Inventory Methods for Marsh Birds: Bitterns and Rails

Standards for Components of British Columbia's Biodiversity No.7

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Ministry of Environment, Lands and Parks
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Preface

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

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

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

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

Species Inventory Unit
Wildlife Inventory Section, Resource Inventory Branch
Ministry of Environment, Lands & Parks
P.O. Box 9344, Station Prov Govt
Victoria, BC V8W 9M1
Tel: (250) 387 9765

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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:

The Executive Secretariat
Resources Inventory Committee
840 Cormorant Street
Victoria, BC V8W 1R1

Tel: (250) 920-0661
Fax: (250) 384-1841

http://www.for.gov.bc.ca/ric

Terrestrial Ecosystem Task Force

All decisions regarding protocols and standards are the responsibility of the Resources Inventory Committee. The current version of this manual is the result of the hard work and expertise of Michael Setterington, with review comments from Russ Weeber, Aquatic Surveys Coordinator, Bird Studies Canada.

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

Table of Contents

List of Figures

List of Tables

1. INTRODUCTION

Each of the bird species described in this manual, with the exception of the American Coot, is secretive and more often heard than seen. This generally secretive nature, combined with an affinity for marshy, inaccessible habitats, has resulted in a very limited understanding of the biology and habitat use of most rails and bitterns. Their elusive lifestyle also means it is very challenging to monitor bittern and rail populations.

Rails (Rallidae) have been identified as a family of birds containing more species at risk of extinction globally than would be expected by chance (Bennett and Owens 1997). The decline of American Bittern populations in some states has been clearly associated with the loss of wetlands (Gibbs *et al*. 1992a). Eutrophication, siltation, chemical contamination and human disturbance have also affected habitat use by many marsh birds (Gibbs *et al*. 1992a).

This objective of this manual is to standardize marsh bird surveys in British Columbia. It was also developed with the intention of making these surveys comparable to marsh bird surveys in other North American locations. The Marsh Monitoring program of eastern Canada provided useful protocols in this respect. This program was established by Canadian Wildlife Service (CWS) and Bird Studies Canada (formerly Long Point Observatory) to monitor marsh birds and other associated fauna in southern Ontario and the Great Lakes area. In addition, these two organizations are currently working together with the U.S. Fish and Wildlife Service/ Geological Survey, and others to design a protocol applicable on a national or continental scale (R. Weeber, Aquatic Surveys Coordinator, Bird Studies Canada, pers. comm.). However, at the time this manual was being prepared, such a monitoring program did not yet exist.

2. INVENTORY GROUP

This section summarizes the distribution and ecology of bitterns and rails that may be found in B.C. These include American Bittern (*Botaurus lentiginosus*), Virginia Rail (*Rallus limicola*), Sora (*Porzana carolina*), and American Coot (*Fulica americana*). Also included in this survey standard are descriptions of Least Bittern (*Ixobrychus exilis*), considered *casual* in summer (see Glossary), and Yellow Rail (*Coturnicops noveboracensis*) whose occurrence is considered *hypothetical* in B.C. (Campbell *et al*. 1990b). Given that several good sightings have been made since the publication of Campbell *et al*.(1990b), it might be more appropriate to consider the occurrence of the Yellow Rail as *accidental* (Table 1).

Table 1. Species covered in the bitterns and rails inventory group.

Common name	Scientific name	Species code	Status in B.C. (1997)
American Bittern	*Botaurus lentiginosus*	B-AMBI	Blue
Least Bittern	*Ixobrychus exilis*	B-LEBI	Yellow
Yellow Rail	*Coturnicops noveboracensis*	B-YERA	Accidental
Virginia Rail	*Rallus limicola*	B-VIRA	Yellow
Sora	*Porzana carolina*	B-SORA	Yellow
American Coot	*Fulica americana*	B-AMCO	Yellow

Bitterns and rails are generally secretive, making them very difficult to locate and observe. Thus, it is equally difficult to conduct an inventory of this group of birds. Rails are generally more often heard than seen. Virginia Rail and Sora are the most abundant rails in North America and will, within their range, occur in most marshes where emergent vegetation exists (Capen and Low 1980). The provincial distributions of other species, such as Yellow Rail and Least Bittern, are unknown, and therefore information derived from future RIC surveys will help to determine their occurrence and distribution within the province.

Biologists conducting surveys for bitterns and rails should be familiar with the life history and habitat characteristics of other wetland birds. There are several other species (including *hypothetical* and *casual* occurences) that share similar behaviours and/or similar habitats with bitterns and rails in B.C. These include the Great Blue Heron (*Ardea herodias*), Green (Green-backed) Heron (*Butorides virescens*), Little Blue Heron (*Egretta caerulea*), Great Egret (*Ardea albus*), Cattle Egret (*Bubulcus ibis*), Snowy Egret (*Egretta thula*), Black-crowned Night-Heron (*Nycticorax nycticorax*), White-faced Ibis (*Plegadis chihi*), and possibly Black Rail (*Lateralus jamaicensis*). None of these species are discussed further in this document, but it is expected that the methods suggested for this inventory group could be applied to at least some of these additional species. Awareness of life histories of all marsh birds will help to ensure that the survey activities for the target inventory group do not affect the behaviour of non-target species. Specific survey methods for the Great Blue Heron are

covered in the Resources Inventory Committee (RIC) manual No. 8 (Resources Inventory Committee 1998).

The species accounts below include the major citations of life history descriptions such as found in the American Ornithologists' Union's "Life Histories of North American Birds" or species accounts in Tacha and Braun (1994). Individuals interested in conducting intensive studies of these species should refer to these publications for greater detail.

2.1 American Bittern *Botaurus lentiginosus* B-AMBI

2.1.1 Description

The American Bittern is a medium-sized (60–80 cm long, 370–500 g) heron with cryptic brown plumage, a stout body and neck, and relatively short legs. It has a long black stripe that begins below its eye and extends down the side of its neck. The plumage of males and females has similar colouring, but males are slightly larger. Flight is relatively ungraceful, characterized by long wingbeats (Gibbs *et al*. 1992a).

American Bittern calls carry long distances relative to the other species included in this manual. Calls include "pumping", a low and resonant 3-syllable *pump-er-lunk* or *dunk-a-doo* repeated 1–10 times in succession (Gibbs *et al*. 1992a). When flushed, they will give a hoarse *kok-kok-kok* (Peterson 1990; Gibbs *et al*. 1992a), or a nasal *hoink* (Gibbs *et al.* 1992a). Although calling can occur day and night at the height of the breeding season, most vocalizations occur early in the breeding season, and generally in the dim light at dawn and dusk.

2.1.2 Habitat, Distribution and Status

American Bitterns prefer vegetated edges and shorelines of wetlands that are dominated by tall, emergent vegetation (i.e. taller than the bird itself). They have been found in wetlands of all sizes, but appear to prefer impoundments or beaver-created wetlands (Gibbs *et al*. 1992a). Use of wetlands appears to be restricted to those portions with water which are shallow enough to stand in (less than 10 cm).

American Bittern nests are platforms of reeds and other vegetation usually 25–40 cm in diametre and 15–40 cm high (Campbell *et al*. 1990a; Gibbs *et al*. 1992a). They are usually well concealed within dense emergent vegetation such as cattail and bulrush. Gibbs *et al*. (1992a) describe nests occurring over water ranging from 5 to 20 cm deep; however, nests in B.C. have been built above water up to 36 cm deep (Campbell *et al*. 1990a). Bitterns will occasionally nest on dry ground in dense vegetation greater than 30 cm tall in grasslands adjacent to wetlands (Gibbs *et al*. 1992a).

American Bitterns are "stand-and-watch" foragers. Their prey includes water insects, small fish, amphibians, snakes, and small mammals. Bitterns will hide themselves in the vegetation and assume a "bittern" stance when approached. This involves pointing their bill skyward, stretching the body vertically, compressing their feathers against the body, and swaying in the breeze (Gibbs *et al*. 1992a).

American Bittern is listed by the B.C. Conservation Data Centre (CDC) as common at the national scale, but provincially rare to uncommon and potentially susceptible to large scale disturbances. It is on the 1997 Provincial Blue list in B.C.

2.1.3 Migration/Seasonal Movements

There is little information about movement and migrations of American Bitterns. They begin arriving at breeding marshes and wetlands in early spring (March – April) (Gibbs *et al*. 1992a). Generally speaking, they arrive later at more northerly locations. Bitterns have arrived in the Chilcotin-Cariboo during the second and third weeks of May, and have reached the Peace Lowlands in late May (Campbell *et al*. 1990a). Most Bitterns leave the breeding marshes in late September and early October (Campbell *et al*. 1990a), although fall migration may begin as early as late August in northern B.C. and may last as late as November. Major river systems and coastal belts are probably important for migrational movements (Gibbs *et al*. 1992a). Small numbers of American Bitterns winter in marshes in the Fraser Lowlands and southeastern Vancouver Island (Campbell *et al*. 1990a).

