suitable perches are located.

Locating Nests

This owl nests in natural and animal-created (usually Flicker or Pileated Woodpecker) cavities. Cavities in both deciduous and coniferous trees are used as well as nest boxes. Nests can be located by using the above (call playback surveys) to locate calling males. Try to pinpoint the location of these birds over several observation sessions and then search the immediate vicinity in daytime for possible nest site holes. These possible nests should be marked but not checked until later in the breeding season by which time a female may have been attracted to the nest and be in the latter stages of incubation or brooding chicks. Females may respond to a sharp rap on the tree by looking out of the nest hole, but others will sit tight on eggs and young and therefore the nests should be inspected visually for the presence of the birds. Field signs, such as the presence of down feathers around the edge of the nest hole and possibly the presence of small flies around the entrance hole, can also be used to indicate a nest site is active.

Risks

Female Northern Saw-whet Owls discovered on nests before, during, or shortly after egg laying have deserted their nests. It is best to wait a week before checking the contents of any newly found nest.

Survey Notes

The RIC recommended method for surveying the Northern Saw-whet Owl is call playback during the breeding season.

Male Northern Saw-whet Owls give advertising calls from February through April in southern British Columbia, with the peak period in late February and March. A minor resumption of singing in late summer and fall has been recorded. Road surveys for singing males gave a rough measure of relative population densities in several habitats in the Okanagan Valley (Cannings 1987). Cannings (1987) used nest boxes, but did find several nests in natural cavities by looking for singing males in March and April and surveying for nests in areas where they were heard. When listening for voluntarily calling Northern Saw-whet Owls, it is important to arrive before singing begins and to remain silent and motionless, as birds are easily disturbed.

Call playback surveys

- Tape playback of recorded song was used to effectively survey Northern Saw-whet Owls by Swengel and Swengel (1987).
- Northern Saw-whet Owls have been found to respond to Boreal Owl calls (Francis and Bradstreet 1997) and human imitations.
- In Ontario, Francis and Bradstreet (1997) found that many Northern Saw-whet Owls responded spontaneously, however, call playback did increase response success. Deal and Lamont (1996b unpubl.) found that the majority of Northern Saw-whet Owls detected started calling prior to broadcasting taped calls.
- Timing:
  - Greatest calling intensity for the Northern Saw-whet Owl is within a half-hour of sunset to just before sunrise, therefore surveys should be conducted between 0.5 hours after sundown and 0.5 hours before sunrise. Gill and Cannings (1997) conducted their surveys on the Queen Charlotte Islands starting at dark and continuing for five hours.
  - Singing activity is thought to peak in March or April at least in some parts of British Columbia (Cannings 1993). As a caution, playback surveys conducted in early spring may have to be scheduled to avoid times when snow melt noise is high. Running water greatly obscures owl hoots, and may affect the optimal time for surveying depending on the location.
  - Early in the breeding season the Northern Saw-whet Owl will respond even at midday with short song burst (Cannings 1993).
- Stop Duration
  - After broadcasting a series of calls, listen and wait the standard 5 minutes for any responses. In northern Ontario, Francis and Bradstreet (1997) found that in northern Ontario a prolonged final listening period was not efficient for this species as only a 30% increase in detections resulted from listening another 8 minutes after the initial 4 minutes of calls and listening period. They suggest keeping the stops short and doing more stations.
  - Gill and Cannings (1997) broadcasted up to 3 recordings of taped call series if no response was elicited after the first broadcast, with total station time lasting 8-10 minutes.

- Interstation Distance
  - Recommended distance between call playback stations for this species of inconspicuous owl is 0.7 (Palmer 1987).
  - Swengel and Swengel (1987) used a distance of 0.1 km. This may be appropriate if initial surveys indicate that there is a very high density of Northern Saw-whet Owls in the area. In 1997, they also used a distance of 0.1 km between call playback stations to calculate calls/station rather than owls/station.

5.8 Species Frequently Identified Incorrectly As Raptors

5.8.1 Crows and Ravens

American Crow	B-AMCR	*Corvus brachyrhynchos*
Northwestern Crow	B-NOCR	*Corvus caurinus*
Common Raven	B-CORA	*Corvus corax*

BoBC III–220, 228, 236; BH–416, 420; NGS–182; PWB–182

These species can be confused with raptors when they are seen flying high in the sky. These species also construct large stick nests similar in size and location to many raptors, and on occasions will build on old raptor nests.

Habitat

Crows are found in central, southern, and coastal British Columbia. They are most frequently seen in urban and agricultural settings. The Common Raven is found throughout the province from sea level to mountain peaks, and numerically over-take the American Crow in the central and northern parts of the province.

Diet

Corvids are true generalists, with diets ranging from vegetation and meat to scavenging kills to picking through garbage.

Locating Nests

Ravens build large (30–50 cm wide) nests that are located on cliffs, human-made structures, and near the top of mature deciduous and coniferous trees. Nests can be located by standwatches, aerial surveys, boat surveys and foot transects. Begging young often reveal the presence of a nest during foot searches in early summer. The nest is often surrounded by whitewash from the young and perching adults. Nests are reused, but a pair may have several other nest sites within the area that may have been used in other years. If a nest is not in use, raptor species such as Red-tailed Hawks could use the same nest.

