# Inventory Methods for Swallows and Swifts

## Standards for Components of British Columbia's Biodiversity No. 16

Prepared by
Ministry of Environment, Lands and Parks
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# Preface

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

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

Standardized data forms are required for all RIC wildlife inventory. Survey-specific data forms should accompany most manuals while general wildlife inventory forms are available in the Data Form Appendix. This is important to ensure compatibility with provincial data systems, as all information must eventually be included in the Species Inventory Datasystem (SPI). For more information about SPI and data forms, visit the Species Inventory Homepage at: http://www.env.gov.bc.ca/wld/spi/ric_manuals/

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

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

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

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## Terrestrial Ecosystems Task Force

All decisions regarding protocols are the responsibility of the Resources Inventory Committee. Background information and protocols presented in this document are based on the unpublished draft manual, *Standardized Inventory Methods for Components of Biodiversity in British Columbia: Swallows and Swifts,* prepared for the Resources Inventory Committee by Tom Ethier, with revisions by Ian Hatter, Rob Butler, Barb Beasley, and editorial assistance by Ann Eriksson.

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

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# 1. INTRODUCTION

Swallows (Family Hirundinidae) and Swifts (Family Apodidae) forage for insects on the wing. Their aerial proficiency can be observed on any summer day, as they dart and dash over open fields, skim along the surface of water bodies, or soar above forest canopies. While the members of these two families are often observed by even the most casual observer, they are regularly missed during formal bird surveys designed to estimate density. For example, of the 104 articles contained in the monograph *Estimating Numbers of Terrestrial Birds* (Ralph and Scott 1981), only two articles contain information about swallows and swifts, both of which use data of relative density obtained through the North American Breeding Bird Survey (BBS) (Robbins 1981; Robbins and Stallcup 1981). The reason for this discrepancy is that traditional surveys such as spot mapping, line transects, or point counts have been designed to take advantage of the behaviour of birds, which, in general, defend an all purpose (relatively small) territory, solicit for mates by singing from a branch (or other suitable structure), and are not colonial (Erskine 1981). Swallows and swifts do not exhibit these behaviours, thus they are not suitable for surveying with these methods.

The swallows and swifts which breed in British Columbia are migratory. The early migrants such as the Tree Swallow or the Violet-green Swallow, return to the province in late February, while the later migrants such as the Barn Swallow and Black Swift, usually make their first appearance in mid to late May (Cannings *et al.* 1987; Campbell *et al.* 1990). All of the species belong to the same foraging guild, aerial pursuers of aerial insects (Ehrlich *et al.* 1988).

This manual recommends methods and outlines protocol for standardizing data collection procedures for swallows and swifts. This is an important group to monitor because they often forage in areas of potential high pollution (river and estuaries) and high pesticide use (agricultural lands).

# 2. INVENTORY GROUP

**Order Passeriformes**

**Family Hirundinidae**

| | |
|---|---|
| Violet- green Swallow | *Tachycineta thalassina* |
| Tree Swallow | *Tachycineta bicolor* |
| Cliff Swallow | *Hirundo pyrrhonota* |
| Barn Swallow | *Hirundo rustica* |
| Bank Swallow | *Riparia ripara* |
| Northern Rough-winged Swallow | *Stelgidopteryx serripennis* |
| Purple Martin | *Progne subis* |

**Order Apodiformes**

**Family Apodidae**

| | |
|---|---|
| Black Swift | *Cypeseloides niger* |
| Vaux's Swift | *Chaetura vauxi* |
| White-throated Swifts | *Aeronautes saxatalis* |

**Status:** The Purple Martin is Red-listed and the White-throated Swift is Blue-listed. All other swallows and swifts found in British Columbia are on the provincial Yellow list (taken from the 1996 species status list).

## *2.1* Violet-green Swallow *Tachycineta thalassina*

The breeding range for the Violet-Green Swallow extends from Alaska to Mexico, and west of the Great Plains (Bent 1942). Violet-Green Swallows appear to be most abundant in the vicinity of human habitations, but can also be found along mountain slopes and forested areas. The Violet-Green Swallow is usually the earliest of the migrant swallows to arrive in spring, sometimes as early as late February in the southwest corner of the province. Although these are early migrants, nesting does not usually occur in great numbers until late May (Gabrielson and Jewett 1970; Cannings *et al*. 1987).

Violet-Green Swallows nest in open habitat, a variety of holes, cavities and crevices, nest boxes, snags and cliffs (Brown *et al.* 1992). They will occasionally nest in colonies of up to 20 pairs, and also with other species such as the White-throated Swift in the Okanagan (Cannings *et al.* 1987).

## 2.2 Tree Swallow *Tachycineta bicolor*

The Tree Swallow breeds throughout North America from northwestern Alaska and northern Quebec south to the southern states. Tree Swallows have been studied extensively in nest boxes, but little is known about their ecology in natural habitats (Rendell and Robertson 1989).