2.1.4 Survey Notes

Territorial American Bitterns call infrequently, except for a short period of time each morning near at dawn and dusk, or in response to conspecific call playback (Gibbs and Melvin 1992; Sauer *et al*. 1997). In a study of statistical power, Gibbs and Melvin (1997) conducted multispecies call playback surveys of grebes, rails, soras, and bitterns in Maine. The power to detect population trends was lower for the American Bitterns than for any other species. Bitterns appear to be particularly unresponsive in inclement weather conditions. However, the researchers speculate that the problem could be partly compensated for by conducting surveys earlier in the season, and in absolutely favourable weather conditions.

2.2 Least Bittern *Ixobrychus exilis* B-LEBI

2.2.1 Description

The Least Bittern is a small (28–36 cm, 80 g), thin bird with a greenish-black crown, back and tail, and a thin yellow bill. In flight it can be confused with a rail because of its dangling feet and weak, short flight pattern. Plumage is dimorphic; females have a more purple-chestnut or brown crown and back, while males appear blacker. The neck of the female is also darkly streaked (Gibbs *et al*. 1992b; Sauer *et al*. 1997).

All calls are generally soft and barely audible (Johnson *et al*. 1981), Least Bitterns will make a variety of vocalizations, including the male's low, dove-like *coo-coo-coo* (Gibbs *et al*. 1992b) and an *ank-ank* when flushed (Gibbs *et al*. 1992b).

2.2.2 Habitat, Distribution and Status

Least Bitterns are found in freshwater and brackish marshes with dense, tall growth of aquatic or semi-aquatic vegetation interspersed with clumps of woody plants and open water. They are *not* associated with open water, sparse or short vegetation, or muddy openings (Gibbs *et al*. 1992b). A few Least Bitterns have been recorded in summer in the central

southern interior and in a brackish marsh on the southern mainland coast of B.C. (Campbell *et al*. 1990a). Least Bittern appear to prefer deeper water habitats for nesting and foraging than do American Bitterns (Gibbs *et al*. 1992b). They feed on aquatic insects, small fish, amphibians, and some small mammals.

Least Bitterns build there nests 15–76 cm above relatively deep (8–96 cm) water. The nest platform may be made from stems of surrounding vegetation, folded over with other vegetation placed on top. Nests are 15–20 cm in diametre, 5–12 cm thick, and have a canopy. They are often found less than 10 m from open water, along channels, or muskrat trails (Gibbs *et al*. 1992b).

The Least Bittern is on the 1997 Yellow list for B.C.

2.2.3 Migration/Seasonal Movements

Least Bitterns arrive at breeding marshes in early April to late May and leave again to return south in late August through September. Few birds are found north of the Gulf States past mid-October (Gibbs *et al*. 1992b). Specific movement and migration dates in B.C. are unknown.

2.2.4 Survey Notes

There is generally a lack of information on survey techniques for Least Bittern. Gibbs and Melvin (1993) found that Least Bittern response rates to call playback surveys in Maine were lower than American Bittern, Pied-billed Grebe (*Podilymbus podiceps*), Virginia Rail and Sora. The authors suggest that this could have been the result of a fewer number of Least Bitterns being present; however their actual abundance relative to the other species was unknown.

2.3 Yellow Rail *Coturnicops noveboracensis* B-YERA

2.3.1 Description

Yellow Rails are small (18 cm, 52–59 g, smaller than a Sora) birds with short quail-like bills. They are generally buff-brown, but show distinctive white secondary wing patches when in flight. Plumage is similar for both sexes, but the male's bill turns corn yellow during breeding, while the female's remains an olive-black (Bookhout 1995). As well, males are generally larger than females. Yellow Rails are very secretive birds that are difficult to see or flush, even while standing directly overhead of calling males (Peterson 1990; Bookhout 1995).

The calling of the males during the breeding season is a very distinctive metallic sounding 5-note *tic-tic, tic-tic-tic* that sounds exactly like two stones being tapped together. This call is heard most frequently after complete darkness (Bookhout 1995), but has also been heard during the day. Other vocal sounds include "squeaks" from retreating birds, and "wheezing" from females (Bookhout 1995).

2.3.2 Habitat, Distribution and Status

The Yellow Rail is mainly found east of the Rockies (Godfrey 1986), although there is an isolated population in Oregon (Stern *et al*. 1993). There have been no officially "confirmed" sightings of Yellow Rail in B.C. For this reason, it has been considered a *hypothetical* species in the province (Campbell *et al.* 1990b); however, it might better be considered an *accidental* visitor given the number of recent reported encounters (Cannings in *The Vertebrates of British Columbia: Scientific and English Names*, Standards for Components of BC's Biodiversity, No. 2. 1998). Apparent sightings or auditory identifications appear to be distributed throughout the province. One unconfirmed auditory record comes from Somenos Lake on Vancouver Island while two records exist from southeastern B.C., including an auditory record from Lake Lillian in the east Kootenay, and Corn Creek marsh near Lone Pine Hill (Creston). There are also two auditory records from northeastern B.C. One was reported on 10 June, 1989 on the west side of Boundary Lake east of Goodlow (Campbell *et al*. 1990b; Bookhout 1995), and two individuals were heard calling in a roadside ditch near Chetwynd, B.C. (M. Setterington, pers. comm., early June and early to mid-July 1997). There have also been confirmed sightings in Washington on the Skagit River and near Othello, WA (Campbell *et al*. 1990b).

Yellow Rail habitat typically includes fresh and brackish water wetlands, swampy meadows, grassy marshes, and occasionally wet cut-over hay fields (Godfrey 1986; Bookhout 1995). There appears to be a strong association with sedges (*Carex* spp.), although Yellow Rails are *rarely* associated with cattail (*Typha* spp.) (Bookhout 1995). Nest sites have been found in marshes varying in water depth from saturated soil through to shallow marshes with water depth <15 cm (Bookhout 1995). Nests are a 7–10 cm cup composed of fine sedges and grasses that are covered with a canopy of dead vegetation. Females move their broods to uncovered brood nests one to two days after hatching (Bookhout 1995).

Due to its accidental status, the Yellow Rail is not included on the Red, Blue or Yellow list in B.C.

2.3.3 Migration/Seasonal Movements

There is no information on Yellow Rail migration for B.C. Arrival dates in other regions range from the last week of April to the first week of May in Michigan and Minnesota, and range from 8 to 29 May in Quebec (Bookhout 1995). Males stopped calling on 15 August in a study in Michigan (Bookhout and Stenzel 1987). Departure dates typically extend from September to late October (Bookhout 1995). Yellow Rails are most often encountered in wet prairie or grassland during migration (Eddleman *et al*. 1988). Winter habitats include moist coastal grasslands and marshes (Eddleman *et al*. 1988). It is unlikely that Yellow Rail winter in B.C.

2.3.4 Survey Notes

Male Yellow Rails were attracted at night (2200–0400) by striking two small stones together to imitate the territorial call of the male (Bookhout and Stenzel 1987). Responses have been elicited from Yellow Rail by both call playback and striking stones (Stern *et al*. 1993), however it is unknown if response rates differ between the two methods. It is difficult to estimate the distance from the observer to a calling Yellow Rail because the birds often turn while calling, thus changing the apparent volume of their calls (Bart *et al*. 1984). One

observer can cover a 1.6 km long and 0.4 km wide fixed-width transect in one hour in Michigan wetlands when surveys are conducted at night between approximately 2300 to 0430 (Bart *et al*. 1984). However, due to difficulties, including hearing and detecting individual Yellow Rails, Bart *et al*. (1984) decided that line transect data were unsuitable as an index for population monitoring. Four surveys were required to detect most of the calling birds. In another study, a pointing dog was used to locate female and male rails that did not respond to call playback. Birds were then captured with hand nets (Bookhout and Stenzel 1987).

2.4 Virginia Rail *Rallus limicola* B-VIRA

2.4.1 Description

Virginia Rails are small (23 cm, 55–124 g) rusty birds with a long, slightly decurved reddish bill and reddish legs. They have short upturned tails and banded black and white flanks (Conway and Eddleman 1994; Conway 1995). It is the only British Columbian rail with a long, slender bill (Peterson 1990). When walking, they often flick their short tails and expose white undertail coverts (Sauer *et al*. 1997). While males are generally larger than females, there is no reliable technique for distinguishing males from females in the field.

There are four predominant calls of the Virginia Rail (Conway 1995). The most common is referred to as *grunts* which are heard as duets between males and females. *Tick-it* calls are heard briefly in the spring, and are probably given by males only. *Kicker* calls may be given prior to breeding calls, and the species also gives a sharp *kiu* call. Peterson (1990) refers to a *wak-wak-wak* call while Scott (1983) describes a series of *kid kid kidick kidick* phrases as being distinctive of Virginia Rail (one Spanish name for this rail is *Kidika* (Conway 1995)). Vocalizations occur most frequently in the two to three hour period around dawn and dusk, and occasionally through the night (Conway 1995). The peak calling season is from the second to fourth weeks in April in southern parts of the Virginia Rails breeding range, and the second to fourth week of May in the northern extent of their breeding range (Conway and Eddleman 1994).

