Inventory Methods for Woodpeckers

Standards for Components of British Columbia's Biodiversity No. 19

Prepared by
Ministry of Environment, Lands & Parks
Resources Inventory Branch
for the Terrestrial Ecosystem Task Force
Resources Inventory Committee

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Preface

This is a newer version of a manual presenting standard methods for inventory of woodpeckers in British Columbia at three levels of inventory intensity: presence/not detected, relative abundance, and absolute abundance. The current version incorporates comments from field personnel as well as a review by a quantitative ecologist. Like the previous version, this manual was compiled by the Elements Working Group of the Terrestrial Ecosystem Task Force, under the auspices of the Resources Inventory Committee (RIC). The objectives of the working group are to develop inventory methodologies that will lead to the collection of comparable, defensible, and useful inventory and monitoring data for the species component of biodiversity.

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

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

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

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

For further information about the Resources Inventory Committee and its various Task Forces, please access the Resources Inventory Committee Website at: http://www.for.gov.bc.ca/ric.

Terrestrial Ecosystem Task Force

Michael Setterington (AXYS Environmental Consulting Ltd.) reworked the previous version of this manual, based largely on statistical review comments by John Boulanger, to produce Version 2.0. The previous version, 1.1, was based on the background information and protocols presented in the unpublished government report, *A Methodology for Surveying Woodpeckers in British Columbia*, prepared for the Resources Inventory Committee by Christopher Steeger and Marlene Machmer of Pandion Ecological Research Ltd., with assistance and/or comments from Lisa Bate, Evelyn Bull, Andrew Carey, Catherine Raley, Mike Wisdom, Ted Miller, Walt Klenner, John Cooper, Claudia Ripley, Erica McClaren, Ann Eriksson and Tom Ethier.

This manual and its associated dataforms were edited to their final forms by James Quayle and Leah Westereng.

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1. Introduction

Woodpeckers are a group of forest birds with a unique set of characteristics not found in any other avian family. Their most distinguishing features include: (i) very stiff pointed tail feathers adapted for climbing and clinging; (ii) toes with sharply-curved claws two of which point forward and two backward (with the exception of Three-toed and Black-backed Woodpeckers, which have only one toe pointing forward); (iii) relatively long chisel-shaped bills for pecking wood; and (iv) long barbed tongues and paired sublingual salivary glands which secrete a sticky fluid. Variation in the length of the tongue and its shape distinguish species which feed mainly by pecking, excavation or sapsucking (Winkler *et al.* 1995). Characteristic behavioural traits of this group include their tree-climbing habit, an undulating flight pattern, and bill-hammering for communication. Not only are woodpeckers easily distinguishable from other birds but individual species are readily identified by their conspicuous markings (Guiguet 1954).

Woodpeckers belong to a guild of forest birds known as "primary cavity excavators". Members of this guild (which also include chickadees and nuthatches) excavate nest cavities in dead or live defective trees (from here on referred to as "wildlife trees"). Because cavity excavation is part of their annual courtship ritual (and for other possible reasons including predation and parasitism avoidance or availability of cavities), woodpeckers usually build one or more nest cavities each year. Most species also excavate tree cavities for roosting and during the process of foraging.

Woodpeckers play important roles within forest ecosystems. The cavities they excavate are often used by "secondary cavity users[1] ", including small ducks, owls and raptors, many passerines, and mammals such as bats and squirrels. Species such as the Red-naped Sapsucker are considered "keystone species" because they excavate nest sites that are used by many secondary cavity nesters (Steeger *et al*. 1996) including Mountain Chickadees, House Wrens, Violet-green and Tree Swallows. They also drill sap wells which provide nourishment for a wide variety of species (*e.g*., hummingbirds, warblers, chipmunks, and various insects; Daily *et al*. 1993). Furthermore, the significance of woodpeckers in the regulation of forest insect pests is widely recognized (for a recent review, see Machmer and Steeger 1995).

Woodpeckers are highly dependent on wildlife trees for nesting, roosting and feeding. They require forests with structural components such as standing dead and decaying trees, stem rot-infected trees, large live trees, hardwoods, and stumps. Conservation of these ecosystem components necessitates the integration of wildlife habitat requirements with timber harvesting and pest management objectives. Responding to this need, a variety of research and management projects have been initiated in the Pacific Northwest and elsewhere that include surveillance and long-term monitoring of woodpeckers (*e.g.*, Dickson *et al*. 1979; U.S. Dep. Agric. For. Serv. 1991; The Wildlife Society, Oregon 1992; Wildlife Tree Committee of British Columbia 1993).

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[1] Secondary cavity users are cavity nesting or roosting animals which are unable to excavate their own cavities.

Despite this recent flurry of interest in the conservation of woodpeckers and their habitat, no consistent methodology has been developed in British Columbia to survey and monitor this group of species. The purpose of this manual is to present an overview of the province's woodpecker species, and to recommend inventory methods best-suited for these species in different habitats and forest types throughout British Columbia. Three levels of intensity for species or population inventory are considered: (i) presence/not detected, (ii) relative abundance and (iii) absolute abundance.

2. Inventory Group

Twelve representatives of the family Picidae from five genera breed in British Columbia (Campbell *et al*. 1990). This section provides an overview of the current provincial knowledge on each species, including information on general description, distribution, range, habitat utilization, and status. Much of the information presented in the species accounts is based on Campbell *et al*. (1990). Biogeoclimatic zone and ecoprovince codes follow Meidinger and Pojar (1991) and Demarchi (1995, 1996). Information regarding home range size and territory size per individual for each species was derived from studies conducted outside of British Columbia. Red and Blue list designations are from 1998 Red and Blue Lists (B.C. Ministry of Environment Lands and Parks (MELP) 1999).

2.1 Lewis's Woodpecker

B-LEWO
Melanerpes lewis (Gray)

Description

Physical Characteristics: A medium-sized woodpecker averaging 27 cm in length. Adults have glossy greenish-black upper parts, a grey collar and breast, a dark red facial patch and a pinkish-red belly. Juveniles lack the collar and red face; the belly may be only faintly pink. Flight is slow, with even, crow-like flapping.

Vocalizations: Generally silent but occasionally emits a harsh *churr* or *chee-ur* and single *yick* notes when alarmed.

Activity and Movement Patterns: Winters from southern B.C. to northern Mexico and western Texas. Spring migration extends from early April to mid May; autumn migration commences in late August and carries through to early October.

Distribution In British Columbia

The Lewis's Woodpecker is a migrant and summer visitant locally distributed across southern B.C. from Vancouver Island east to the Kootenays and north to the Chilcotin-Caribou Basin. Very rare summer visitant to the south coast and to the interior north of 52° N latitude. In winter, uncommon in the Okanagan and very rare on the south coast. Found in open forest and bottomland from sea level to 1,150 m elevation.

Biogeoclimatic Zones: CDF, CWH, BG, PP, IDF, ICH, SBPS, SBS.

Ecoprovinces: CAM, GED, SOI, SIM, CEI, SBI.

Habitat Utilization

Feeding: Forages in open woodlands and riparian areas usually with < 30% canopy cover. In spring and summer, it feeds mainly on flying insects which are caught on the wing or by hawking from exposed perches. Insects are also caught on the ground, in low brush, and are occasionally gleaned from tree surfaces. Fruits and berries comprise the main diet in late

summer and fall, while winter food consists mainly of acorns and commercial nuts or corn. Shells and stores acorns in bark crevices.