Tree Swallows arrive around mid to late March in the southern areas of British Columbia (Cannings *et al.* 1987). Nest construction can begin as early as mid April, with most of the work being done by mid-May. Most clutches are laid in mid to late May.

Tree Swallows take readily to nest boxes and many studies have been focused on nest site selection based on choice of nest boxes. Of the few studies which have looked at selection of non-artificial nest sites, the focus has been on the type of tree and size of cavity. Few studies have looked at the landscape surrounding the nest site.

In British Columbia, data from the nest record scheme showed that 46% of all Tree Swallow nests were in natural sites (woodpecker holes in nest trees and shrubs) (Erskine 1979). This proportion is probably an under-estimate since there is a bias to collecting data in anthropogenic landscapes, as compared with natural, undeveloped and/or areas less visited by people.

## 2.3 Cliff Swallow *Hirundo pyrrhonota*

In British Columbia, Cliff Swallows nest in association with human altered sites. The nests are highly friable, and require overhead protection from rain and runoff water (Erskine 1979). This swallow can nest in large colonies (up to 1000 in some areas), but the average number of nests per colony in British Columbia is 31 (Erskine 1979).

## 2.4 Barn Swallow *Hirundo rustica*

The Barn Swallow is probably the most recognized of the swallow group. With its deeply forked tail and reddish-brown and blue colouring, it is very common in city parks and school yards, and agricultural pastures. This species is the last swallow to arrive at its breeding site in spring, showing up in the south of the province in late April to early May.

Erskine (1979) reports that only 1% of all Canadian nest records for Barn Swallows were in natural areas (cave or cliff sites), with the rest being in (54%), or on (33%) the outside of buildings, or on other anthropogenic structures (12%). Barn Swallows build solitary mud nests, or in loose colonies inside barns, under eaves and porches of houses and other protected areas. Prior to European settlement, Barn Swallows nested primarily in caves and other protected areas.

## 2.5 Bank Swallow *Riparia ripara*

The Bank Swallow is a highly colonial species which builds its nests in the cut banks along lakes, rivers, highways, and gravel pits. Their nests are placed at the end of burrows, which they dig into the cutbanks. Colonies are not necessarily used year after year, for example, Cannings *et al.* (1987) report that in one year there were nine colonies along Skaha Lake supporting a total of 180 breeding pairs. The next year, there were only colonies along the same bank, yet there were 400 breeding pairs. Pairs within colonies tend to breed synchronously.

## 2.6 Northern Rough-winged Swallow *Stelgidopteryx serripennis*

The Northern Rough-winged Swallow is a relatively solitary species which will sometimes nest in small colonies. They can be found in any open habitat with banks of sand or gravel available for nesting. They arrive in southern British Columbia in the latter half of April, with egg laying probably occurring in the first week of June (Cannings *et al.* 1987).

## 2.7 Purple Martin *Progne subis*

The Purple Martin, a red listed species, is at the northern extent of its range in southern British Columbia. In natural settings, it nests in cavities created by woodpeckers and sapsuckers, in association with open habitat. Natural nest sites for this species however, are extremely rare with most nest sites throughout North America provided by people. In British Columbia, the population of Purple Martins is completely dependent on nest boxes and nests on southeastern Vancouver Island. British Columbia's Purple Martins are surveyed annually, by local naturalists.

## 2.8 Black Swift *Cypeseloides niger*

Black Swifts appear in the skies of southern British Columbia in late April (Campbell *et al.* 1990). Although usually seen in small flocks of about 20 birds, they sometimes congregate into huge flocks of several hundred. Only two nest sites have been found in British Columbia, both on walls in steep canyons near waterfalls. Five parameters that Knorr (1961) suggests are important in this species nest site selection are presence of water, high relief, protection from terrestrial predators, darkness, and an open flyway near the nest.

## 2.9 Vaux's Swift *Chaetura vauxi*

Vaux's Swifts return to southern British Columbia in late March to early April, with egg laying probably beginning in the first week of June (Campbell *et al.* 1990).

Although greater than half of the species' breeding population occurs in British Columbia (there are 33 breeding records), there are very few records documenting the natural nest sites of this species. Most records are from human settlements, especially in chimneys of abandoned houses. Natural nest sites are particularly difficult to find, because they are usually located inside hollow trees. Thus these birds can potentially be harmed by current forest practices of snag removal. There is concern in the Pacific Northwest that nest sites for this species may become limited.

## 2.10 White-throated Swifts *Aeronautes saxatalis*

The White-throated Swift is blue-listed in British Columbia. A recent survey of White-throated Swifts in British Columbia estimated the breeding population to be at ± 400 breeding birds (St. John 1992). The survey also revealed that two-thirds of the population nests in the Okanagan, with other nesting areas in the interior plateaus, the Similkameen Valley and in the Kootenays.