2.4.2 Distribution, Habitat and Status

Breeding Virginia Rails are rare to locally fairly common from southeastern Vancouver Island (Victoria to Comox), the Fraser Lowlands and the Okanagan valley and Creston valley, and locally near 100 Mile House, Williams Lake and Kleena Kleene (Campbell *et al*. 1990b). They have been found breeding in suitable habitat from near sea level to 915 m ASL (Campbell *et al*. 1990b). Winter distribution in B.C. includes southern Vancouver Island from Victoria to Campbell River on the east coast, and Victoria to Halfway River on the west coast, Fraser Lowlands, and the Okanagan valley (Campbell *et al*. 1990b).

Virginia Rails are usually found in freshwater wetlands, but have also been found in salt marshes. They favour areas with warm spring air temperatures, and appear to have an affinity for the drier portions of marshes (relative to cooler areas used by Soras) (Conway 1995). Virginia Rails are found in stands of robust vegetation including cattails and bulrushes (Conway 1995). They have been frequently observed in areas with 5–15 cm deep water, and heard from areas with less than 5 cm water (described in Conway and Eddleman 1994). Nests are loosely woven baskets (~ 15 cm diametre) made of surrounding vegetation, usually

concealed with an overhead canopy. Nests can be well above the water, or at the base of taller vegetation (Harrison 1978). Dates for clutches range from 6 April to 20 June, and broods from 3 May to 18 August (Campbell *et al*. 1990b). The peak of egg laying occurs in mid-May in Iowa (Johnson and Dinsmore 1986).

The Virginia Rail is on the 1997 Yellow list for B.C.

2.4.3 Migration/Seasonal Movements

Spring movements of Virginia Rails occur late March to early May, and fall movements occur September through November in B.C. (Campbell *et al*. 1990b). As described above, Virginia Rails over-winter in southern B.C.

2.4.4 Survey Notes

Response to call playback surveys from races of the Clapper Rail (*Rallus longirostris* — considered to be similar to Virginia Rail; Conway 1995), varied from some birds answering but not approaching the broadcast site, some approaching but not answering, and some both approaching and answering (Tomlinson and Todd 1973). Virginia Rails frequently responded to broadcast Clapper Rail calls in Arizona, especially during fall and winter (Tomlinson and Todd 1973). Tomlinson and Todd (1973) discuss the success of various Clapper Rail calls at various times of the year, but generally suggest that birds were most responsive during the breeding season. Virginia Rails will also respond to King Rail calls in Southern Ontario (R. Weeber, Bird Studies Canada). However, although Virginia Rails may be responsive to the calls of other species, it is best to perform surveys using conspecific calls.

Systematic searches for Virginia Rail nests in Colorado were generally unsuccessful, but nests were found when the rails were heard giving *keep*-like calls (Glahn 1974). A study in Iowa found that nighttime surveys (one to four hours after sunset) conducted in early June for Virginia Rail were just as successful as daytime surveys (from one hour before to three hours after sunrise) (Johnson and Dinsmore 1986). Foot surveys have been used for finding Sora and Virginia Rail nests in a shallow (less than 1 inch deep) 0.5 acre marsh in Michigan (Berger 1951).

2.5 Sora *Porzana carolina* B-SORA

2.5.1 Description

The Sora is a medium-sized (20–25 cm, 72–88 g) rail with a stubby yellow bill, and black face mask and throat. The females has a duller and smaller black face patch, a mantle which is more spotted with white, colours which are less intense, a darker bill, and a smaller overall size (Dimmick and Pelton 1994). Soras are difficult to flush, but fly more readily than Virginia or Yellow Rails (Melvin and Gibbs 1996).

Among other vocalizations, Soras have a distinctive descending whinny described as *whee-hee-hee-hee-hee-hee*. The females make shorter calls that are more variable and at a higher frequency than those of the males. Peak for calling appears to occur in mid-May (Melvin and Gibbs 1996).

2.5.2 Distribution, Habitat and Status

Soras are the most abundant and widely distributed North American rail (Melvin and Gibbs 1996), and often occur sympatrically with Virginia Rail (Melvin and Gibbs 1994). In B.C. they are fairly common along southeastern Vancouver Island, Fraser Lowlands, and in suitable habitat throughout the interior to the Peace River and other boreal areas (Campbell *et al*. 1990b).

Soras prefer freshwater and brackish wetlands with an interspersion of emergent vegetation and open water from near sea level to 1,220 m ASL (Campbell *et al*. 1990b). Nests are usually found in robust or fine-leaved vegetation within 18–22 cm of water, and are often placed at vegetation edges, near patches of open water, or in mixture of robust and fine vegetation (e.g., cattail with an understory of sedge) (Melvin and Gibbs 1994). Dominant plants around nest sites often include cattail and sedges, and, less commonly, bulrushes, burreeds, and grasses (Melvin and Gibbs 1994). Nests are composed of the surrounding vegetation woven together with some finer material, such as dry grasses, to form a cup. Similar to other rails, the surrounding vegetation is folded over to form a covering dome.

Sora is on the 1997 Yellow List for B.C.

2.5.3 Migration/Seasonal Movements

Soras have a regular migration. Spring migration may begin as early as mid-March, but usually migrants will arrive in late-April and early May (Campbell *et al*. 1990b). Peak fall migration occurs in September and early October. Small numbers of Soras may sometimes winter in the lower Fraser River valley (Campbell *et al*. 1990b).

2.5.4 Survey Notes

Soras will respond to call playback of conspecifics and Virginia Rail, as well as loud noises (Melvin and Gibbs 1996). Soras respond to call playback during the early part of the breeding season (late April to early June in most states), but respond less frequently in summer and fall (Melvin and Gibbs 1994). Soras frequently responded to Clapper Rail calls in Arizona, especially during fall and winter (Tomlinson and Todd 1973). Systematic searches for Sora nests in Colorado were generally unsuccessful, but nests were found more readily when Soras were heard giving *keep*-like calls (Glahn 1974). A study in Iowa found that nighttime surveys (one to four hours after sunset) conducted in early June for Sora were just as successful as daytime surveys (from one hour before to three hours after sunrise) (Johnson and Dinsmore 1986).

2.6 American Coot *Fulica americana* B-AMCO

2.6.1 Description

The American Coot is a rail that superficially looks like a medium-sized dark coloured duck with “chicken-like” legs and bill and a small head (Alisauskas and Arnold 1994). The Coot’s plumage is slate gray but appears black from a distance, and its short, white bill extends up the forehead forming a frontal shield. Coots swim more than other rails, aided by their lobed toes which allow them to move like ducks through the water, constantly bobbing their heads (Baron and Acorn 1997). Due to the similar plumage and size overlap between the sexes, it is

difficult to distinguish males and females in the field. Voice differentiation is the most reliable method of differentiation (Gullion 1950), but requires field experience with the species before it can be attempted with any degree of confidence.

2.6.2 Distribution, Habitat and Status

American Coots are abundant and conspicuous in many wetland environments throughout B.C. They can be found in a variety of habitats including lakes, ponds, or marshes, and may be seen foraging on grass in parks and fields. Coots prefer fresh water but will frequent shallow saltwater environments. They will also defend small territories, sometimes against other marsh birds (Alisauskas and Arnold 1994).

The greatest densities of coot nests have been found in well-flooded, persistent emergent wetlands characterized by a mixture of emergent vegetation and open water (Alisauskas and Arnold 1994). The largest breeding colonies of American Coot in B.C. are found at Westwick Lake, Cecil Lake and Boundary Lake (Campbell *et al*. 1990b).

American Coot is on the 1997 Yellow List for B.C.

2.6.3 Migration/Seasonal Movements

American Coots wintering on the coast begin their northward migration in early April to May while the migration of birds from the B.C. interior starts in March and peaks in April (Campbell *et al*. 1990b). Nesting usually begins 10–14 days after arriving on the breeding grounds (Alisauskas and Arnold 1994). Main movements for fall migration occur from mid-September to mid-October (Campbell *et al*. 1990b).

2.6.4 Survey Notes

Brood size counts derived from visual surveys are not reliable because adult coots tend to split up broods and feed them in different areas of the territory. Therefore, both parents must be seen within a territory and counts made of the young with each of them (Gullion 1956). Ground counts are reputedly more effective than aerial counts, even though some ground surveys detect only half of known nesting populations and provide only an index of abundance (ref. in Alisauskas and Arnold 1994). Visual surveys in general appear to underestimate coot populations.

2.7 General Identification Problems

Sexes of most rails cannot be differentiated by plumage characteristics (Dimmick and Pelton 1994). Techniques for separating immature from adult rails have not been documented in commonly available field guides; however, complete plumage descriptions of the various age classes are provided in the accounts from Life Histories of North American Birds (Gibbs *et al.* 1992a; 1992b; Bookhout 1995; Conway 1995; Melvin and Gibbs 1996).

Sora and Virginia Rails may utter identical alarm calls at the nest (Robbins and Stallcup 1981). The calls of Black, Yellow and Virginia Rails may be difficult to separate (Robbins and Stallcup 1981).