Reproduction: Preferred breeding habitat is open ponderosa pine forest from 275 to 950 m elevation. Other habitats are deciduous riparian woodlands and selectively logged or burned coniferous forest. Orchards, grassland, pasture, and urban areas are rarely used for breeding. Usually nests in cavities excavated by other woodpecker species (*e.g.,* Northern Flicker), but natural cavities are occasionally used. Nest cavities are excavated in large (*i.e.,* >30 cm dbh) deciduous and coniferous trees. Both dead and living trees with decaying centers are used, although snags, often partially stripped of bark are preferred. Nest heights range from 1 to 30.5 m, with most between 3.5 and 9 m. Normally lays 4–6 eggs with a breeding period extending from early May to late July.

Roosting: In winter, roosts in mature deciduous and coniferous trees and snags similar to those used for nesting.

Home Range Size: 8–18 ha per individual.

Territory Size: 6 ha per individual.

Status — Blue

The Lewis's Woodpecker formerly bred from south-eastern Vancouver Island east through the lower mainland and the Fraser Valley, and east of the Cascades from Princeton, throughout the Okanagan Valley, north to Williams Lake and east to Revelstoke and Elko. It no longer breeds in coastal B.C. and has experienced steady population declines in the southern interior since 1980. The Lewis's Woodpecker is suspected to still be in decline throughout much of its range in B.C. and it is on the 1998 blue-list. Population declines have been attributed to loss of suitable nest and food storage trees and loss of riparian and burned ponderosa pine habitats.

Selected References

Bent 1939; Bock 1970; Thomas 1979; Short 1982; Block and Brennan 1987; Galen 1989; Campbell *et al*. 1990; Siddle and Davidson 1991; Marshall 1992*a*; Winkler *et al*. 1995.

B-YBSA

2.2 Yellow-bellied Sapsucker

Sphyrapicus varius (Linnaeus)

Description

Physical Characteristics: A small to medium-sized woodpecker averaging 22 cm in length. Adults have a red forehead, a black and white head, a black chest band separating the throat from a yellow belly, a long white wing patch, a barred back and a white rump. Males have a red throat. Juveniles are brownish and resemble adults by first spring.

Vocalizations: Calls are variable and include a whining *whaee*. Performs ritual tapping in distinctive rhythms (3–5 taps given in quick succession, followed by a pause, 2 taps, pause, 2 taps, pause, etc.).

Activity and Movement Patterns: Winters from the southern part of its breeding range southward. Spring migration begins in late April, with most birds arriving in early May and leaving by late August.

Distribution In British Columbia

Migrant and summer visitant distributed throughout the north-east corner of B.C. from south-east of MacKenzie to Vanderhoof and Stoner in the south extending north through the Peace Lowlands and the boreal forest in the north. Frequents deciduous and mixed deciduous-coniferous forests.

Biogeoclimatic Zones: SBS, BWBS.

Ecoprovinces: TAP, BOP, SBI, NBM.

Habitat Utilization

Feeding: Forages in mixed and deciduous forests. Drills rows of squarish holes into live conifers and hardwoods and feeds on sap and on insects attracted to the sap wells. Diet consists of insects, tree sap, bast, cambium, fruit and berries.

Reproduction: Prefers riparian forest or deciduous or mixed deciduous-coniferous forests from 380 to 730 m elevation. Nest sites tend to be at the forest edge adjacent to lakes, ponds, marshes and backwater river channels. Excavates its nest cavities in deciduous trees >25 cm dbh. Live nest trees infected with fungal heartrots are preferred. Nest cavity entrances are rounded and nest heights range from 2.4 to 12.2 m, with most between 3.4 and 6.1 m. There are no records available for clutch size in B.C. but a clutch size of 5–6 eggs is reported for birds breeding in other parts of North America. The breeding period extends from late May to early August in B.C.

Roosting: Excavates its own roosts in trees similar to those used for nesting.

Status — Yellow

Uncommon migrant and summer visitant to the Alberta Plateau, Fort Nelson Lowlands, and Liard Basin; locally very rare in the Northern Mountains and Plateau regions.

Selected References

Bent 1939; Lawrence 1967; Tate 1973; Williams 1975, 1980; Ehrlich *et al*. 1988; Campbell *et al*. 1990; Winkler *et al*. 1995.

B-RNSA

2.3 Red-naped Sapsucker

Sphyrapicus nuchalis Baird

Description

Physical Characteristics: A medium-sized woodpecker averaging 22 cm in length. Adults have a red forehead and a variable red patch on the nape. Chin and throat are red in males; females have a white chin and a variable amount of red on the throat. Otherwise resembles

the Yellow-bellied Sapsucker with a long white wing patch, a barred back and a white rump. Juveniles are brownish and attain adult plumage by the first fall.

Vocalizations: Calls are variable and include a mewing *meeah*. Drumming consists of an initial burst, followed by irregular slower bursts of 2–3 strokes.

Activity and Movement Patterns: Winters from the southern portion of the breeding range to northern Mexico. The main spring influx occurs in April and birds leave from late August through mid-September.

Distribution In British Columbia

The Red-naped Sapsucker is widely distributed across southern B.C. east of the Pacific and Cascade ranges and north through the Chilcotin-Cariboo Basin and the Nechako Plateau. Very rare west of the Pacific and Cascade ranges.

Biogeoclimatic Zones: CWH, BG, PP, IDF, MS, ICH, SBPS, SBS.

Ecoprovinces: GED, CAM, CEI, SOI, SIM.

Habitat Utilization

Feeding: Feeds in deciduous and mixed woodlands, usually containing aspen. Drills rows of squarish holes in deciduous and coniferous trees and feeds on sap and on insects attracted to the sap wells. Diet consists of insects and tree sap, supplemented by bast, cambium, fruit and berries.

Reproduction: Widespread breeder in a variety of deciduous and mixed woodlands from 300 to 1,300 m elevation. Nest trees are often on the edge of woodlands adjacent to water bodies such as streams, ponds, sloughs, lakes or other open areas such as road edges, logging slashes, transmission line right-of-ways or mountain meadows. Most nests are in deciduous trees but coniferous trees are also used. Living trees are preferred for nesting and this trend is reversed for coniferous trees. Nest tree diameters and nest hole heights range from 15 to 64 cm dbh and 0.5 to 22.9 m, respectively. Nest cavity entrances are rounded. Normally lays 4–5 eggs with a breeding period extending from May to early August.

Roosting: Excavates its own roost cavities in deciduous trees > 25 cm dbh.

Status — Yellow

Uncommon to fairly common migrant and summer visitant to the south-central and southern interior of B.C. Very rare vagrant west of the Pacific and Cascade ranges.

Selected References

Bent 1939; Crocket and Hadow 1975; Short 1982; Cannings *et al*. 1987; Campbell *et al*. 1990; Tobalske 1992; Daily *et al*. 1993; Winkler *et al*. 1995.

B-RBSA

2.4 Red-breasted Sapsucker

Sphyrapicus ruber (Gmelin)

Description

Physical Characteristics: A small to medium-sized woodpecker averaging 22 cm in length. Adults have a red head, nape, throat and breast, a large white wing patch and a white rump in flight. The back is black and lightly spotted with yellow or white depending on subspecies. Briefly held juvenile plumage is brownish, showing little or no red.

Vocalizations: Calls include a nasal mewing note or squeal slurring downward: *cheerrr* or *chee-aa*. Drumming is several rapid thumps followed by 2–3 slow irregular strokes.

Activity and Movement Patterns: Winters throughout the breeding range except in the B.C. interior. Wintering birds leave southern Vancouver Island during spring and move into interior breeding areas mainly through April and into May. Birds wintering on Vancouver Island appear to return in early September.

Distribution In British Columbia

The Red-breasted Sapsucker is a widely distributed resident along the coast and a widely distributed migrant and summer visitant to the central interior between 52° and 56° N latitude. It is more localized in the north-western portions of the province and is occasionally sighted in the southern interior ecoprovince. Found from sea level to 1,950 m elevation in coniferous and deciduous woodlands.

Biogeoclimatic Zones: CDF, CWH, MH, BG, PP, IDF, ICH, SBS, BWBS.