This species prefers to nest in small colonies on ledges of precipitous cliffs. Spring migration commences in early April, with egg laying probably beginning in mid June.

# 3. PROTOCOLS

As mentioned, swallows and swifts are not suited for the traditional survey methods which estimate density, such as spot mapping, line transects, or fixed radius point counts. Most studies, even if they collect data on one of these species, ignore such data in the analysis because of extreme data variation. For instance, Manuwal (1991) used the variable radius point count method to determine which bird species showed a dependency on old growth forests in the Pacific Northwest. He could not use the data collected for Vaux's Swifts because "of its wide ranging behaviour" (p.165). There are several reasons why traditional techniques are inefficient for swallows and swifts.

First, there is a problem of a mismatch in scale. Traditional surveys are usually conducted on areas no larger than 20 ha, while the foraging area for swallows can be much greater. For example, the Tree Swallow has been found foraging up to 100 km from its nest site (Robertson *et al*. 1992). These mismatches result in samples taken within only a fraction of the foraging area, so the probability of one of the birds being in that area at any one time is quite low. Second, for most of these species, singing for solicitation or defence of mates occurs before dawn (Bent 1942). Since most surveys begin at or just shortly after dawn, this key activity is missed. Third, swallows and swifts begin foraging about four hours after sunrise, once their prey have become airborne. Robertson *et al.* (1992) report that Tree Swallows often do not leave the nest site until midday during incubation. Again, the timing of the traditional surveys during the morning chorus is not suited for this group. Fourth, in a general sense this group can be considered colonial. Some species show this behaviour more than others, but it is commonly understood that they have a clumped foraging distribution. The traditional surveys are designed for species which are regularly distributed in space. Finally, surveys are rarely conducted in urban environments, yet these are the areas where the many of this inventory group forage and breed (Weller and Francis 1987).

Because swallows and swifts are not suited for traditional surveys, other methods must be designed. One of the keys to a successful survey design is an understanding of the birds' behaviour. The survey designs recommended in this manual take advantage of two characteristic behaviours: group foraging and coloniality.

**Group Foraging**

Unlike breeding pairs of other small passerines (*e.g.,* warblers and sparrows) that feed in exclusive territories, where food is more or less uniformly distributed, swallows and swifts tend to congregate where food is abundant. Due to the ephemeral nature of their prey base, and because the precise location of good feeding sites varies from hour to hour, swallows and swifts use each other as clues to finding food (Gill 1990). Consequently, large mixed species flocks can be observed foraging over open areas where the food supply is abundant.

**Coloniality**

Whereas stable food resources and defensible areas promotes territoriality, unstable food resources and indefensible areas promote coloniality (Gill 1990). Consequently, the transitory nature of the prey base which promotes flocking, also promotes coloniality. For example, Emlen and Demong (1975) found that Barn Swallows keyed on the location of aerial insects by following the flight line of other swallows which returned to the colony with food.

The nature of the food base is not the only reason for coloniality and flocking. Another important factor is reduction in risk of predation. Swallows which nest in large colonies or forage in large flocks, can reduce their risk of predation in any of three ways: 1) confusion of the predator because there are too many birds for it to focus on; 2) reducing the probability of predation per individual in larger flocks; and/or 3) increasing the chance of a predator being detected. Consequently, the behaviours associated with flocking and coloniality determine the type of survey methods which can be deployed.

Table 1 outlines recommended methods for inventory of swallows and swifts in British Columbia at three levels of intensity. The survey types listed are unlimited radius point count surveys (presence/not detected and relative abundance), and active nest counts (relative abundance). Mark-resight survey protocol for swallows and swifts (absolute abundance) is experimental at this time, and is not recommended for use as a standard inventory method. The two methods recommended for relative abundance measure different attributes of the population. Active nest counts are appropriate for barn, bank, cliff, violet-green and possibly tree swallows. However, unlimited radius point counts are recommended for swifts because of the hidden nature of their nests. Potentially all swallows and swifts could be enumerated during an unlimited radius point count survey (dependent on habitat and geography).

**Table 1. Recommended inventory methods for swallows and swifts in British Columbia at 3 levels of intensity.**

| Level of Intensity | Recommended Method(s) |
|---|---|
| Presence/Not Detected | • Unlimited Radius Point Count Survey |
| Relative Abundance | • Unlimited Radius Point Count Survey<br>• Active Nest Counts (Swallows) |
| Absolute Abundance | • No Methods Recommended |

## 3.1 Sampling Standards

The following standards are recommended to ensure comparison of data between surveys, and to mitigate several sources of bias common in surveys. Individual protocols provide more detailed standards applicable to the method(s) and design recommended.