3. PROTOCOLS

This section reviews the recommended survey methods and provides protocols for inventories of American Bittern, Least Bittern, Virginia Rail, Yellow Rail, Sora and American Coot. Because species detection in these protocols depend on territorial or nesting behaviour by the birds, these survey methods are only reliable during the breeding season.

For most of the species described in this manual, visual surveys will not be effective because rails and bitterns are either difficult to flush, or are only visible in open habitats. Therefore, more pro-active measures such as eliciting responses using call playbacks, or searching for nests with a trained dog will be required.

Recommended methods for each of the species described in this manual are indicated in Table 2. Each method is then outlined in the following sections. The call playback method can be used as both a measure of presence/not detected as well as relative abundance with little adjustment to the sampling design. For measures of nesting density (included under "Absolute Abundance"), trained pointing dogs will likely be required to locate nests within wetlands.

Table 2. Recommended methods for inventory of bitterns and rails in British Columbia at three levels of survey intensity.

Species	Presence/Not Detected	Relative Abundance	Absolute Abundance
American Bittern	Call Playback	Call Playback	Fixed-width Transect
Least Bittern	Call Playback	Call Playback	Fixed-width Transect
Virginia Rail	Call Playback	Call Playback	Fixed-width Transect
Yellow Rail	Nocturnal Call Playback	Nocturnal Call Playback	Fixed-width Transect
Sora	Call Playback	Call Playback	Fixed-width Transect
American Coot	Call Playback	Call Playback	Fixed-width Transect

3.1 Sampling Standards

The following are guidelines for conducting inventory studies on bitterns and rails in B.C. 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. The key to successful comparison between studies is the standardization of the estimated parameters and a measure of the variability (e.g., standard deviation, confidence intervals) associated with the estimated parameter (Fuller and Mosher 1981).

3.1.1 Weather

Weather affects both the observer's abilities and the marsh bird's behaviour. If it is too cold, too wet, or too windy to see, hear, and identify birds, then the survey should not be conducted. Although this section provides guidelines as to what conditions are inappropriate, ultimately the field biologist must decide when her/his ability to survey effectively is compromised. In general, when surveys rely on an observers ability to hear, field work should not be conducted when the wind is greater than 20 km/hr (not greater than Beaufort 3), or when other conditions, such as heavy rain, thunder, traffic, etc. may impair a surveyor's hearing abilities. In addition to interfering with the observer's ability to listen, rain may also place the nestlings at risk of becoming wet and cold if adults are flushed off the nest as a result of survey activities. Therefore, surveys should not be conducted if precipitation is more than a drizzle or light rain.

3.1.2 Time of Year

All of the species described in this manual are migrants (e.g., they move outside of B.C. for a portion of the year) or partial migrants (e.g., they move within the province to lower elevations or to coastal sites). Winter surveys for American Coot and Virginia Rail are possible, but rely on direct counts of individuals based on visual rather than aural identification. Since these species are generally more active, and thus more visible when they are breeding, breeding surveys probably provide a better indication of true population numbers, and more intensive visually-based surveys will be required in the non-breeding season. For these reasons, only breeding-season surveys are recommended and described in this manual.

Breeding bittern and rail counts can theoretically be conducted during late-April to early July in southern B.C. and during late-May to July in northern B.C. However, to standardize survey dates throughout the province, marsh bird surveys should be conducted between 20 May and 5 July throughout B.C. Repeat surveys should be separated by at least 10 days (Marsh Monitoring Program 1997). To determine peak times in breeding chronology for each species, refer to the life history accounts described above, or to the information included in Campbell *et al*. (1990a; 1990b). Surveys should be conducted as close to peak breeding activity as possible. For aural surveys, peak calling periods (e.g., communication among mates, territorial challenges) are preferred target dates. For transect, nest-finding surveys, inventories should fit local peak nesting periods as closely as possible.

3.1.3 Time of Day

The best time of day to conduct a survey varies by species. American Bitterns are best heard during a dawn survey. There is little information to determine at what time of day it is best to hear Least Bitterns. Yellow Rail are best surveyed at night. Virginia Rail can be sampled at dawn and dusk surveys. Sora can be encountered at any time of the day, but are most responsive in early morning and evening. American Coot can be seen throughout the day, but surveys during the early morning will probably be most productive.

Multiple species surveys of marsh birds should include both morning and evening visits. Morning surveys should be conducted from 30 minutes before to four hours after sunrise (Gibbs and Melvin 1993). Evening surveys should be conducted 30 minutes prior to, and finish at or before sunset (i.e., beginning after 1800 h; Marsh Monitoring Program 1997). Nocturnal surveys for Yellow Rail should be conducted from shortly after dark through to sunrise (Bart *et al*. 1984).

3.1.4 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 target species, and the objectives of the inventory. Since most provincially-funded wildlife inventory projects deal with terrestrial-based wildlife, the terrestrial Ecosystem Field Form or the Ground Inspection Form, developed jointly by Ministry of Forests (MOF) and Ministry of Environment, Lands and Parks (MELP) can be used when appropriate. Although both of these forms have been used primarily in terrestrial ecosystems, they can also be used in wetlands to describe emergent vegetation and other relevant attributes. Further information about standard habitat data collection is available in the introductory manual, *Species Inventory Fundamentals, No. 1.*

Wetlands Defined

For the purpose of calculating the area of wetlands and marsh features, it is necessary to define how these features are delineated. The following wetland definition differs slightly from that appearing in the Forest Practices Code Riparian Area Guidebook by including sites which possess either of the following characteristics, but not necessarily both. Under this modified definition, **wetlands** have either:

- plant communities characterized by species that normally grow in soils which are water-saturated for a major portion of the growing season (“hydrophytes”);
- soils with surface peat (“O”) horizons or gleyed mineral horizons (Bg or Cg) within 30 cm of the soil surface.

Hydrophytes should make up greater than 20 % or more of the combined cover of low shrub and herbaceous vegetation. Most (>80 %) of the remaining vegetation should be species that are able to grow on water-saturated soils, even though they may not be restricted to these soils. Wetlands do not necessarily have trees, but if trees are present, the canopy should be generally open (< 15 % canopy closure of trees > 12.5 cm DBH).

According to the formal definition, a **marsh** is a type of wetland, with distinct soil characteristics, as well as seasonally-fluctuating levels of near-neutral to basic surface water. Declining water levels typically expose mudflats and matted vegetation. Emergent vegetation includes grasses, cattails, sedges, rushes, and reeds.

Within the context of this manual, the term "**marsh habitat**" is used with reference to a vegetated wet area that is periodically or regularly inundated with nutrient rich water up to a depth of 2 m. The area is usually dominated by emergent non-woody vegetation such as cattails, bulrushes, reeds, grasses and sedges. In comparison, swamps, bogs and fens are generally dominated by trees and shrubs.

Some General Wetland Characteristics

A small amount of general habitat data should be collected about each wetland and included in the final report to provide context for the inventory. This should include the following attributes:

- Type of wetland (i.e. fen, bog, marsh, swamp) - refer to the wetlands section in the Riparian Management Area Guidebook (B.C. Min. Environ. and For. Serv. 1995);
- Size of wetland (in hectares);
- Area covered by non-woody emergent vegetation and a calculation of the ratio of non-woody emergent vegetation to open water. Larger wetlands or wetland complexes can have large areas of open water that are obviously unsuitable habitat for most of the bitterns and rails described in this manual. For wetlands like this, you should only describe the shoreline to one metre depth beyond emergent vegetation;
- General description of emergent vegetation — especially to distinguish between woody and non-woody vegetation (e.g., willow versus sedge).

3.1.5 Maps and Aerial Photographs

All RIC survey standards suggest that maps (topographic and TRIM) of the project area be obtained. Maps will help you locate general study areas and general access routes. However, wetlands are seldom mapped in sufficient detail to allow you to determine required survey methods and methods of travel within the wetlands (e.g., use of canoe, or the possibility of shoreline surveys). Recent colour aerial photographs will give you the best information about wetland conditions. Emergent vegetation will be readily visible to allow you to determine the total area of suitable habitat. Unmapped features such as recent seismic lines or old trails will also be visible and will help you decide whether it will be possible to transport a boat into the site.

Photos at 1:15 000 or smaller (1:5 000) scales will be suitable for designing many surveys. To provide field crews with appropriate maps of wetlands, the photos can be copied and enlarged; digitized and printed photos with various sections enlarged will be useful. To make orientation easier for untrained field personnel, individual maps can be created. These maps could show a variety of wetland features including emergent woody stems versus emergent sedge or cattail cover. It is a good idea to invest some time in identifying initial Study Areas and reproducing maps of them to assist field personnel in selecting appropriate and productive areas in which to place marsh bird survey routes.

3.1.6 Survey Design Hierarchy

Marsh bird surveys follow a sample 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 for marsh birds. A survey set up following this design will lend itself well to standard methods and RIC data forms.