Ecoprovinces: GED, SOI, SIM, CAM, CEI, SBI, BOP, NBM.

Habitat Utilization

Feeding: Forages in a variety of forested habitats. Drills rows of holes in coniferous and deciduous trees and feeds on sap and on insects attracted to the sap wells. Occasionally strips bark. Insects (especially ants) make up >50% of the diet, and sap, bast, cambium and berries make up the remainder.

Reproduction: Breeds from sea level to 1,220 m in a variety of wooded habitats. Found in coniferous forests, deciduous and riparian woods and cottonwood bottomland. Breeding habitat also includes orchards, power line rights-of-ways and forest burns. Nests are often located in edge habitat adjacent to a marsh, lake, estuary or other open areas. Excavates its own nest cavities in dead and living deciduous or coniferous trees >25 cm dbh. Deciduous nest trees are preferred, especially at lower elevations. Nest cavity entrances are rounded and nest heights range from 1.8 to 24.3 m, with most between 3.4 and 9.1 m. Lays 4–7 eggs with a breeding period extending from early May to late July.

Roosting: Excavates its own roost cavities in decaying trees >25 cm dbh.

Status — Yellow

Uncommon resident in coastal B.C. including Vancouver Island and the Queen Charlotte Islands. Uncommon to rare migrant and summer visitant to the central interior and the north-western part of the province and casual in the Okanagan valley.

Selected References

Bent 1939; Short 1982; Campbell *et al*. 1990; Winkler *et al*. 1995.

B-WISA

2.5 Williamson's Sapsucker

Sphyrapicus thyroideus (Cassin)

Description

Physical Characteristics: Medium-sized woodpecker averaging 23 cm in length. Males have a black head with narrow white stripes, a bright red chin and throat, a black back and breast, a yellow belly, a white rump and a large white wing patch. The female has a brown head, wings barred white and dark brown, a large dark patch on the breast, a white rump and a variably yellow belly. Juveniles resemble adults but are duller, and attain adult plumage in their first winter.

Vocalizations: Calls include a weak wheezy *whang* and a number of rolling R's beginning with a gutteral *kkrrr*. Tapping is distinctive and consists of a series of blows in irregular or broken rhythm.

Activity and Movement Patterns: Winters from Arizona to central Mexico. Birds arrive on the breeding grounds by mid-April and most leave by mid-September.

Distribution In British Columbia

Uncommon migrant and summer visitant to the Thompson-Okanagan Plateau and Kootenay Trench regions. Frequents montane forests primarily of the interior Douglas-fir zone from 310 to 1,425 m elevation.

Biogeoclimatic Zones: IDF, MS, ESSF.

Ecoprovinces: SOI, SIM.

Habitat Utilization

Feeding: Prefers to forage in live coniferous trees (*e.g.*, Douglas fir and western larch) in open forests (<75% canopy cover). Gleans insects from sap wells and by pecking under loose bark. Diet consists of tree sap, phloem and insects (especially ants during the nestling period).

Reproduction: Breeds in western larch, interior Douglas-fir and ponderosa pine forests between 850 and 1,300 m elevation. Nests mainly in large coniferous trees (>30 cm dbh) but may also nest in groves of trembling aspen. Requires live or recently dead trees with advanced heartwood decay for cavity excavation. Nest cavity entrances are rounded and nest

heights range from 2 to 18 m. Normally lays 5–6 eggs with a breeding period extending from May to late July.

Roosting: Excavates its own roost cavities in trees of similar size and species composition to those used for nesting.

Territory Size: 4 ha per individual.

Status — Red & Blue

Uncommon migrant and summer visitant to the Thompson-Okanagan Plateau and the Kootenay trench regions of the province. The *nataliae* (Rocky Mountain) subspecies is thought to be in decline and has been placed on the 1998 red-list. The *thyroideus* (Thompson-Okanagan) subspecies is thought to be more stable and appears on the 1998 provincial blue list. Removal of old trees and conversion of old-growth and mature stands to managed stands of even-aged young trees are thought to be responsible for population declines.

Selected References

Crockett and Hadow 1975; Crockett and Hansley 1977; Thomas 1979; Short 1982; Cannings *et al*. 1987; Campbell *et al*. 1990; Marshall 1992*b*; Conway and Thomas 1993; Cooper 1993; Winkler *et al*. 1995.

B-DOWO

2.6 Downy Woodpecker

Picoides pubescens (Linnaeus)

Description

Physical Characteristics: A small woodpecker averaging 17 cm in length. Adults have a white back and underside, a black and white head, and black wings barred with white. White outer tail feathers are spotted with black. Males have a red patch on the back of the head.

Vocalizations: Calls include a flat *pik* call and a one to two-second burst of notes descending in pitch, resembling the whinny of a horse. Drumming consists of a one- or two-second burst of pecking on a resonant surface; a softer sound but similar to that of the Hairy Woodpecker.

Activity and Movement Patterns: Winters throughout the breeding range. Records suggest that birds may move from higher elevations to valley bottoms and partially withdraw from northern areas in winter.

Distribution In British Columbia

Widely distributed resident throughout the province south of 57° N latitude. Sparsely distributed in northern regions of the province and rarely seen on the Queen Charlotte Islands. Found from sea level to 1,250 m elevation in deciduous and mixed forests.

Biogeoclimatic Zones: CDF, CWH, BG, PP, IDF, MS, ICH, SBPS, SBS, ESSF, SWB BWBS.

Ecoprovinces: GED, CAM, CEI, SOI, SIM, SBI, BOP, TAP, NBM.

Habitat Utilization

Feeding: Forages on coniferous and deciduous trees usually < 25 cm dbh and frequents bird feeders, especially in winter. Removes insects from bark surfaces and uses surface (*e.g.*, flaking, pecking) and sub-surface foraging techniques (*e.g.*, drilling, excavation) to penetrate under bark where beetle larvae and ants are extracted. Diet consists predominantly of insects, supplemented by fruit, seeds and sap from sapsucker holes.

Reproduction: Breeds in deciduous forests, bottomland, mixed woods, riparian thickets, forest burns, logged areas, gardens and orchards from sea level to 1,100 m elevation. Nest cavities are excavated primarily in deciduous trees. Dead or dying trees with fungal heart rot are preferred and nest tree diameters range from 19.1 to 31.4 cm dbh with a mean of 26.3 cm dbh. Nest cavity entrances are rounded and nest heights range from 0.9–30 m. Normally lays 4–5 eggs with a breeding period extending from late April to late July.

Roosting: Excavates roosting cavities in dead or decaying trees.

Territory Size: 4 ha per individual.

Status — Yellow

Rare to locally fairly common resident throughout B.C. south of 57°N latitude; very rare further north and casual on the Queen Charlotte Islands.

Selected References

Bent 1939; Lawrence 1967; Jackson 1970; Thomas 1979; Cannings *et al*. 1987; Harestad and Keisker 1989; Campbell *et al*. 1990; Winkler *et al*. 1995.

2.7 Hairy Woodpecker

B-HAWO
Picoides villosus (Linnaeus)

Description

Physical Characteristics: Medium-sized woodpecker averaging 24 cm in length. Has a larger, thicker bill but is otherwise similar in appearance to the Downy Woodpecker with a white back and underside, a black and white head, black wings barred with white and a red patch on the back of males' head. Outer tail feathers are entirely white (with the exception of juveniles on the Queen Charlotte Islands). Juveniles lack barring on sides and have white spotting on the forehead. Juvenile males have red or orange streaking on the crown.

Vocalizations: Call is a loud, high-pitched *peek* and a slurred *whinney*. Drumming is loud with a rapid burst of rhythmic taps and a terminal slowdown.