### 3.1.1 Habitat Data Standards

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

### 3.1.2 Office Procedures

Investigating past records and consulting the British Columbia Nest Records Scheme for distribution information is recommended. The British Columbia Nest Records Scheme is administered and conducted by volunteer naturalists who collect data on bird nests that they find during the breeding season. The information collected on each nest includes: species, nest description (height, position, material), number of eggs, number of young, exact location, altitude, habitat description, date, and observer's name. This data set has played an important role in the development of the 'Birds of British Columbia'.

However, caution must be taken when using nest records to help determine study areas. If no record exists in an area, it does not necessarily mean that no nests exist. Lack of nest records may simply be because no one has visited the area, or coverage of the area was incomplete.

### 3.1.3 Survey Design Hierarchy

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

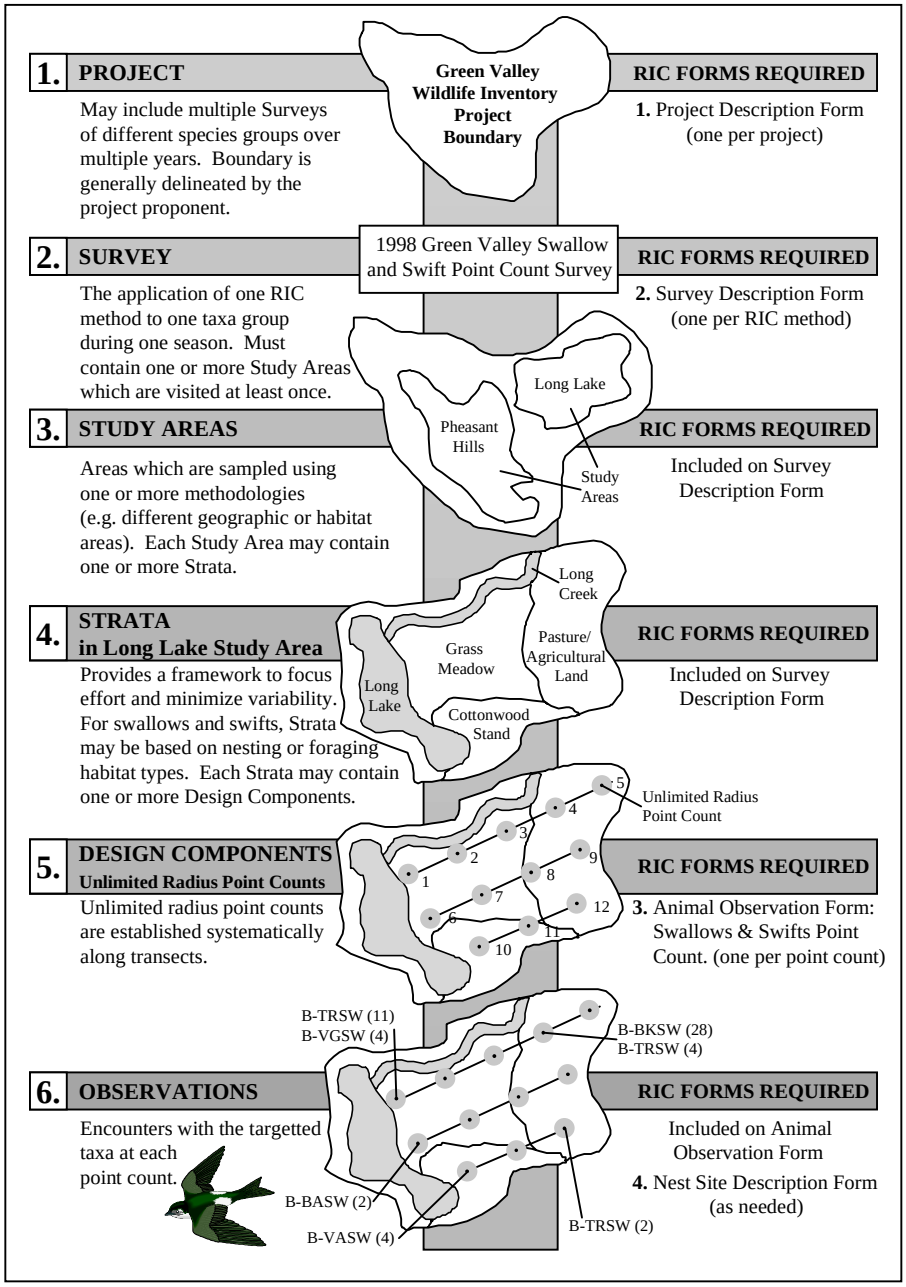


**Figure 1. RIC species inventory survey design hierarchy with examples.**

## 3.2 Inventory Surveys

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

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

| Survey Type | Forms Needed | *Intensity |
|---|---|---|
| Unlimited Radius Point Counts | • Wildlife Inventory Project Description Form<br>• Wildlife Inventory Survey Description Form-General<br>• Animal Observation Form- Swallows & Swifts Point Count<br>• Ecosystem Field Form | • PN<br>• RA |
| Nest Counts | • Wildlife Inventory Project Description Form<br>• Wildlife Inventory Survey Description Form-General<br>• Animal Observation Form- Swallows Nest Count<br>• Ecosystem Field Form | • RA |