Crows build smaller nests (20–30 cm wide), and are located in a variety of locations from human-made structures to cliffs. However, these nests will usually be placed in a tree. Nests in trees are often lower down in the crown than a Raven's nest, and there may be a loose colony of nests with pairs in several nearby trees (Ehrlich *et al*. 1988). As with ravens, crow nests are important platforms for the nests of some owl species, and therefore their presence may influence the distribution of these raptors. Nests are most readily located before leaf out as the birds are actively displaying and building nests (Dunk *et al*. 1997).

Survey Notes

These species are not part of the RIC *Inventory Methods for Raptors*, but nests and sightings of these species will frequently be encountered and it is important to be able to distinguish between these and raptor species.

In flight, ravens are the species most easily confused with raptor species such as hawks and eagles. It can be readily distinguished from similar sized raptor species by the characteristic wedge shaped tail.

Ravens breed early in the spring and are very defensive against large raptor species around their nest sites, often preventing hawks from breeding within several hundred meters of their nests. Location of raven nests is therefore a useful tool when determining the distribution of raptors that breed later in the breeding season. Nests of crows and ravens provide ideal nest sites for those species of owls that use stick nests of other species. Therefore, corvid nest distribution may affect the distribution and abundance of certain owl species.

As for all raptors where aerial surveys are used, helicopter flights should be flown a minimum of 50 m above the nest and should be terminated if birds are becoming agitated. Confirmation of nest occupancy can be determined on a later flight during the nestling stage when young are visible from a greater distance.

5.8.1 Common Nighthawk

An American Kestrel sized bird that like the smaller falcons has long pointed wings. This grey/brown bird is commonly seen at dusk and early morning as it circles and swoops for insects over open areas. It is best distinguished from the small falcons by the single white wing splashes across the primaries, the sweptback wings and slightly forked tail. Further, it has a distinctive call a nasal *peent* that is frequently heard while in flight.

5.8.1 Other Species

Fleeting glimpses of many species, notably waders (snipe), pigeons and grouse can and will be confused with raptor species, especially when seen in poor light and areas of poor visibility (forests). Mourning doves, blue grouse and common snipe can all sound like owls.

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.

ACCURACY: A measure of how close a measurement is to the true value.

AERIE (also eyrie): a cliff ledge or mountain top nest site of a raptorial bird species.

BIODIVERSITY: Jargon for biological diversity: "the variety of life forms, the ecological roles they perform, and the genetic diversity they contain" (Wilcox, B.A. 1984 cited in Murphy, D.D. 1988. Challenges to biological diversity in urban areas. Pages 71 - 76 in Wilson, E.O. and F.M. Peter, Eds. 1988. Biodiversity. National Academy Press, Washington, DC 519 pp.).

BIOGEOCLIMATIC SUBZONE: a geographic area with a uniform regional climate which is characterized by the same distinct climax vegetation on midslope (zonal) sites and relatively uniform mean temperature and precipitation.

BIOGEOCLIMATIC ZONE: a habitat mapping classification system which divides the province of British Columbia into 14 broad, climatically distinct areas usually named after the dominant climax tree species. Zones are differentiated by distinct patterns of vegetation and soil and can be more finely divided into subzones, variants and phases.

BLUE LIST: Taxa listed as BLUE are sensitive or vulnerable; indigenous (native) species that are not immediately threatened but are particularly at risk for reasons including low or declining numbers, a restricted distribution, or occurrence at the fringe of their global range. Population viability is a concern as shown by significant current or predicted downward trends in abundance or habitat suitability.

BROAD ECOSYSTEM UNIT: is a permanent area of the landscape that supports a distinct type of dominant vegetative cover, or distinct non-vegetated cover (such as lakes or rock outcrops). It is defined as including potential (climax) vegetation and any associated successional stages (for forests and grasslands). Broad Ecosystem Units are meant to be used for small scale mapping of large areas, mainly at the 1:250,000 scale.

CALL STATION: a unique location from which raptor calls are broadcasted. These are usually spaced at equidistances along a line transect.

CBCB (Components of British Columbia's Biodiversity) Manuals: Wildlife species inventory manuals that have been/are under development for approximately 36 different taxonomic groups in British Columbia, in addition, six supporting manuals.

CREPUSCULAR: Active in twilight, at dawn or dusk.

DESIGN COMPONENTS: Georeferenced units which are used as the basis for sampling, and may include geometric units, such as transects, quadrats or points, as well as ecological units, such as caves or colonies.

DIHEDRAL: Shape formed by birds when wings are held above the body in flight. It is the most aerodynamic/energy efficient position.

DISPERSAL: the movement of young birds from the site where they hatch to the site where they breed.

DIURNAL: Active during the daytime.

ECOPROVINCE: is an area with consistent climate or oceanography, relief and plate tectonics, there are nine terrestrial and one maritime ecoprovinces in British Columbia.