Activity and Movement Patterns: During the winter months, birds may move from higher elevations to valley bottoms and partially withdraw from northern areas. Also uses residential areas more frequently in winter.

Distribution In British Columbia

Widely distributed resident throughout most of B.C., including Vancouver Island and the Queen Charlotte Islands. Very rare in the north-west corner of the province. Occupies all forested zones from sea level to near 1,900 m elevation.

Biogeoclimatic Zones: CDF, CWH, MH, BG, PP, IDF, MS, ICH, SBPS, SBS, ESSF, SWB, BWBS.

Ecoprovinces: CAM, GED, CEI, SOI, SIM, SBI, BOP, TAP, NBM.

Habitat Utilization

Feeding: Foraging habitats include mature coniferous forests, deciduous and mixed forests. In winter, also frequents openings such as meadows, marshes, ponds, logged or burned areas. Extracts insects from the subcambium layer using sub-surface foraging techniques (*e.g.*, drilling, excavation). Diet consists mainly of insects and is occasionally supplemented by fruits and seeds.

Reproduction: Prefers mixed forests or forest edges, with most nest cavities excavated in living or dead deciduous trees. Cavities are occasionally excavated in fence posts, power poles; nest boxes are occasionally used. Nest cavity entrances are rounded and nest heights range from 0.9 to 38 m, with most between 1.8 and 6.1 m. Normally lays 3–5 eggs with a breeding period extending from early April to late July.

Roosting: Roosting requirements are not well known but the Hairy Woodpecker is thought to use tree cavities for roosting.

Territory Size: 10 ha per individual.

Status — Yellow & Blue

Uncommon resident throughout most of B.C., including Vancouver Island and the Queen Charlotte Islands; very rare in the north-west portion of the province. The *picoideus* subspecies (endemic to the Queen Charlotte Islands) is on the 1998 blue-list; the five other subspecies found in B.C. are reportedly stable and not listed.

Selected References

Bent 1939; Lawrence 1967; Thomas 1979; Cannings *et al*. 1987; Morrison and With 1987; Campbell *et al*. 1990; Villard and Beninger 1993; Winkler *et al*. 1995.

B-WHWO

2.8 White-headed Woodpecker

Picoides albolarvatus (Cassin)

Description

Physical Characteristics: A medium-sized woodpecker averaging 24 cm in length. Adults have a white head and throat, a black body, and white wing patches. Males have a red patch on the back of the head.

Vocalizations: Calls include a grating two-noted *peek-it* and a sharp *chick*, sometimes rapidly repeated *chick-ik-ik-ik.* Drumming is a short, even series.

Activity and Movement Patterns: Casual in winter in the north Okanagan valley and east of the Okanagan.

Distribution In British Columbia

Very rare resident in the Okanagan valley and irregular summer visitant to the Similkameen. Restricted to the Thompson-Okanagan Plateau and Southern Columbia Mountains regions from Manning Park east to Creston and north to Falkland. Frequents ponderosa pine, mixed pine-Douglas-fir and Engelmann spruce-lodgepole pine forests to 1,300 m elevation.

Biogeoclimatic Zones: BG, PP, IDF, MS, ICH, ESSF.

Ecoprovinces: SOI, SIM.

Habitat Utilization

Feeding: Forages in open ponderosa pine and mixed pine-fir forests. In late summer, fall and early winter, usually forages in the crowns of conifers for large ponderosa pine seeds. In early summer, forages mainly for insects (*e.g.,* ants, woodboring beetles, spiders, fly larvae) on the lower portions of large, live ponderosa pine trees.

Reproduction: Breeds only in open-canopied (< 70% canopy cover) stands of mature ponderosa pine forests from 450 to 600 m elevation. Nests are often located in or on the edge of forest clearings. Excavates cavities in dead or dying trees, with a preference for large ponderosa pine (mean dbh = 60 cm). Leaning or broken-topped snags or stumps are commonly used. Nest cavity entrances are rounded and nest heights range from 2.5 to 9 m. A clutch of 4–5 eggs is layed during the breeding period extending from mid-May to late July.

Roosting: Roosts in cavities and under sloughing bark of large (mean = 61 cm dbh) living or dead ponderosa pine.

Home Range Size: Reported as 101–202 and 59–193 ha per individual.

Status — Red

The southern interior represents the northernmost limit of the White-headed Woodpecker's range. It is therefore considered a peripheral species in B.C. and appears on the 1998 red-list. It is a very rare resident in the Okanagan valley, casual in the Similkameen valley and east of the Okanagan. Logging and fire suppression in the southern interior, resulting in dense, young stands with reduced snag densities and poor seed production are thought to negatively impact this species. Despite apparently recent sightings of White-headed Woodpeckers in the South Okanagan, call playback surveys conducted during 1996 and 1997 could not locate any individuals (B.C. Conservation Data Center).

Selected References

Ligon 1973; Weber and Cannings 1976; Morrison and With 1987; Milne and Hejl 1989; Mathews 1990; Cannings 1991; Frederick and Moore 1991; Blair 1993; Winkler *et al*. 1995.

B-TTWO

2.9 Three-toed Woodpecker

Picoides tridactylus (Linnaeus)

Description

Physical Characteristics: A medium-sized woodpecker averaging 22 cm in length. Adults have black and white barring on the flanks, a variable barring down the back and a white breast, throat and belly. The head is black with a white stripe and males have a yellow crown. Has three rather than four toes.

Vocalizations: Call is a single *pik*, softer and higher pitched than that of the Black-backed Woodpecker. A fast, short rattle call is also used. Drums frequently and drumming is slower with shorter bursts and fewer beats than that of the Black-backed Woodpecker.

Activity and Movement Patterns: Winters throughout its range.

Distribution In British Columbia

Widely distributed resident throughout most of the province east of the coastal gap and the Pacific and Cascade ranges. Occurs locally on the south coast and Vancouver Island and is absent from the Queen Charlotte Islands. Found in coniferous forests from 450 to 2,100 m elevation.

Biogeoclimatic Zones: CDF, CWH, MH, PP, IDF, MS, ICH, SBPS, SBS, ESSF, SWB, BWBS.

Ecoprovinces: GED, CAM, SOI, CEI, SIM, SBI, BOP, TAP, NBM.

Habitat Utilization

Feeding: Forages in spruce and true fir forests and in lodgepole pine and mixed forests. Feeds almost exclusively on insects (mostly wood-boring beetle larvae, but also eats caterpillars, ants and other woodboring insects). Uses mainly surface foraging techniques (*e.g.*, flaking, scaling) to extract insects from beneath the bark. This species concentrates in forest burns and/or insect-infested areas to feed in winter. Dead or dying feeding trees are reportedly favoured.

Reproduction: Breeds in mature and overmature stands of coniferous forests from 520 to 1,690 m elevation. Dead or living conifers are preferred nest trees, but deciduous species are also used. Uses trees >30.5 cm dbh for nesting and those located near openings created by burns, clearcuts, ponds, lakes and bogs are typical. Nest cavity entrances are rounded and nest heights range from 1 to 24 m, with most between 1 and 4.6 m. A clutch of 3–4 eggs are layed during the breeding period extending from May to late July.

Roosting: Excavates roosting cavities in soft snags found in mature and overmature stands.

Home Range Size: 53–304 ha per individual.

Status — Yellow

Uncommon to rare resident throughout most of B.C. Very rare west of the coast ranges, including Vancouver Island and absent from the Queen Charlotte Islands.

Selected References

Bent 1939; Yunick 1985; Bull *et al*. 1986; Goggans *et al*. 1987; Campbell *et al*. 1990; Marshall 1992*c*; Winkler *et al*. 1995.

B-BBWO

2.10 Black-backed Woodpecker

Picoides arcticus (Swainson)

Description

Physical Characteristics: A medium-sized woodpecker averaging 24 cm in length. Adults have a solid black back, heavily barred sides, and a white belly, breast and throat. The head is black with white stripes and the male has a yellow crown. Has three toes rather than four.