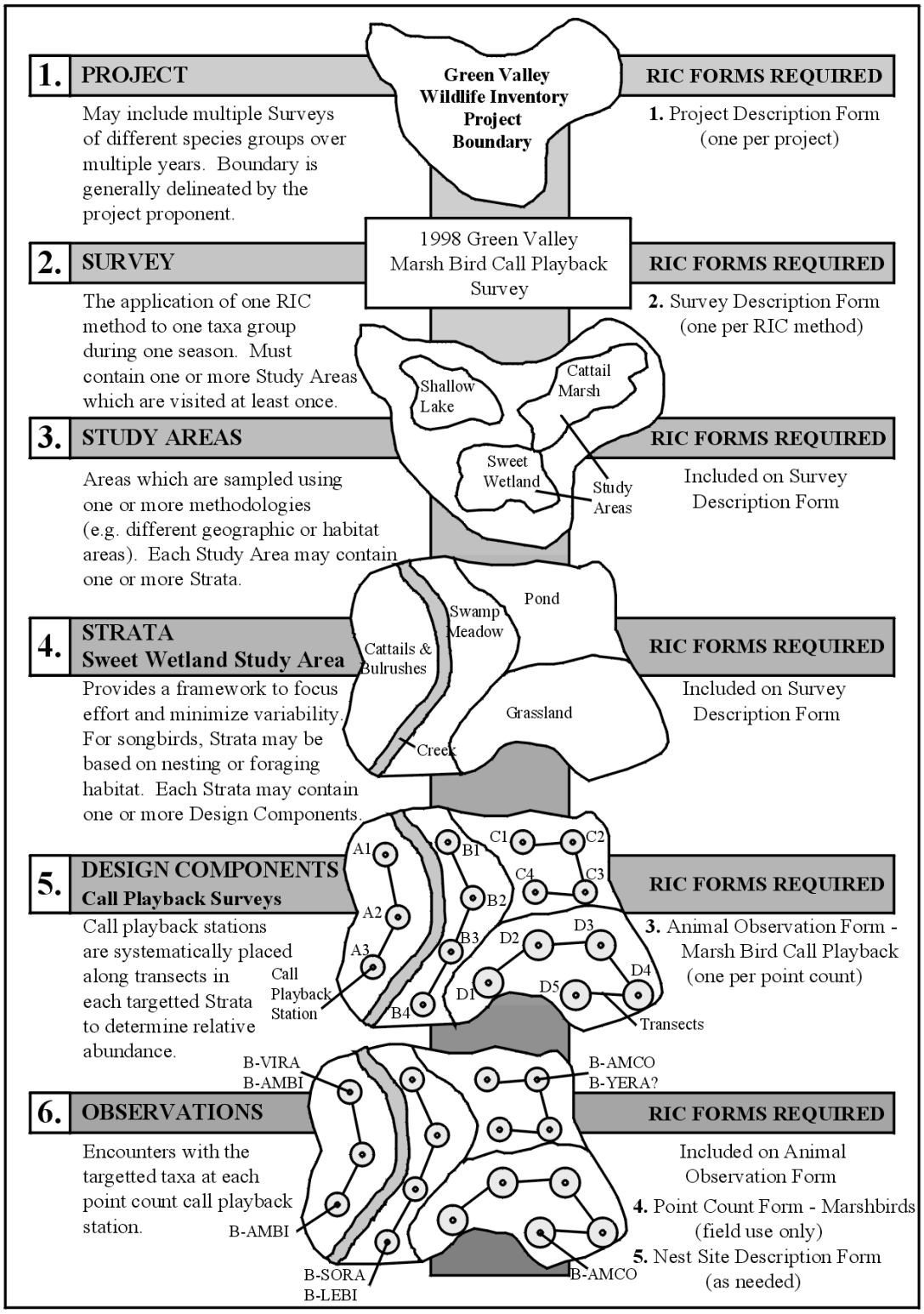

Figure 1. RIC species inventory survey design hierarchy with examples.

3.2 Inventory Surveys

The table below (Table 3) outlines the type of surveys that are used for inventorying bitterns and rails for the various survey intensities. These survey methods have been recommended by wildlife biologists and approved by the Resources Inventory Committee (RIC).

Inconspicuous waterbirds are undersampled by most standard bird survey techniques, especially those relying on visual or unsolicited call counts (Gibbs and Melvin 1997). Since bitterns and rails are secretive birds that live in relatively inaccessible and densely vegetated habitats, inventory methods are limited to those where birds are heard rather than seen. Therefore, the call playback method that is used for some other RIC standards (e.g., raptor call playback, Resources Inventory Committee 1997a) will also be used for bitterns and rails. The survey described below is essentially a Point Count using broadcasts of tape-recorded birds to elicit responses from target species.

Table 3. Types of inventory surveys, the data forms needed, and the level of intensity of bittern and rail surveys.

Survey Type	Forms Needed	*Intensity
Call Playback	• Wildlife Inventory Project Description Form • Wildlife Inventory Survey Description Form-General • Point Count Data Form- Marsh Birds • Animal Observation Form- Marsh Birds Call Playback • Wetland Description Form	• PN • RA
Fixed-width Transect (Nest Count)	• Wildlife Inventory Project Description Form • Wildlife Inventory Survey Description Form-General • Animal Observation Form- Marsh Birds Transect • Nest Description Form	• AA

* PN = Presence/Not detected (possible); RA = Relative Abundance; AA = Absolute Abundance

Since the calls will be elicited from males (for most species and conditions), a measure of absolute abundance will not be possible using only call response surveys. As an alternative, a measure of absolute abundance is possible using fixed-width (strip) transect surveys if sufficient time and skill are invested. Mark-recapture procedures present another option but are not recommended as an inventory procedure for bitterns and rails. Since most rails are generally difficult to observe, but relatively easy to capture (Bub 1978; Bookhout and Stenzel 1987), capturing and marking the birds would not pose many problems. However, colour tags, neck-bands, or feather marking are not recommended because these conspicuous markers will compromise natural camouflage. Leg bands can be used, but they are not visible because the birds legs are in the water, or can not often be seen through marsh vegetation. Therefore, mark-recapture methods would dictate that birds be repeatedly recaptured to determine population size within a marsh. This would create unnecessary amounts of disturbance. As a result, the measure of Absolute Abundance for bitterns and rails will be limited to a count of active nests within given marshes or areas within a marsh.

3.2.1 Survey Intensity

The same methods are used whether Presence or Relative Abundance of bitterns and rails is desired, and it is recommend that surveys strive for measures of relative abundance whenever possible. The difference between the two levels of intensity is generally just a matter of meeting a few basic statistical assumptions discussed briefly in the introductory manual *Species Inventory Fundamentals No. 1.*

If the desired objective is to determine whether a species is present within a marsh, then call playback should be conducted until a response is elicited, confirming the presence of the target species. If call playbacks are conducted every 10 days throughout the breeding season and no response is elicited from a target species, then that species can be given a "Not Detected" status *for that sample point for that season.* A "Not Detected" status *for the marsh* can be given to that species if sample points are sampled as above, and if they are distributed throughout a marsh at one point for every 5 ha of suitable habitat. If an objective is to evaluate presence between habitat types, then each habitat type should be sampled proportional to availability. For further discussion of Presence/Not Detected surveys, refer to the introductory manual *Species Inventory Fundamentals No. 1*.

If the desired objective is to compare Relative Abundance of a target species between habitat types, then each habitat type should be sampled with an equal number of point count stations as a balanced design lends itself well to statistical testing. For instance, if you want to determine Relative Abundance of marsh birds (number of birds per plot of marsh habitat) between big (i.e., greater than 50 ha) and small (i.e., less than 5 ha) marshes, further consideration of your sampling design will be necessary prior to establishing field plots. In cases such as this, you may want to either establish a similar number of point count stations, or an equal sample of different size marshes. Further discussion of this aspect of sampling is beyond the scope of this manual, so the reader is referred to the introductory manual *Species Inventory Fundamentals No. 1.* Project managers interested in this scale of question must also have some statistical design experience to make a Relative Abundance project worthwhile.

Conducting a survey to determine Absolute Abundance of bitterns and rails requires a significant amount of field experience and life history knowledge. The measure of Absolute Abundance is limited to a count of active nest sites. Despite the temptation to do so, do not assume that the number of nests counted is equal to the total population of birds in the Study Area, as it will only include the breeding portion of the population. As well, finding a large proportion of the all the nests present requires a considerable amount of effort and experience both working in marshes and finding marsh birds and their nests by interpreting their behaviour.

3.2.2 Forms for Point Counts

Two of the forms required for marsh bird point counts have specific roles which may not be readily apparent. For this reason, the uses of each of these forms is described below.

1. Point Count Data Form — Marsh Birds

- This form is used only in the field to map bird locations and their responses to call playback. It is similar to data sheets used for songbird point counts (Resources Inventory Committee 1997b). However, there is only one circular plot for the entire 10 minute

count rather than separating the count into three different time periods. One of these sheets is completed at each point each time it is visited (i.e., for each design component visit).