ECOREGION: is an area with major physiographic and minor macroclimatic oceanographic variation, there are 43 ecoregions in British Columbia, of which 39 are terrestrial.

ECOSECTION: are areas with minor physiographic and macroclimatic or oceanographic variation, there are 110 ecosections in British Columbia, of which 100 are terrestrial.

EWG (Elements Working Group): A group of individuals that are part of the Terrestrial Ecosystems Task Force (one of 7 under the auspices of RIC) which is specifically concerned with inventory of the province's wildlife species. The EWG is mandated to provide standard inventory methods to deliver reliable, comparable data on the living "elements" of British Columbia's ecosystems. To meet this objective, the EWG is developing the CBCB series, a suite of manuals containing standard methods for wildlife inventory that will lead to the collection of comparable, defensible, and useful inventory and monitoring data for the species populations.

FLUSHING: to cause a raptor to temporarily leave its present location.

FLYWAY: geographical corridors such as mountain ridges or valleys along which raptors concentrate during migration.

INVENTORY: The process of gathering field data on wildlife distribution, numbers and/or composition. This includes traditional wildlife range determination and habitat association inventories. It also encompasses population monitoring, which is the process of detecting demographic changes (e.g. growth rate, recruitment and mortality rates) or distribution changes in a population. This is done by using information from repeated inventories and relating these changes to either natural processes (e.g. winter severity, predation) or human-related activities (e.g. animal harvesting, mining, forestry, hydro-development, urban development, etc.). Population monitoring may include the development and use of population models that integrate existing demographic information (including harvest) on a species. Within the species manuals, inventory also includes, species statusing which is the process of compiling general (overview) information on the historical and current abundance and distribution of a species, its habitat requirements, rate of population change, and limiting factors. Species statusing enables prioritization of animal inventories and population monitoring. All of these activities are included under the term inventory.

IRRUPTION: mass dispersal of populations caused by environmental factors such as food scarcity.

MIGRATION: a massive shift of birds twice each year between regular breeding and wintering ranges.

MONITOR: To follow a population (usually numbers of individuals) through time.

NOCTURNAL: Active at night.

NOMADISM: movement from one place to another usually seeking food supplies.

OBSERVATION: The detection of a species or sign of a species during an inventory survey. Observations are collected on visits to a design component on a specific date at a specific time. Each observation must be georeferenced, either in itself or simply by association with a specific, georeferenced design component. Each observation will also include numerous types of information, such as species, sex, age class, activity, and morphometric information.

PELLETS: undigested food items (hair, feather fragments, bones) that are regurgitated by raptors.

POPULATION: A group of organisms of the same species occupying a particular space at a particular time.

PRECISION: A measurement of how close repeated measures are to one another.

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).

PREY REMAINS: feathers, bones, carcasses from prey items eaten by raptors.

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 or species inventory. Sampling for species generally takes place within smaller, representative study areas so that results can be extrapolated to the entire project area.

PROJECT: A species inventory project is the inventory of one or more species over one or more years. It has a georeferenced boundary location, to which other data, such as a project team, funding source, and start/end date are linked. Each project may also be composed of a number of surveys.

QUADRAT: areas equal in size and shape and are usually generated by laying a grid over a map of the project area.

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

RED LIST: Taxa listed as RED are candidates for designation as Endangered or Threatened. Endangered species are any indigenous (native) species threatened with imminent extinction or extirpation throughout all or a significant portion of their range in British Columbia. Threatened species are any indigenous taxa that are likely to become endangered in British Columbia, if factors affecting their vulnerability are not reversed.

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.

RIC (Resources Inventory Committee): RIC was established in 1991, with the primary task of establishing data collection standards for effective land management. This process involves evaluating data collection methods at different levels of detail and making recommendations for standardized protocols based on cost-effectiveness, co-operative data collection, broad application of results and long term relevance. RIC is comprised of seven task forces: Terrestrial, Aquatic, Coastal/Marine, Land Use, Atmospheric, Earth Sciences, and Cultural. Each task force consists of representatives from various ministries and agencies of the Federal and BC governments and First Nations. The objective of RIC is to develop a common set of standards and procedures for the provincial resources inventories. [See http://www.for.gov.bc.ca/ric/]

SPI: Abbreviation for 'Species Inventory'. Generally used in reference to the Species Inventory Datasystem and its components.

STANDWATCH: passive observation of suitable habitat looking for raptors flying above the canopy and/or listening for raptor vocalizations within suitable habitat.

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 taxonomic 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.

TERRESTRIAL ECOSYSTEMS TASK FORCE: One of the 7 tasks forces under the auspices of the Resources Inventory Committee (RIC). Their goal is to develop a set of standards for inventory for the entire range of terrestrial species and ecosystems in British Columbia.

TERRITORY: an area defended by a pair of nesting raptors; boundaries are flexible over the years.

TRANSECT: a sampling design whereby the subject of interest is sampled along a line that is traversed using some form of transportation.

YELLOW-LIST: Includes any native species that is not red- or blue-listed.

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