Vocalizations: Call note is a single sharp metallic *kik*. Also has a rattle call similar but slower than that of the Three-toed Woodpecker. This species drums frequently with longer bursts and more beats than that of the Three-toed Woodpecker.

Activity and Movement Patterns: Probably winters throughout its range but records are scarce.

Distribution In British Columbia

The Black-backed Woodpecker is resident and found locally east of the Coast Ranges. It is casual west of the Coast Ranges and absent from Vancouver Island and the Queen Charlotte Islands. It frequents the subalpine, sub-boreal and boreal coniferous forests, and the higher elevations of the interior Douglas-fir and western hemlock forests from 335 to 1,400 m.

Biogeoclimatic Zones: CWH, BG, PP, IDF, MS, ICH, SBPS, SBS, ESSF, SWB, BWBS.

Ecoprovinces: CAM, SOI, SIM, CEI, SBI, NBM, BOP, TAP.

Habitat Utilization

Feeding: Forages in mature and overmature stands of lodgepole pine and mixed conifer stands dominated by lodgepole pine. Eats almost exclusively insects and in particular, wood-boring beetle larvae. It uses mainly surface foraging techniques (*e.g.,* flaking, pecking) to extract insects from under the bark. Feeds in recently dead and (to a lesser extent) in live trees.

Reproduction: Breeding habitat includes coniferous forests from 335 to 1,400 m elevation, often in or near openings such as burns, logged areas, lakeshores, streamsides, swamps and bogs. Excavates its own nest cavities in living or dead coniferous trees. Nest tree dbh averaged 50 cm in Oregon. Nest entrance cavities are rounded and nest heights in B.C. range

from 1 to 24 m, with most between 1 and 3 m. A clutch of 3–4 eggs is layed during the breeding period extending from May to late July.

Roosting: Reportedly uses tree deformities (*e.g.*, scars, western gall rust cankers, mistletoe clumps) in mature and overmature trees for roosting but may use cavities as well.

Home Range Size: 72–328 ha per individual.

Status — Yellow

Rare to very rare resident east of the Coast Ranges and casual west of the Coast Ranges.

Selected References

Bent 1939; Short 1982; Yunick 1985; Bull *et al*. 1986; Goggans *et al*. 1987; Marshall 1992*d*; Villard and Beninger 1993; Winkler *et al*. 1995.

B-NOFL

2.11 Northern Flicker

Colaptes auratus (Linnaeus)

Description

Physical Characteristics: The Northern Flicker is a relatively large woodpecker averaging 32 cm in length. Adults have a brown barred back, a spotted belly and a black crescent-shaped chest band. Wings lack white patches and a white rump is conspicuous in flight. Males have a red or black whisker stripe. Flight is undulating.

Vocalizations: Very active, noisy bird. Calls include a rapid *wik-wik-wik-wik* and *wick-er, wick-er*, usually repeated more than 10 times and a single, loud *klee-yer*, very sharp and descending in pitch.

Activity and Movement Patterns: In winter, some of the northern populations withdraw to southern interior valleys or move to the coast. Birds arrive at the breeding grounds in early March in southern areas and in late May in the north. Fall migration begins in late August, reaches a peak during the latter half of September and extends through October. In winter, flickers often concentrate in loose flocks in protected feeding areas.

Distribution In British Columbia

Widely distributed resident in the southern third of B.C.; uncommon resident north to the Queen Charlotte Islands and the north coast. Rare to uncommon summer visitant throughout the rest of the province. Found from sea level to 2,100 m elevation in a variety of forested habitats as well as rangeland, pasture and urban and rural areas.

Biogeoclimatic Zones: CDF, CWH, MH, BG, PP, IDF, MS, ICH, SBPS, SBS, SWB, BWBS.

Ecoprovinces: CAM, GED, SOI, SIM, CEI, SBI, NBM, BOP, TAP.

Habitat Utilization

Feeding: Forages in open or semi-open habitats on or near the ground for insects (especially ants, which form about 75 % of the diet). Occasionally gleans insects from bark surfaces and fly catches. Also eats nuts, grains and fruits, including cultivated varieties. Commonly frequents bird feeders.

Reproduction: Prefers open habitats, such as aspen-lodgepole pine parkland, ponderosa pine parkland, Douglas-fir and ponderosa pine forests, riparian woodland, forest edges, burns, logged areas, urban and rural gardens, rangeland, pasture, orchards and alpine meadow edges. Nests in existing holes or excavates new cavities in both natural and human-made sites. Natural sites include living and dead deciduous and coniferous trees and stumps, and occasionally silt and clay cliffs. Human-made sites include fenceposts, power poles, nest boxes and abandoned buildings. Soft, decayed trees are required for cavity excavation. Mean dbh for coastal and interior nest trees are 48 and 38 cm, respectively. Cavity entrances are oval and nest heights range from ground level to 27 m. A clutch of 4–9 eggs are layed and 5–7 young are usually raised, with a breeding period extending from April to late July.

Roosting: Roosts in dead and decaying trees at night and during inclement weather. Will sometimes drill holes in barns or under the eaves of houses for winter roosts.

Status — Yellow

Fairly common local resident in the southern third of the province, including Vancouver Island; uncommon resident north to the Queen Charlotte Islands and Prince Rupert on the coast. Rare to uncommon summer visitant throughout the remainder of the province.

Selected References

Bent 1939; Lawrence 1967; Campbell *et al*. 1990; Winkler *et al*. 1995.

B-PIWO

2.12 Pileated Woodpecker

Dryocopus pileatus (Linnaeus)

Description

Physical Characteristics: A large woodpecker averaging 42 cm in length Adults have a solid black back and a conspicuous red crest. The females' crest is less extensive than the males. Juveniles look similar but are paler than adults.

Vocalizations: Call is a fast *kek kek kek*, usually repeated 12 times or less and falling in pitch. Drumming is very loud, relatively slow, and softens toward the end. Drumming lasts 2–3 seconds and is repeated every 40–60 seconds, 4–7 times in a row.

Activity and Movement Patterns: In winter, appears to withdraw from northern parts of its range to southern valleys and coastal areas.

Distribution In British Columbia

Widely distributed from sea level to 1,200 m in forested areas across southern B.C. Found more sparsely across central B.C. north to the Peace River area and in the north-east corner of the province. Absent in the north-west corner of B.C.

Biogeoclimatic Zones: CDF, CWH, MH, BG, PP, IDF, MS, ICH, SBPS, SBS, ESSF, BWBS.

Ecoprovinces: CAM, GED, SOI, SIM, CEI, SBI, BOP, NBM, TAP.

Habitat Utilization

Feeding: Forages in old-growth and mature forests, in younger forests that contain mature and old-growth remnants, and in deciduous riparian areas. Forages by excavating into wood and scaling and chipping bark of standing dead trees, stumps and fallen logs of large diameter (>30 cm dbh). The large, rectangular feeding notches chiseled into the lower boles of trees are diagnostic. Live trees of sufficient diameter (>20 cm) are also used for feeding. Diet consists primarily of insects (especially carpenter ants and to a lesser extent woodboring beetle larvae and caterpillars), supplemented by berries and seeds.

Reproduction: Breeds in a variety of forested habitats from open deciduous forests to dense, mature coniferous stands. Excavates a nest cavity each year in deciduous or coniferous trees. Both live and dead standing trees are used but live trees are preferred. In a study on south-eastern Vancouver Island, confirmed nesting trees had a mean dbh of 82 cm and a mean height of 22 m. In an Okanagan valley study, nest trees were a minimum of 25.8 cm dbh and mean nest tree diameter was 40.5 cm. Nest cavities entrances were oval and ranged from 8 by 10 cm to 10 by 15 cm. Nest cavity heights ranged from 4 to 30 m, with most between 6.4 and 12.2 m. Most birds lay 2–4 eggs and raise 2–3 young with a breeding period extending from early April to late July.