- As this form is for field purposes only, information collected on it will be transcribed onto a *Animal Observation Form - Marsh Bird Call Playback.* However, Point Count Data Forms should be kept on file by the Field Manager.

2. Animal Observation Form - Marsh Bird Call Playback

- Information from the *Point Count Form- Marsh Birds* is transferred to this form. One form is used to summarize all observations at one point count station, for one visit. Record *each* bird detected on a line on the *Animal Observation Form - Marsh Bird Call Playback.*
- From these forms total counts by species can be tallied for each visit to a point. An index of abundance for each species for each point can also be calculated.

3.3 Presence/Not Detected and Relative Abundance

3.3.1 Call Playback

A call playback/call response survey is the most economical monitoring survey for bitterns and rails. Call playback surveys improve detectability of secretive-species compared to passive (look-and-listen) observations, or detection through responses to disturbances such as clapped hands or rocks thrown into the water (Glahn 1974; Gibbs and Melvin 1993). As noted in the species life history descriptions, call playback has been used successfully in monitoring populations of most marsh-inhabiting birds. Visual surveys have a high degree of detection error due to the densely vegetated habitat and secretive nature of the birds.

Advantages

- Call playback surveys will increase the chances of locating birds that may otherwise remain quiet and undetected.
- Call playback stations can be established at the edges of marsh habitats, thus reducing the risk of damaging habitat by trampling the vegetation.

Disadvantages

- Call playback does not sufficiently sample females or young in a population, therefore it only provides an index of a breeding population.
- The relationship between the number of calling or responding birds and the actual breeding population is unknown.
- The use of tapes and broadcast equipment introduces an additional source of variation (i.e., in addition to observers, weather etc.).

Office Procedures

- Review the section, Conducting a Wildlife Inventory, in the introductory manual Species Inventory Fundamentals No. 1. For further discussion on statistical power in waterbird surveys refer to Gibbs and Melvin (1997).
- Obtain relevant maps of the project area (e.g., 1:50 000 air photo maps, 1:20 000 forest cover maps, 1:20 000 TRIM maps, 1:50 000 NTS topographic maps).
- Outline the Project Area on a map and 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.
- Generally, establish Study Areas by stratifying the Project Area by size of wetland (see Habitat Description for definition). One Study Area may consist of one or more marsh habitats (see Glossary for definition). Recent colour aerial photographs of the habitat that will be surveyed will be especially useful (see Sampling Standards above).
  For each Study Area:
  - Determine Biogeoclimatic zones and subzones, Ecoregion, Ecosection, and Broad Ecosystem Units for areas surrounding the wetland. Determine wetland type using

the Riparian Management Area Guidebook (B.C. Min. Environ. and For. Serv. 1995) as a general reference.
    - Determine the size of each marsh habitat by estimating the area covered by non-woody emergent vegetation.
    - Identify access points and potential call playback stations for surveys from large scale, colour aerial photographs.
- Review the life histories of the marsh birds that may potentially be in your Study Areas. Since marsh birds have generally not been studied in B.C., use the known range only as a general guideline, and rely more on general habitat descriptions for each species as an indication of potential presence.
- Prepare a survey tape of the target species' calls.
    - Tapes should include, for each species, three series of 20 seconds of calls (c) followed by 30 seconds of silence (s), (except after the last call in a sequence, which should have one minute of silence before the next species), [sequence 20(c1)-30(s1)-20(c1)-30(s1)-20(c1)-60(s1)-20(c2)-30(s2)-etc.]. Each species can be recorded consecutively on one tape.
    - If you are recording from a commercial CD or tape, do not include the announcement of the species!
    - For comparable results, broadcast tapes should be identical in terms of duration, sequence and quality of calls. Some birds (e.g. B-VIRA) will reply to calls of other species, as well as conspecifics, and so whether they are first or last on the tape will influence the duration of time available for a response. Although it has not been well explored, it is also possible that loud calls (e.g. B-AMCO) may suppress calling of quieter species (e.g. B-AMBI and B-LEBI). It is probably best to be conservative and play calls from quietest species to loudest.
    - Tapes degrade with exposure and should be replaced at least once per field season.
- Test the call playback equipment to ensure that it works (see Call Playback Equipment section below).
- Complete the following Data Forms that are included in the *Species Inventory Fundamentals No. 1 [Forms]* (previously referred to as the *Dataform Appendix)*:
    - Wildlife Inventory Project Description Form.
    - Wildlife Inventory Survey Description Form — General.
- Locate capable Field Personnel.

Sampling Design

- Superficially evaluate the wetlands within the Project Area. Gibbs and Melvin (1993) suggest stratifying effort among large, typically species-rich, wetlands and wetlands that are smaller, of marginal habitat quality, or were historically occupied.
- Randomly choose Study Areas to be surveyed from each of the different strata. The objective here is to strike a balance between maximizing species detections and surveying a sample of habitats which are representative of the Project Area (Gibbs and Melvin 1993).
- For each marsh habitat within a Study Area, establish Point Count Stations systematically, either throughout or along the edges of the marsh habitat(s) of interest. To avoid replication of counts, stations are placed a minimum of 250 m apart. This also means that stations will be placed at approximately one station for every 5 ha of marsh habitat, a sampling intensity suggested by Gibbs and Melvin (1993).

Sampling Effort

- Each Point Count Station must be visited at least three times during the peak of the breeding season. To ensure sufficient coverage throughout the breeding season, survey visits should be separated by a minimum of 10 days.
- Samples are based on a 100 m radius plot. Depending on whether the observer is at the edge of a wetland or within it, s/he may sample either a complete circular plot (3.14 ha) or a semi-circular plot (1.57 ha), either of which must be predominately marsh habitat.
- Gibbs and Melvin (1993) surveyed approximately 10–15 Point Count Stations of 10 minutes in 4.5 hours. Many of these were done from a canoe while others were completed on foot.
- The number of Point Count Stations sampled in a marsh habitat is based on a sampling intensity of one station for every 5 ha (see above), to a maximum of 10 stations.

Personnel

- All field personnel should be familiar with identifying features and life histories of the species described in this manual. To avoid mis-identification, personnel should also be familiar with other marsh birds. The project biologist should train all observers with appropriate books, tapes, study skins, etc.
- At least one person should be familiar with the collection of habitat data. This will require someone who is familiar with wetland plants and wetland classification.

Equipment

- Several copies of *Point Count Data Form - Marsh Birds* on waterproof paper attached to a wooden clipboard (metal ones are too noisy when handled and may scare the birds)
- Several copies of appropriate forms for habitat description (see *Species Inventory Fundamentals No. 1*)
- Nest Site Description Forms (you may find nests during your surveys; follow the RIC guidelines for completing these forms that are found in the *Species Inventory Fundamentals No. 1* [Forms])
- Small kayak, canoe, or inflatable if traveling through wetland to do surveys
- Puncture-resistant hip or chest waders
- 8–10x wide angle binoculars
- Compass
- Bright flash light (headlamp preferable) for nocturnal surveys
- Black permanent ink marker to mark flagging tape and posts
- 3 m sections of ½" electrical conduit piping to mark Point Count Stations (one for each station)
- Blaze orange flagging tape, or reflective tape to mark stations so they can be relocated at night
- 35 mm camera for photodocumentation of the habitat
- Call playback equipment (waterproofing the equipment may be a good idea) -see below

Call Playback Equipment

The broadcast of each species' calls should be heard by birds 100 m from the point of broadcast. Gibbs and Melvin (1993) utilized a standard maximum sound pressure of 80 dB at one metre from the source. A cruder means of assessing sound level is to subjectively evaluate the sound level at 100 m from the speaker, but there is no way of assuring that you will be hearing what the birds will be hearing. A small portable tape player with two speakers (i.e., a portable stereo) should be sufficient for the purpose of these surveys. An alternative is to use a walkman attached to an amplified speaker. Describe whatever equipment is used by brand name, model name, and power of sound output (these specifications can be found in the owner's manual or from the dealer). Play calls at a maximum volume where there is minimal tape-noise in the background. This usually seems to be a step below maximum output. To keep your hands free during the survey you may want to attach the tape player and speaker to a strap and hang them around your neck.

Field Procedures

- Visit your proposed field routes during daylight to familiarize yourself with the habitat features and to see if there will be any particular transportation problems both to and through the Study Area. Determine if the wetland can be sufficiently sampled along its edge, or if a boat will be required for full coverage. Visit the survey sites prior to the peak of the breeding season, but after plants have emerged so habitat data can be completed. Do not try to do both at the same time!
- Establish the Point Count Stations as described below.

Establishing a Route and Marking the Stations

Take the time before conducting the surveys to establish the call playback stations and travel routes. Each Point Count Station (Call Playback Station) has to be clearly identified to aid relocation both within and between seasons. Remember that you may not be the one to relocate stations, so the location of each must be clearly described to anyone who is unfamiliar with the area. Recording only UTM coordinates (using NAD83) of each plot is useful, but generally insufficient alone because this will mean that future field personnel will need a differential GPS to relocate plots within 10 m. A few well-worded comments can be very helpful.