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

## 3.3 Presence/Not detected

**Recommended method(s):** Unlimited radius point count survey for presence/not detected for all species.

### 3.3.1 Unlimited Radius Point Count Surveys

Point counts involve one observer who remains stationary at a point and counts all birds seen or heard during a predetermined amount of time. Many variations are played on this design such as distance between points, duration of observation at a point, and the radius in which the birds are recorded. Exactly which combination of design parameters is optimal for swallows and swifts is unknown, however, some clues are provided by the Breeding Bird Survey (BBS). The BBS, using point count methodology successfully detects swallows in sufficient numbers to allow directional trend analysis. The BBS design has points spaced 800 m apart, with a three minute count per point and an unlimited detection distance. This design is recommended with only one change, and that is the distance between points be reduced from 800 m to 400 m. The distance between points should be such that the detections from different points remain statistically independent (Reynolds *et al.* 1980). This recommended distance represents a compromise between sample size generation and independence of samples (Hutto *et al*. 1986).

**Office Procedures**

- Review the section, Conducting a Wildlife Inventory, in the introductory manual, *Species Inventory Fundamentals* (*No.1).*
- Obtain relevant maps for project and study(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). At minimum 1:50 000 map of region is needed, so that study areas can be delineated.
- Determine Biogeoclimatic zones and subzones, Ecoregion, Ecosection, and Broad Ecosystem Units for the project area from maps.
- Select study areas from maps that are likely to have suitable swallow and swift habitat. Do this by stratifying the project area by habitat or based on expected densities.
- Identify all potential transect routes and mark them on the maps.
- Investigate past records. Consult the British Columbia Nest Records Scheme for distribution information.

**Sampling Design**

- Stratified random sampling: The habitat of an area strongly influences the distribution and abundance of swallows and swifts. Due to the clumped distributions of swallows, both when foraging and nesting, it is strongly recommended that the survey area be stratified into homogenous zones based on expected densities. Having knowledge of the preferred characteristics of a species allows for stratified random sampling.
    - In British Columbia, there have not been any sample based surveys done, thus reliable knowledge for habitat stratification is lacking. Consequently, to stratify habitat it is suggested to use best guesses based on previous work elsewhere, local bird watcher experience, and habitat models.

- Hutto *et al*. (1986) recommend at least 25 point counts be conducted in a habitat. Individual point counts should only be used once, so that if repeated transects are planned for an area ensure that individual point counts are not duplicated. Such duplication only serves to inflate the index of abundance, because the time at each point is extended, thus rendering comparisons between sites invalid unless exactly the same number of visits are conducted at each site.
- A design which could be used in a number of areas is a transect of 4 km in length, with 10 point counts of 3 minute duration. This transect could be repeated 3 times over the nesting season (ensuring the same point count stations were not used), thus giving the area 30 independent sample points.

**Sampling Effort**

- Repeat transects 3 times over the nesting period ensuring that each point count station is an independent sample points.

**Sampling Standards**

- **Weather:** Surveys should only be conducted on days with wind speeds less than 10 km/hr and no precipitation. Temperature and sun will also cause variation in insect emergence.
- **Time of Year**: Surveys should begin in late May or early June, depending on timing of breeding, which can vary up to four weeks between years.
- **Time of Day:** The time of day is extremely important and to minimize variance, surveys should be conducted at times when there will be little change in the conspicuousness of the birds. Thus all the surveys must be conducted at the same time of day between the hours of 10:00 hours and 15:00 hours and under the same weather conditions.

**Personnel**

- Surveys should be conducted by a biologist with prior experience in bird surveys, and an expert in swallow and swift species identification.
- At least one person should be familiar with the collection of habitat data.

**Equipment**

- A vehicle (or bicycle if off-road) which provides good vision to the surrounding landscape
- Binoculars (minimum 7X)
- Field note books and data forms
- Compass
- Digital watch or stop watch
- Flagging tape and hip chain

**Field Procedure**

- Select a direct route (transect) 10 km long or shorter parallel transects separated by 800 m. Ensure that the transect(s) passes through habitat that is homogenous and visibility is equal at each point count.
- Mark starting point with flagging tape and note its location on the map.

- Points from which counts are to be made should be separated by 400 m, measured by odometer if in a vehicle, by hip chain if off-road.
- All point counts must be conducted outside of the vehicle.
- Identify and count all swallows and swifts observed during a 3 minute interval at each point count station. If a species that has not yet been detected is observed between point count stations or after the 3 minute period, record it with the observations of the closest point count station, making a note in the comments field.
- Collect habitat information at each point count station using the Ecosystem Field Form.
- When repeating the transect, initiate the start point 150 m from the previous start point to ensure independence of samples.