Roosting: Excavates roosting cavities (usually several for each individual male and female) in live or dead trees >50 cm dbh; conifers may be preferred for roosting.

Home Range Size: Reported as 321–630 and 267–1056 ha per individual.

Status — Yellow

Uncommon to rare resident in southern B.C., including Vancouver Island. Very rare throughout the rest of the province, except in the north-west portion.

Selected References

Bent 1939; Bull and Meslow 1977; Mannan 1984; Beckwith and Bull 1985; Bull 1987; Bull *et al*. 1992; Marshall 1992*e*; Mellen *et al*. 1992; Bull and Holthausen 1993; Winkler *et al*. 1995; Hartwig 1999.

3. Protocol

Interest in woodpecker field surveys has increased over the last decade. The interest is primarily a response to habitat alterations caused by widespread forest fragmentation, simplification of forest structure through even-aged stand management, and reduction in certain forest habitat components such as wildlife trees. There is great variation, however, in the amount of study effort expended on different species. While Pileated Woodpeckers have been extensively investigated (especially in the United States), few studies have been conducted on most of the other species. Surveys of woodpeckers as a subgroup of cavity-nesting birds (*e.g.*, Raphael and White 1984; Sedgewick and Knopf 1986; Lundquist and Mariani 1991) are more common than investigations of individual woodpecker species or genera. Most surveys have been conducted during the spring/summer or breeding season. Winter surveys are rare and may be important as habitat requirements during this period may be more restrictive (Raphael and White 1984; Galen 1989).

The recommended protocols are based on information obtained from: (i) a monitoring workshop for Pileated Woodpeckers and other cavity-nesters in February 1992, organized by The Wildlife Society, Oregon chapter, (ii) direct communication with active woodpecker researchers in the Pacific Northwest; (iii) methods outlined in various woodpecker studies; (iv) a wildlife tree/woodpecker research project in the interior of British Columbia (Steeger and Machmer 1995; Steeger *et al*. 1996); and (v) a subsequent review of optimal survey design and statistical techniques (Integrated Ecological Research 1998). An excellent critical review of methods for censusing diurnal forest birds (including woodpeckers) is given in Manuwal and Carey (1991).

For all survey methods, the following general assumptions must be met if conclusive, accurate, precise, and statistically valid results are to be obtained (from Manuwal and Carey 1991; see also RIC *Species Inventory Fundamentals* manual):

- Birds are correctly identified;
- Sampling effort is sufficient and adequately timed to detect presence of species or to obtain the desired precision for comparative purposes;
- Differences among observer survey ability are insignificant or can be accounted for;
- Differences among species detectability are insignificant, can be accounted for, or are unimportant;
- Differences in species detectability among habitats or survey periods are insignificant or can be accounted for.

Design and evaluation of woodpecker inventory methods must take species-specific characteristics and local ecological conditions into consideration. The following points are worth considering:

- There is potentially great variation within and between forest stands in vegetation density and terrain features. The probability of detecting and identifying individual woodpeckers, their nests and territories can vary accordingly.
- Woodpeckers with relatively large home ranges or territories (*e.g.*, Pileated, Black-backed, or Three-toed Woodpeckers) are not very numerous. Surveying such species

usually involves sampling an area proportional to the species-specific home range or territory size.

- During non-breeding seasons, most woodpeckers are solitary, quiet and therefore difficult to detect. They are, however, year round residents in British Columbia and may be surveyed throughout the year.
- Occurrence of woodpeckers within any given area is variable in space and time and closely linked to the availability of suitable nesting, feeding and roosting trees. Woodpecker aggregations and population irruptions are periodically observed in burns and areas of epidemic bark beetle infestations (Yunick 1985, Murphy and Lehnhausen 1988, Hutto 1995, Machmer and Steeger 1995).
- As occurrence and abundance of woodpeckers is highly dependent on the availability of wildlife trees, surveyors are encouraged to collect data on trees used by woodpeckers (*e.g.*, nesting, roosting, feeding trees). Such information is important for assessing woodpecker habitat use and quality.

3.1 Sampling Standards

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

3.1.1 Personnel

- The number of surveyors required will depend primarily on the size of the sampling area and the study objectives. For areas less than 20 ha, two surveyors may be sufficient to cover the area during each sampling period. For larger areas, teams of four or six crew members may have to be employed.
- Crew leaders should be professional biologists with woodpecker experience. Crew members should either have experience in woodpecker surveys or receive proper training prior to the sampling period.
- Useful field training tools are the "Guide to the Vocalizations of Woodpeckers in North-eastern Oregon", a cassette produced by the U.S.D.A. Forest Service (1992) and the "Training Guide for Bird Identification in Pacific Northwest Douglas-Fir Forests" (U.S.D.A. Forest Service 1990). A detailed procedure for training observers is given in Kepler and Scott (1981).
- Crew members should be in good physical condition and have comparable surveying ability.
- Crew Leaders or the Project Biologist must have working knowledge of the statistical concepts of surveys as presented in the RIC *Species Inventory Fundamentals* manual and associated references.

3.1.2 Controlling for observer bias

Various studies have shown that observer bias is one of the most noteworthy bias factors in trend analysis of many bird populations. In fact, one study suggests that a potential reason for the apparent recent increase in some songbird populations (as determined by breeding bird surveys) is the apparent increase in skill of birdwatchers (Sauer *et al*. 1994). In another study, it was found that a significant change in trend resulted if individual observer's first year of observation in a breeding bird survey was removed (Kendall *et al*. 1996). However, if observers are trained appropriately from the start of a project, methods to account for observer bias should not be required (see note 5 below). Strategies to avoid observer bias include:

1. When possible, change observers between stations, transects, or rotate observers between habitat types on repeated surveys to minimize recurring bias in any segment of a survey;

2. Observers should be tested to ensure that bias due to misidentification of calls or drumming is minimized. The performance of observers should be recorded for possible use as a weighting factor or criteria for stratification in the analysis of data as described in Point 5 (below). Obviously, these tests should be done prior to surveys;

3. Field coordinators must ensure that observers include all woodpecker observations on appropriate data sheets using standard species codes as designated in this manual. Woodpeckers that were observed either visually or aurally, but for various reasons could

not be identified to species, should *also* be recorded on data sheets to the highest taxonomic classification possible (*e.g.*, Picidae, for an unknown woodpecker species). It may also be useful to include a written comment as to why a species could not be identified (*e.g.*, heard calling, but could not locate for positive ID). Particularly in dense forest habitats, it is not always possible to identify each woodpecker observation to species. Crew leaders should ensure that field personnel are aware that, although it is important to make a best effort to identify species (within the constraints of the survey methodology), it is better to document an "unknown" rather than record guesses. Crew leaders must ensure that each observer has a suitable level of competence in identification;

4. Replicating counts from an individual site can identify the influence of within-site variability on results using the methods of Link *et al.* (1994). Within-site variability can be defined as variation due to factors such as differences between observers, and short-term variation in population size at a count station or monitoring site. This is not to be confused with between-site variability, which is due to large-scale differences in the spatial distribution of species, and forms the basis for most experimental designs. In general, Link *et al*. (1994) found that if the proportion of within site variation is large, and the cost of replicating a site is small compared to setting up a new site, then it is optimal to replicate counts. If the proportion of within site variation is small, and the cost of replicating a site is equal to that of setting up a new site, then it is optimal to not replicate. Not surprisingly, this study found that counts for birds with lower abundance, such as many woodpeckers, had the highest percentage of within-count variation. Therefore, project biologists should consult Link *et al*. (1994) when designing monitoring studies, especially for woodpeckers that will have low average counts. In general it will be expensive and time-consuming to locate sufficiently large and contiguous sites for woodpecker surveys, and access to those sites for establishing point count stations or transects will be problematic. Therefore, it is expected that replication of sites will be more cost-effective than establishing new sites;
5. If there was significant variation between observer skills, data sets can be tested for observer effects by stratification by observers (ANOVA) (Buckland *et al*. 1993) or addition of covariates or weighting factors for trend models (Sauer *et al*. 1994, Thomas 1996, Link and Sauer 1997). However, this is not necessarily a good strategy for a reduction in the power of tests and precision of estimates may result with the addition of covariates (to trend analysis) or strata (to ANOVA) designs. Power analysis in the design phase can be used to explore this problem (see RIC *Species Inventory Fundamentals* manual). The best strategy is to use qualified observers or to train new observers adequately to minimize potential bias rather than rely on complex statistical analysis.