1. Establish a fixed marker at the initial point of access. Indicate this point on TRIM mapsheets, and aerial photographs if it improves relocation by other field personnel.

2. Once you reach marsh habitat, select a representative Point Count Station that has a 100 m radius:

    - Position the station so that the maximum amount of marsh habitat is being sampled. Based on this, you will need to decide whether to count the station as a full plot (3.14 ha) or a half plot (1.57 ha). Since many wetlands can be surveyed from the roadside, it is convenient to count these as half plots. In these situations, only half of a circular plot may be marsh habitat, while the other half of the plot behind you may be road or forest. Situations like this can be accommodated since the measure of abundance will be standardized to the number of responding birds per full plot. It is important to realize however, that sampling along the edge of a wetland does have some

disadvantages, including a lower ratio of effort:coverage and a bias toward species at the periphery of wetlands as opposed to the interior.
- Situate the Point Count Stations so that as much as possible of the 100 m radius sample area can be seen and to minimize obstructions to hearing. Slightly elevated points with an unobstructed view are good locations.

3. Permanently mark the station:
   - Since each Point Count Station will be re-visited, the centre must be marked permanently with a metal or wooden stake so the stations can be relocated. Wooden 2x2" stakes can be used, but a better alternative is ½" metal electrical conduit piping. Three metre long stakes can be firmly pushed into the marsh bottom, and should be able to withstand wind, wave and ice activity (Marsh Monitoring Program 1997). A less permanent marker may be used if the station will only be visited for one season.
   - Point Count Station identification numbers can be inscribed on aluminum tags that are used commonly in forestry cruise plots. Identification numbers should include a code for the Study Area, plus consecutively marked stations beginning with A (e.g., the first station in Whitty's Marsh Study Area would be WHIT-A). Attach the metal tags to the pole with binding wire, and attach some reflective flagging tape so the plot can be relocated for nocturnal surveys. With a black felt pen (e.g., Sharpie), label each stake with the same individual plot identification number that you put on the aluminum tag. This marking will only last one season, but will be a "back-up" to the aluminum tag and can often be read at a distance (Marsh Monitoring Program 1997).
4. To help avoid replication of counts, additional Point Count Stations must be separated by a minimum of 250 m. This can also be minimized by paying attention to where individual birds call from and how they may move in response to a broadcast.

Describing the Habitat

Habitat must be described according to guidelines specified in *Species Inventory Fundamentals* No. 1.

1. Prepare photodocumentation of each site following the guidelines described in *Photodocumentation for Aquatic Inventory* (Resources Inventory Committee 1996). The intense level of photodocumentation described in that manual will not be required for habitat description, but it does provide some good guidelines to follow for description of marshes.
   - Ensure that your plot is predominantly in marsh habitat (see Glossary for definition). To meet this requirement you may choose to use a half plot instead of a full plot or re-position your Point Count Station.
   - Include the following in the description of the habitat around each Point Count Station:
   - Percent cover of the dominant non-woody emergent vegetation found in the plot.
   - Mean water depth within the 100 m radius plot.
   - It is useful to draw a map of the habitat within the plot on the *Point Count Form - Marsh Birds*.

Conducting the Survey

Marsh bird surveys will be conducted between 20 May and 5 July throughout B.C. Repeat surveys should be separated by at least 10 days (Marsh Monitoring Program 1997).

1) Begin your survey half an hour before dawn and continue until no later than four hours after sunrise. Evening surveys should start at twilight and finish shortly after dark. Nocturnal surveys should begin within one hour after dark and finish before sunrise. Travel to your first Point Count Stations quietly.
2) Each count lasts 10 minutes.
3) Do nothing for the first two minutes at the station. Give yourself and your surroundings time to settle down now that you have stopped moving. Use this time to listen for any unsolicited calls and to orient the *Point Count Data Form-Marsh Birds* — this orientation will be used in subsequent surveys. Note all locations of calling birds, or birds that you may see within the plot. List the birds outside of the study plot as incidental sightings. The symbology used on your field data cards should be the same as that used for songbird point count surveys (Resources Inventory Committee 1997b). This standard mapping symbology can also be found in several other sources including Ralph *et al*. (1993) or other bird survey manuals. Also take this time to record the start time, temperature, cloud cover, wind, etc.
4) Hold the speaker at chest height. Broadcast a species' call for 20 seconds, then listen and watch for 30 seconds. Play a series of three calls for each call type. For a full circular (3.14 ha), broadcast the three calls at 60^0, 180^0 and at 300^0 from your line of travel (this means rotating the speaker 120^o after each 20 seconds of call of each species). For a half plot (1.57 ha), broadcast the calls at 45^0, 90^0 and 135^0 from the straight edge of the half plot. Map the response locations and sightings as they occur on the *Point Count Data Form-Marsh Birds* (refer to prior step).
5) Wait one minute before playing the series of calls for the next species. Repeat the procedure as above. Ideally, the surveyor should complete call playbacks for all of the species within the 10 minute visit to the plot, leaving two minutes before the end of the survey to listen for calls. This gives enough time to play calls for up to three different species (not including the initial two minute wait before starting broadcasts).
6) Be conservative when counting responses from bitterns and rails. Unless they are simultaneous calls, two responses from approximately the same location should be counted as only one individual.
7) Be aware that certain birds (especially B-VIRA and B-SORA) will move inward towards a call broadcast. This should make observers cautious about counting a bird at 100 m and then later another at 50 m when both have similar angles to the observer.

Also,

- Due to potential observer bias and variability, rotate observers among stations to ensure that species are not overlooked or misidentified.
- The field crew leader should ensure that field personnel are sufficiently confident in their field identification and data sheet completion. This may require some mentoring on the part of senior field crew.
- Standardize handling of difficult problems such as counts for flocks of birds (if this ever occurs), and potential double counts (e.g., potentially eliciting responses from the same bird at more than one point count station). Stress that observers should pay attention to where individual birds call from and how they may be moving in response to the tape

broadcast. This will help to distinguish individuals. Standardize your procedures among all field personnel, and document these procedures in the final report.

Data Analysis and Report Preparation

Within a 24 h period of completing the survey, transcribe the sightings from the *Point Count Data Form — Marsh Birds* to the *Animal Observation Form - Marsh Bird Call Playback.* The *Animal Observation Form - Marsh Bird Call Playback* is a record of the total number of individuals, by sex and age, heard or observed within 100 m of the Point Count Stations. It will be helpful to cross-off a counted individual from the *Point Count Data Form — Marsh Birds* with a highlighter. Crossing them out with a pen may make your raw data difficult to read if it is required at a later date.

The standard measure of abundance will be the number of each species *seen* or *heard* by sex and age (although admittedly unlikely) within a 100 m radius from the centre (station) of the sample plot. Birds outside of the 100 m radius will be counted on a present/not detected basis. This measure of abundance is similar to the index of abundance used in the Marsh Monitoring Program developed in eastern Canada and the United States of America (Marsh Monitoring Program 1997).

Many of the following suggestions for data analysis and report preparation are adapted from Robbins and Stallcup (1981):

- Start an initial draft of maps, tables and text before the end of the field season so major problems will become apparent. You may find that sampling procedures, sampling intensity or field personnel will have to be changed.
- Compare your results to other studies to be sure that your methods and results are consistent with other procedures.
- Check carefully for errors in transcribing field notes — this is especially important for transcribing the five-letter species codes (e.g., B-YERA or B-YRAI could either be different species, or different codes for Yellow Rail). Ensure consistency of field notes and code usage among observers (see RIC manual No. 2, *Vertebrates of B.C.* for proper species codes);
- In the report, include a list of all species detected in the Study Area. Include incidental observations, and a measure of survey effort wherever possible.

When submitting your completed data forms, the completed *Animal Observation Form - Marsh Bird Call Playback* should be accompanied by the required project and survey description data sheets, habitat descriptions, and TRIM map sheets with Point Count Stations plotted. It is expected that photocopies, or print-outs of digitized aerial photographs of the sample sites, with Point Count Stations indicated on the photos will be useful as well.

3.4 Absolute Abundance

The following protocol for conducting nest counts is included under the heading "Absolute Abundance" as it provides an estimate of nesting density. This technique is by no means "absolute" as it will not account for the presence of juveniles, other non-breeders, failed breeders, or the occurrence of polygyny (noted among American Bitterns, Gibbs *et al.* 1992). In addition, this technique is relatively experimental and will have potentially greater impacts on marsh birds and their habitat then will call playback surveys. For these reasons, biologists are encouraged to limit the use of this technique to those sites where nest information is specifically required, and to continually re-assess the benefits of each survey against its impacts, and cease if appropriate.

3.4.1 Fixed-width Transect (Nest Count)

It has been suggested that surveys of breeding rails (especially those using call playback) suffer from lack of an independent measure of actual breeding numbers (Eddleman *et al*. 1988). Using Pointing dogs may provide a measure of nesting numbers which is independent of call playback.