**Data Analysis**

***Presence/Not Detected***

- Record the presence of each species in each of the homogeneous habitat stratum.

## 3.4 Relative Abundance

**Recommended method(s):** Active nest count for swallows for relative abundance. Unlimited radius point count survey for relative abundance for all species.

### 3.4.1 Unlimited Radius Point Count Surveys

This technique is also used for presence/not detected surveys. Only differences from the presence/not detected survey are listed here. For details on how to conduct this type of survey see section 3.3.1

**Field Procedures**

- Only record swallows and swifts that are detected at point count stations during the 3 minute time-interval. Do not record birds observed between point count stations or after the 3 minute period. Any incidental observation of importance (e.g. red- or blue-listed species) should be recorded on the Wildlife Sighting Form.

**Data Analysis**

***Relative Abundance***

Relative abundance can be obtained in three ways:

- The number of birds detected per visit (*i.e.*, the mean number of birds detected per point count multiplied by 100);
- The frequency of occurrence at the point count; and
- The frequency of occurrence of all birds detected from point counts.

A frequency of occurrence is the percentage of point counts at which a species is detected (Manuwal and Carey 1991).

### 3.4.2 Active Nest Count for Swallows

Counting nests is an excellent index of population size for any bird species, although it requires a great deal of effort. Ryder (1986) suggests that it is seldom possible to find enough active nests for measuring a breeding population. For most of the species in this inventory group, where information on preferred nest sites and habitats is available, generating sufficient numbers for an analysis of the breeding population (colony) is possible. It is important to realize that this is only an index to density (*i.e.*, the number of nests per unit area). The number of nests does not necessarily reflect the size of the breeding population because there are many non-breeders (Medvin *et al.* 1989). It may however, be possible to assess whether a nest represents a breeding pair (is active), by watching the birds (e.g. watching for food being taken into the nest, etc.).

Active nest counts differ between individual species due to differences in nest site selection. Consequently, different searching techniques are required. These groups are: 1) Barn Swallow and Cliff Swallow 2) Bank Swallow and Northern Rough-winged Swallow 3) Tree Swallow, Violet-Green Swallow and Purple Martin 4) White-Throated Swift, Violet-Green Swallow (note this species occurs in two inventory groups) 5) Vaux's Swift 6) Black Swift.

In Table 2, the habitat and nesting preferences for swallows and swifts are given. This data can be used to aid the researcher in designing a nest survey. Nest counts are not recommended for swifts as their nests are often hidden and difficult to find. Black Swifts, although relatively common during migration, have a propensity for nesting in precipitous moist canyons thus making it very difficult to find nests (Bent 1940; Campbell *et al.* 1990). Consequently, there are only two nest records for all of British Columbia (Campbell *et al.* 1990). White-throated Swifts are often found in association with Violet-Green Swallows, and nest in the dry steep canyons of the southern interior ecoprovince (Bent 1940; Cannings *et al.* 1987; Campbell *et al.* 1990). Vaux's Swift prefers to nest in broken off, hollowed stumps, within old growth coniferous forests or big cottonwood stands (Bent 1940; Campbell *et al.* 1990; Manuwal 1991). The difficulty in determining nesting for this species is that the nests are placed in hollow stumps, making verification extremely problematic. Unless the potential site can be somehow accessed without destroying the nest site, surveys will not be able to accurately assess the number of nests inside a hollow stump.

**Table 3. Habitat and nesting characteristics of swallows and swifts nesting in British Columbia.**

| Species | Habitat | Nest Location | Breeding System |
|---|---|---|---|
| **Tree Swallow** | Open habitat, near forest edge, often near water with standing dead trees. | In tree cavity created by woodpeckers; readily accepts nest boxes. | Highly social aggregate breeder, but not considered colonial because it defends area 10 to 15 m around nest site. |
| **Violet-green Swallow** | Open coniferous, deciduous forests, often near edge; cliff ledges. Often at high elevations. | In tree cavities, cliff ledges, nest boxes, cracks in buildings such as shingles. | Solitary or colonial depending on availability of habitat. 20 pairs have been recorded in one nest tree. |
| **Purple Martin** | Standing snags, especially near water. | In tree cavity or nest box. In B.C., all known pairs occur in managed nest boxes on Vancouver Island. | Eastern populations are highly colonial; in western part of range they are considered less colonial. |
| **Bank Swallow** | Open country with available cutbanks for nesting; near running water. | Nests are burrows dug into cutbanks along rivers or roadsides. | Highly colonial; up to 1000 pairs have been recorded. |
| **Northern Rough-winged Swallow** | Open country with available cutbanks for nesting; near running water. | Nests in burrows created by other species such as the Bank Swallow or the Kingfisher. Often nests in association with Bank Swallows. | Usually considered a solitary nester, however, recent reports of large colonies up to 300 pairs nesting in human-modified cut banks. |
| **Cliff Swallow** | Open country, near running water and highly associated with human settlements. | Nests under eaves of barns and houses, and under bridges and culverts. | Highly colonial; up to 1000 pairs. |