3.1.3 Time of day

- Woodpeckers, like many birds, are most active in the morning. Therefore, surveys should be conducted from about one half hour after sunrise until noon.
- Hartwig (1999), found that the most reliable time of day for call playback responses of Pileated Woodpeckers on south-eastern Vancouver Island was from 1.5 to 3 hours after sunrise, although they would still reliably respond at about a 1:10 ratio of response to effort up to 5.5 hours after sunrise.

3.1.4 Time of year

- The survey season depends on the particular study objectives. In general however, surveys are most efficiently conducted during the breeding season (when birds are generally most conspicuous). Timing and length of the breeding season is species-specific (see Section 2) and varies with latitude and elevation. Furthermore, pairs within populations differ in their timing of breeding and annual activity schedules. These differences must be considered for sampling during the breeding season.
- Winter surveys are more likely to be affected by inclement weather and snow pack, both of which may reduce the rate of observer travel (from 1 km/hr in spring to 0.5 km/hr during the winter; Carey 1983). However, the visibility of birds may be enhanced in winter when deciduous trees are leafless. Studies considering assessments of impacts on bird populations may wish to consider resident (*i.e.*, most woodpecker species) as well as migratory populations. In such cases, breeding season surveys as well as winter surveys are warranted and highly recommended.
- Call playback surveys should be conducted before or during the breeding season when birds are most territorial. Other survey methods may be employed throughout the year.

3.1.5 Environmental conditions

Poor weather such as high winds, rain, and fog can inhibit both bird behaviour and observer ability (Table 1). High winds and rain are more of a problem in forests than open grasslands due to increased noise in the canopy.

Table 1. Acceptable and unacceptable weather conditions for woodpecker surveys.

	Acceptable	**Unacceptable**
Wind	• Beaufort 0 (< 2 km/hr). Smoke rises vertically. • Beaufort 1 (2–5 km/hr). Some smoke drift. • Beaufort 2 (6–11 km/hr). Leaves rustle.	• Beaufort 3 (12–19 km/hr). Leaves and twigs in motion. • Beaufort 4 (20–29 km/hr). Raises dust - small branches move. • Beaufort 5 (30–39 km/hr). Small trees sway. • Beaufort 6 (> 40 km/hr).
Precipitation	• None • Light drizzle • Light snow (winter)	• Steady rain • Heavy snow
Temperature	• > 7 ^{0}C (breeding) • > 0 ^{0}C (winter coast) • > -10 ^{0}C (winter interior)	• < 7 ^{0}C (breeding) • < 0 ^{0}C (winter coast) • < -10 ^{0}C (winter interior)

3.1.6 Habitat data standards

Habitat data that has typically been correlated to woodpecker abundance includes stand age (structural stage), DBH, tree species composition (*e.g.*, conifer, mixed-wood, deciduous), stand density, and the number and quality of dead or dying trees. A minimum amount of habitat data must be collected for each survey type. The type and amount of data collected will depend on the scale of the survey, the nature of the focal species, and the objectives of the inventory. As most, provincially-funded wildlife inventory projects deal with terrestrially-based wildlife, standard attributes from the terrestrial Ecosystem Field Form developed jointly by MOF and MELP (1995) will be used. The manual, *Species Inventory*

Fundamentals (No.1), contains a generic discussion of habitat data collection as well as a list of the specific requirements for woodpecker surveys (Appendix E).

3.1.7 Survey Design Hierarchy

Woodpecker 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 woodpeckers. A survey set up following this design will lend itself well to standard methods and RIC data forms.

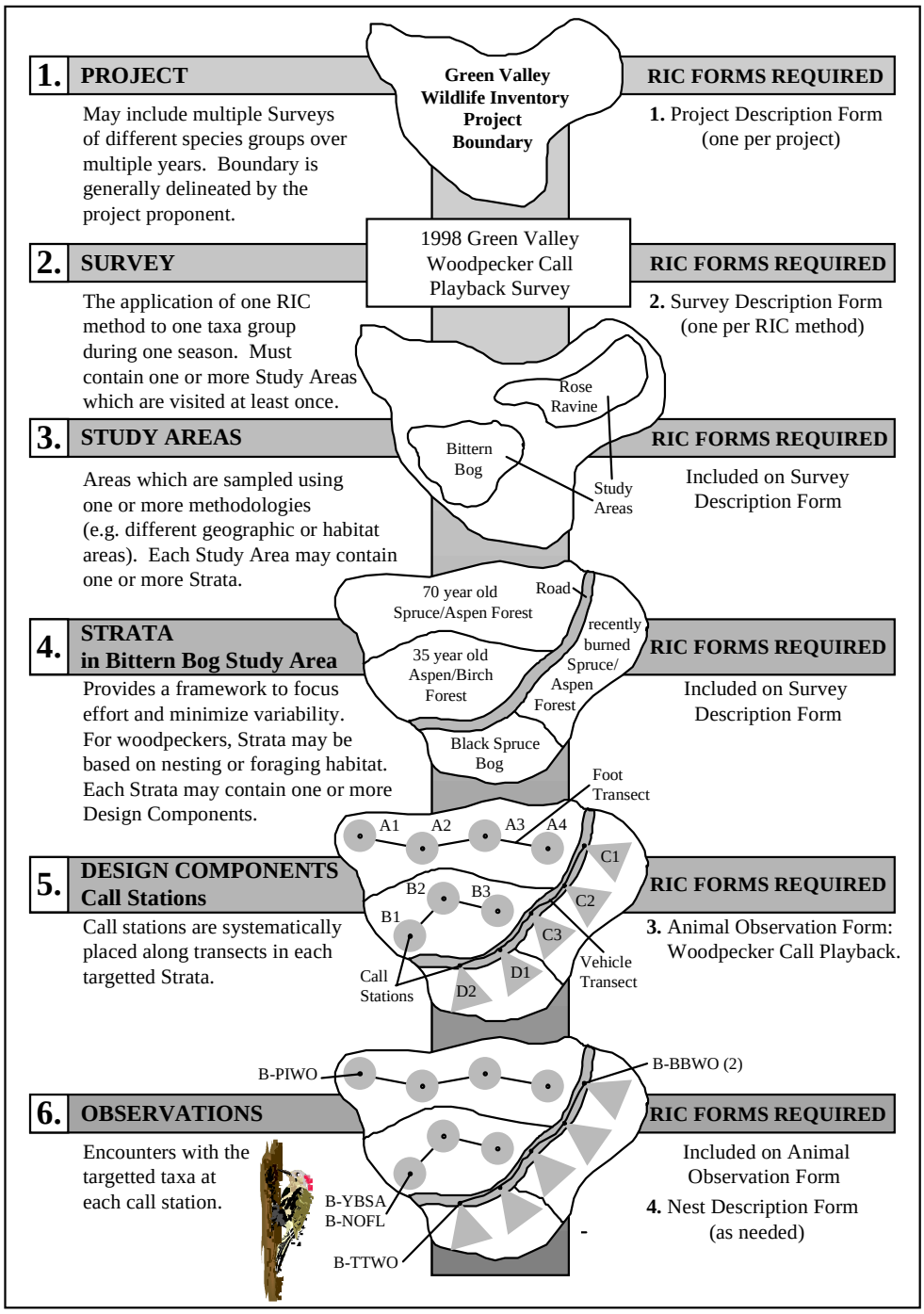


Figure 1. RIC species inventory survey design hierarchy example.