Pointing dogs have been used to locate male and female Yellow Rails that did not respond to call playback (Bookhout and Stenzel 1987). Pointing dogs would be useful for determining Absolute Abundance of bitterns and rails in marsh habitats. This method should not be attempted without expertly trained dogs, a proper permit to use them to locate wildlife, and assurances that the habitat will not be adversely affected (e.g., severely trampled vegetation as a result of repeated transects). Dogs have been used extensively in surveys for upland game birds such as spruce and ruffed grouse. Persons conducting this research should be contacted for information and as a potential source of trained dogs and handlers. Using dogs in wildlife surveys are further described in Zwickel (1980).

It is expected that foot surveys within fixed-width transects will be limited to only areas of wetland and accessible property that will allow surveyors to walk through them. Due to the possibility of permanently damaging emergent vegetation (Oelke 1981), repetition of the transects should be limited to only two or three visits per season.

Advantages

- Using *trained* dogs to find nest and birds is more productive than unassisted foot surveys;
- It is probably the only method that will allow you to find enough nests to estimate the breeding population of rails and bitterns in any size wetland;
- Call playback surveys with a follow-up to locate nests will provide surveyors with two indices of actual breeding populations.

Disadvantages

- Properly trained dogs and handlers may be difficult to find;
- There is potential to damage the vegetation in the wetland with repeated surveys;
- It may be difficult for dogs to locate waterbirds by scent (relative to terrestrial nesting birds);

- Surveys may be biased by the abilities of the dog and their handlers;
- This type of survey can be very time intensive, perhaps to the point that this method might best be used for research-level questions at a small scale.
- Surveys are restricted to shallow marsh areas and areas with permission granted for this type of activity;
- Some studies (e.g., forest birds, waterfowl) have shown that human visitation to nests can be correlated with increased predation risks and incidence of desertion by the laying/brooding bird.

Office Procedures

- To conduct this sort of survey, it will be necessary to obtain permission from the Canadian Wildlife Service office in Delta, B.C. This will hopefully eliminate any confusion which may result if a Conservation Officer encounters you looking for birds with a trained dog. Requests should be made in writing.
- Review the section, Conducting a Wildlife Inventory, in the introductory manual *Species Inventory Fundamentals No. 1* manual. For further discussion on statistical power in waterbird surveys refer to Gibbs and Melvin (1997).
- Obtain relevant maps of the Project Area (e.g., 1:50 000 air photo maps, 1:20 000 forest cover maps, 1:20 000 TRIM maps, 1:50 000 NTS topographic maps).
- Outline the Project Area on a map and 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.
- One Study Area may consist of one or more marsh habitats. Recent colour aerial photographs of the marsh habitats that will be surveyed will be especially useful (see Sampling Standards above).
- Determine Biogeoclimatic zones and subzones, Ecoregion, Ecosection, and Broad Ecosystem Units for areas surrounding the wetland. Determine wetland class using the Riparian Management Area Guidebook (B.C. Min. Environ. and For. Serv. 1995) as a general reference.
- Determine the size of the marsh habitat by estimating the area covered by non-woody, emergent vegetation (see Habitat Data Standards above).
- Identify access points for surveys from the small scale colour aerial photographs.
- Review the life histories of the marsh birds that may potentially be in your Study Areas. Since marsh birds have generally not been studied in B.C., use the known range only as a general guideline, and rely more on general habitat descriptions for each species as an indication of potential presence.
- Complete the following Data Forms that are included in the *Species Inventory Fundamentals No. 1 [Forms]* (previously referred to as the *Dataform Appendix).*
  - Wildlife Inventory Project Description Form
  - Wildlife Inventory Survey Description Form — General
- Locate Field Personnel and TRAINED dogs and dog handlers.

Sampling Design

- Survey lines should run systematically in fixed-width transects throughout a marsh habitat. The intention of this survey is to gain a measure of Absolute Abundance of target species' nests within a marsh habitat, on a marsh-by-marsh basis. Therefore, any design which ensures full coverage of the marsh habitat is encouraged.

Sampling Effort

- A maximum of three visits should be made to marshes and wetlands to avoid extensive damage to emergent vegetation.
- The time that it will take to cover a marsh habitat depends on the expertise of the dogs and the handlers. One observer can cover a 1.6 km long and 0.4 km wide fixed-width transect in one hour in Michigan wetlands when surveys are conducted at night between approximately 2300 to 0430 (Bart *et al*. 1984).

Personnel

- This survey method requires an extremely well-trained dog. A general discussion of breeds, training, and care of dogs can be found in Zwickel (1980). To avoid excessive damage to the marsh vegetation, and disturbing the breeding cycle of marsh birds, this survey should only be attempted by experienced dog handlers using well-trained dogs. Contact local hunting clubs and inquire about persons with this experience.
- A professional biologist familiar with marsh birds and their habitats must accompany all surveys that use dogs. If it is apparent that the dog or the survey itself is posing a threat to the study species, then the survey should be stopped immediately.
- At least one person should be familiar with the collection of habitat data.

Equipment

- Equipment required for the dogs (probably at least a bell; this will be the responsibility of the handler)
- *Animal Observation Form - Marsh Bird Transects*
- *Nest Site Description Form* (see RIC guidelines in the *Species Inventory Fundamentals No. 1* [Forms])
- 8–10x wide angle binoculars
- 35 mm camera for photodocumentation of habitat and nest site. For confirmation of identification you may need very clear colour photographs of the eggs in the nest
- Maps, air photos or GPS units (NAD83) to record locations of transects and nests.

Field Procedures

- It is generally helpful to divide the marsh up into sections and flag these out when you begin. This will help ensure that you are getting complete coverage of the marsh habitat. Two people, one a dog handler and the other a biologist, should then walk fixed-width transects, approximately 50–75 m wide. Ideally, the two people should walk down the middle of the transect while the dog searches a wider area under the direction of the handler.
- Essentially, do whatever it takes to cover the marsh habitat thoroughly without damaging the habitat, or creating excessive disturbance to the birds. The actual methods used will vary in different situations.

- Conduct this survey in the late morning to late afternoon (i.e., outside of the peak calling periods) during the same time of year recommended for call playback surveys (between 20 May and 5 July throughout B.C.).
- It is important to be especially alert so that you may catch sight of the bird flushing off the nest. This will provide positive identification of species and confirmation that the nest is active.
- When a nest site is found, ensure that the dog poses no threat and then describe the nest and map its location. A Nest Site Description form is available in *Species Inventory Fundamentals [Forms]*.

Data Analysis

- Calculate Absolute Abundance by summarizing the number of nests found by the total area covered by fixed-width transects in a marsh habitat (see Glossary for definition).
- Refer to the Data Analysis and Report Preparation section for Call Playback Analysis.

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.

ACCIDENTAL: With regard to the status of a bird species, this refers to an irregularly occurring species with only one recorded occurrence in B.C. (Campbell *et al.* 1990a).

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

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.).

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.

BRACKISH WATER: Water with salinity greater than fresh water (>0.5%), but lower than salt water (35%) (Dunster and Dunster 1996).

CALL RESPONSE SURVEYS: For the purpose of this manual, used interchangeably with "call playback" surveys.

CASUAL: With regard to the status of a bird species, this refers to an irregularly occurring species for which two to six good records exist (Campbell *et al.* 1990a).

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

CREPUSCULAR: Active at twilight (see also Diurnal and Nocturnal).

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.

DIURNAL: Active during the daytime (see also Crepuscular and Nocturnal).

EMERGENT VEGETATION (NON-WOODY): Herbaceous (non-woody) plants that are rooted in the marsh bottom and rise up out of the water.

EUTROPHICATION: Natural or human-induced addition of nutrients (esp. nitrogen and phosphorous) to a body of water. This usually results in high organic production that can create seasonally low oxygen levels, and reduced survival of fish (Dunster and Dunster 1996).

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 B.C.'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.

HYPOTHETICAL: With regard to the status of a bird species, this refers to a species for which only a few questionable, and unconfirmed, observations exist in British Columbia.

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 a demographic (e.g. growth rate, recruitment and mortality rates) or distribution changes in a population 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.

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

MARSH HABITAT: A vegetated wet area that is periodically or regularly inundated with nutrient rich water up to a depth of 2 m. The area is usually dominated by emergent non-woody vegetation such as cattails, bulrushes, reeds, grasses and sedges. In comparison, swamps, bogs and fens are generally dominated by trees and shrubs.

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

NIDICOLOUS: Young remain in nest after hatching until ready to fly.

NOCTURNAL: Active at night (see also Crepuscular and Diurnal).

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.

POINT COUNT: Counting all species observations (either at a fixed distance or unlimited distance) from a single location.

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).

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 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.

RANDOM SAMPLE: A sample that has been selected by a random process, generally by reference to a table of random numbers. For further discussion, refer to the introductory manual Species Inventory Fundamentals No. 1, Krebs (1989), or other biostatistical text books.

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 B.C. Threatened species are any indigenous taxa that are likely to become endangered in B.C., 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 B.C. 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.

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.

SURVIVORSHIP: The probability of a new-born individual surviving to a specified age.

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 task 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 B.C.

WETLAND: A general term used to describe land that is inundated by surface water or groundwater

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

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