| Species | Habitat | Nest Location | Breeding System |
|---|---|---|---|
| **Barn Swallow** | Open country, numerous in agricultural areas; highly associated with human settlements. | Nests under eaves and on ledges, walls of barns and houses, and under bridges and culverts. | Solitary or in loose colonies. |
| **Black Swift** | In moist steep canyons. | On cliff ledges and in crevices. | Nest in small colonies. Colonies have not been recorded in B.C. |
| **Vaux's Swift** | In old growth forests? Often preferring cutover areas or burns which have left snags. | Inside a hollow tree; often up to 20 pairs. Very few natural sites have been recorded in B.C.; most are reports of nesting in chimneys. | Nest in small colonies. |
| **White-throated Swift** | In dry steep rocky canyons of the southern interior. | On cliff ledges and in crevices of precipitous cliffs. | Highly colonial. |

**Office Procedures**

- Review the section, Conducting a Wildlife Inventory, in the introductory manual, *Species Inventory Fundamentals* (*No.1).*
- Obtain relevant maps for project and study(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). At minimum 1:50 000 map of region is needed, so that study areas can be delineated.
- Determine Biogeoclimatic zones and subzones, Ecoregion, Ecosection, and Broad Ecosystem Units for the project area from maps.
- Identify potential survey strata. Select study areas from the strata that are likely to have suitable swallow nesting habitat.
- Consult the British Columbia Nest Records Scheme for possible nest locations and information.
- Contact all landowners prior to surveys and request permission to trespass on their land.

**Sampling Design**

- Varies by species groups as outlined below.

**Barn and Cliff Swallows** build mud nests which are highly friable, thus they must place them in locations protected from rain or run off water. Both species select protected nest sites under eaves and bridges and inside old buildings and culverts (Bent 1942; Gauthier and

Thomas 1992). They nest almost exclusively on artificial structures in human environments (Erskine 1979).

- **Nest counts**: Methods for determining nest densities will depend on where the survey is done. Regardless of whether the focus is on suburban or rural populations, stratify the habitat based on expected densities. For example, structures such as barns or bridges could be placed in a high strata; parks, schools, and vacant lots could be put into a medium strata; and suburban neighbourhoods in the lowest strata (based on percentage of open area to suitable nest sites). Communication with farmers, homeowners, shopowners, and the local police should precede the survey as a precaution, and also for gathering further population information. Farmers and homeowners especially, often know what species are nesting on their property, and the more interested ones will keep a watch for further nesting activity.

**Bank and Northern Rough-winged Swallows** naturally nest in burrows within cutbanks of rivers and streams. They too have benefited from human activities (Erskine 1979; Weeks 1987; Moller 1989) such as extensive rock quarrying and road building which has created gravel pits and cut banks allowing for easy burrowing (nest building).

- **Nest counts**: Colonies can be located by following river courses and roadways in areas where the soil conditions allow for easy burrowing in the cutbanks. It might be practical to stratify quadrats by the length of river or roadways running through the quadrat. After talking to local naturalists, cruise all roadways, gravel pits, and river systems to identify nest sites. Since a burrow may be unused in any given year, the criteria for establishing occupancy are the presence of chicks, fledglings, or adults at the burrow entrance, claw marks outside of the burrow, or lines of faeces outside of the burrow (Jones 1986; Garrison *at al.* 1989). Unused burrows often have vegetation growing out of them or cobwebs hanging across the burrows entrance. The contents of nests of Cliff, Bank and Northern Rough-winged Swallows can be determined using a flashlight and a dental mirror.

**Purple Martin, Tree Swallow and Violet-green Swallow** all are cavity nesters and use natural snags and artificial nest boxes throughout their range. Violet-green Swallows also nest in the cracks and crevices of buildings. Traditionally, they are hole nesters which have depended on other species such as woodpeckers to provide cavities for nest sites. They have also benefited from direct intervention by humans through placement of artificial nest boxes in open habitat (Erskine 1979; Lumsden 1986). The Purple Martin especially, has benefited from artificial nest sites, but most successfully within the eastern part of its range. Southern British Columbia is the northern extent of its western range, with only about 50 breeding birds all confined to artificial nest boxes (Siddle *et al*., in prep.).

- **Nest counts**: Focus on snags or live trees which contain cavities formed by woodpeckers and sapsuckers. Habitat can be stratified (based on expected densities) using a ratio of open habitat (agricultural fields, open water) to snag density. For example, one could assume a continuum from completely open habitat (0%) to completely forested habitat (100%). A plausible stratification may be < 5% or > 70% habitat as a low strata, 30% to 70% as medium strata, and 5% to 30% as high strata. These numbers are only suggestions, and preliminary surveys are required for proper sampling.

**Sampling Effort**

- Will depend on the extent of the survey area to be searched.

**Sampling Standards**

- **Weather:** Nest surveys can go ahead under all reasonable weather conditions, except during rain or when it is unseasonable cold, since the process will flush the parent from the clutch exposing the eggs to the weather.
- **Time of year:** Conduct surveys from the last week of May till the first week of July.
- **Time of day:** Nest surveys can be conducted after 09:00 hours because female is laying before then.

**Personnel**

- Surveys should be conducted by a biologist with prior experience in bird surveys, and an expert in swallow and swift species identification.
- An assistant should be hired to assist in nest searches to permit more area to be covered.
- At least one person should be familiar with the collection of habitat data.

**Equipment**

- Binoculars (minimum 7X) and a spotting scope (minimum 15X)
- Field note books and data forms
- Compass
- Ladder
- Nest checking mirror
- Flashlight

**Field Procedures**

- Search study areas for Barn Swallows and Cliff Swallows.
    - Old buildings, eaves of houses and barns, inside culverts, under bridges and other areas which provide a combination of cover from rain and access to flight paths.
    - Nests are mud structures plastered against the walls of these structures.
- Search study areas for Bank Swallows and Northern Rough-winged Swallows.
    - Cut banks along roadsides, train tracks, rivers, lakes, gravel pits, sawmill-sawdust piles.
    - Nests are placed at the end of burrows which are dug into the sides of cutbanks.
    - Nests are considered active if there are fresh claw marks at the entrance of the burrow, lines of faeces below the burrow, an adult present or a chick present.
    - Nests are considered inactive if there are webs, or vegetation growing across the entrance to the burrow.
- Search study areas for Violet Green Swallow, Tree Swallow, Purple Martin.
    - In natural areas, check snags where the cavity is not obscured by vegetation and the immediate surroundings are open (*e.g.*, natural clearings, beaver ponds *etc*.).
    - To ascertain occupancy of a hole, tap on the snag with a stick to bring the swallow to the entrance for identification.
    - In human landscapes, check natural cavities in fence posts, buildings and other structures; also check artificial nest boxes.
- When a colony/nest is found follow the appropriate protocol below.

***Complete Colony / Nest Count***

- At each colony record its location (UTM), area, and habitat information. If only a solitary nest is found record its location (UTM), area, and habitat information.
- For each nest observed: record the species, number of birds present, their age class and sex, and the appropriate nest description information.

***Partial Colony Count*** *(if a colony is too large to count every nest)*

- Estimate the total number of nests in the colony (active or not).
- Choose a representative Sample Plot(s). Describe its location within the colony and record its area.
- Estimate the proportion of the colony that the Sample Plot occupies.
- For each nest in the Sample Plot(s): record the species, number of birds present, their age class and sex, and the appropriate nest description information.

**Data Analysis**

- Relative Abundance: # of active nests per unit area.

# Glossary

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

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

**BRITISH COLUMBIA NEST RECORDS SCHEME:** A program operated through the Royal British Columbia Museum and run by volunteer naturalists for the collection of data on the location and characteristics of bird nests in British Columbia.

**CLUMPED DISTRIBUTION:** The spatial pattern of arrangement of members of a populations when individuals are irregularly dispersed in clusters within a habitat or landscape. Also called clustered or patchy distribution.

**CLUTCH:** The number of eggs laid at one time.

**COLONIALITY:** The tendency of a species to form a colony or aggregated group of separate animals for a specific purpose such as breeding.

**FLOCKING:** The active coming together of birds to form a flock.

**FORAGING GUILD:** A group of species that use the same foraging strategies.

**FRIABLE:** Fragile and easily crumbled.

**GROUP FORAGING:** The congregation of birds where food is abundant. Birds of different species often use one another as clues to the location of food.

**HOMOGENEOUS ZONE:** A geographical area of habitat that has relatively similar characteristics throughout.

**LINE TRANSECT:** A sampling unit in the form of a long continuous strip in which only those individuals which are observed on the transect line are assumed to be completely counted. The probability of detection (measured from the survey) decreases with increasing distance from the transect line.

**MIGRATORY:** A species which moves seasonally from one region to another.

**NEST BOXES:** Artificial structures designed for nesting.

**POINT COUNT:** A survey method where an observer remains stationary at a location and identifies and counts all species seen or heard for a specified period of time.

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

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

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

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

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

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

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

**SYSTEMATIC SAMPLE**: a sample obtained by randomly selecting a point to

start, and then repeating sampling at a set distance or time thereafter.

**TERRITORIALITY:** The tendency for an animal to defend an area against members of the same species.

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