3.2 Inventory Surveys

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

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

Survey Type	Data Forms Needed	Intensity
Woodpecker Call Playback	• Wildlife Inventory Project Description Form • Wildlife Inventory Survey Description Form - General • Animal Observations Form- Woodpecker Call Playback	• PN • RA
Woodpecker Wildlife tree/sign surveys	• Wildlife Inventory Project Description Form • Wildlife Inventory Survey Description Form - General • Animal Observations Form- Woodpecker Encounter Transect	• PN • RA
Woodpecker Spot-mapping	• Wildlife Inventory Project Description Form • Wildlife Inventory Survey Description Form - General • Animal Observations Form- Woodpecker Spot Mapping	• AA
Distance Sampling Methods	• Consult with the Regional RIC Inventory Authority and with a biostatistician.	• AA
All Surveys	• Nest Site Description Form This is filled out only when a nest is located during the survey. It is included in the *Species Inventory Fundamentals* [Forms]	• All

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

With the exception of the Pileated Woodpecker, there is not enough information on the logistics of surveying particular woodpecker species to recommend species-specific methods. Therefore, the above methods may be used for surveying multiple species at one time or for surveying a single species. However, call playback and wildlife tree/sign surveys are relatively new inventory methods for woodpeckers and it is not known how successful these methods will be for each species. Thus, it is important to consider differences among various woodpecker species and develop inventory strategies accordingly.

3.3 Presence/not detected (possible)

Recommended method(s):

Call playback/drumming imitation surveys are recommended as the most efficient survey method during the breeding season, especially for those species that are known to respond to call playback, occupy relatively large home ranges and/or are otherwise difficult to detect (refer to Section 2).

During the non-breeding season when birds are less conspicuous, wildlife tree and indirect sign surveys for woodpecker feeding, roosting and nesting excavations are recommended as indicators of woodpecker presence.

General considerations: While call playback surveys or encounter transects for sign of woodpecker activity can be used to determine presence/not detected status, their uses should be carefully considered because they may be inefficient uses of resources for determination of simple presence/not detected surveys. In some situations this method may be necessary as the only possible method to locate secretive woodpeckers, or they may be done with little cost, but there is a great statistical problem in specifying the probability of *absence*. The asymmetry between recording a species (= know it is there) and not recording a species (could be there but not enough effort to find it) is a serious statistical problem with both call playback and encounter transects. See the *Species Inventory Fundamentals* manual for a discussion of survey effort needed to detect species which exhibit low population levels.

Sampling Design and Sampling Effort: The number of sample sites and the number of times each site is re-visited will vary with the rarity of the species and variability of the habitat. Adequate sampling effort is required to ensure that data collected is representative of the surveyed area. For presence/not detected surveys, a graph of species detected as a function of call playback points or distance travelled will approximate optimal search effort to detect woodpecker species (refer to RIC *Species Inventory Fundamentals* manual, Chapter 5, section 5.2). Unfortunately, since the diversity of woodpecker species is expected to be smaller than 10 species in any given study area in the province, these graphs may be ineffective. Therefore, they should be used only as a general guideline. Also, these results will only be applicable to the season and area in which the survey was conducted. Other factors such as weather, observer experience and habitat types will also affect the number of species detected. Therefore optimal sample effort for presence/not detected surveys will have to be determined on a study specific basis.

The Project Biologist must stratify the study area according to the objectives and hypotheses of the study. Typical habitat for many woodpeckers includes open, mature forest with an abundance of dead or dying trees suitable for foraging. However, the habitat descriptions for each species as described above should be consulted to determine habitat strata. Some example categories include:

- general habitat types (*e.g.*, seral and structural stages, tree species composition, riparian zones; abundance of dead or dying trees);
- biogeoclimatic units (subzone, variant, site series; see Meidinger Pojar 1991) or ecoregion classification (ecoregions, ecosections; see Demarchi 1995, 1996);
- silviculture systems or land allocation (harvesting regimes, silviculture practices, wildlife tree retention areas, ecological reserves, etc.); and

- natural disturbance history (fire, insects, disease).

Biologists should focus their efforts on strata which have the highest potential population levels if presence/not detected is the principal objective of survey efforts.

3.3.1 Call Playback Surveys

The call playback technique attempts to solicit woodpecker responses to broadcasted recordings of their calls and/or drummings. Playback surveys are suitable for species that respond readily to recordings, occupy relatively large home ranges and/or are otherwise difficult to detect. The response to a call/drumming can be visual and/or vocal. Only 3% of the total responses were visual for a Pileated Woodpecker study that was conducted on south-eastern Vancouver Island. As well, 92% of the responses were solicited as opposed to spontaneous calls (Hartwig 1999). The call playback technique has been successfully used for a variety of species including Pileated (Bull and Holthausen 1993; Hartwig 1999), White-headed (Frederick and Moore 1991), Three-toed and Black-backed Woodpeckers (Goggans *et al*. 1987), and Yellow-bellied Sapsuckers (Rushmore 1973).

For determining presence/not detected (possible), it is possible to census a group of woodpeckers at the same time. However, it should be noted that drumming imitations are only useful if the responding birds approach close enough for accurate identification. Woodpecker identification based solely on drumming may be inaccurate because differences in resonance between drumming substrates can be greater than differences among certain species (Robbins and Stallcup 1981). Additionally, this inventory technique is still in the experimental stages and it is not known how well various species respond to call playback nor at which stage during the breeding season each species will respond most predictably. Therefore, observers should note if more than one species responds to a call.

In general, call surveys are conducted by walking or driving along a transect line and stopping every 100 - 600 m to broadcast a call or imitate drumming, depending on the density of the forest, the quality of broadcasting equipment and the woodpecker species being inventoried (Johnson *et al*. 1981; Aubry and Raley 1994). Appropriate distances for spacing call stations have not been determined for each woodpecker species. A distance of 300 metres between call stations and 800 metres between transects was used by Aubry and Raley (1994) while surveying for Pileated Woodpeckers in Oregon forests. As a general rule, surveys for larger species have greater distances between call stations than small species inventories.

Playback/imitation techniques appear to generate very good results in presence/not detected (possible) surveys for woodpeckers. Although these techniques are most effective during the early parts of the breeding season, they may also prove useful during other seasons, especially for species that defend feeding territories in the winter. Possible disadvantages of playback surveys include (i) the greater effort and expense required relative to silent transect walks or point-counts, (ii) annual variations in ecological conditions which affect the timing of breeding and, in turn, the timing of (peak) responsiveness, (iii) dominance interactions between species which might confound the detectability of particular species when attempting to survey for multiple species; and iv) statistical limitations (discussed above).

Office Procedures

- Review the introductory manual No. 1 *Species Inventory Fundamentals.*
- Compile a list of all potential woodpecker species in the Study Area.

- Obtain relevant maps for Study Area (*e.g.*, 1:5,000 air photo maps, 1:20,000 forest cover maps, 1:20,000 TRIM maps, 1:50,000 NTS topographic maps) and identify regions to inventory on the map.
- Obtain cruise data, wildlife/danger tree assessment reports (Wildlife Tree Committee of B.C. 1993).
- Determine the best distance between call stations based on the density of the survey habitat, the species being surveyed and the quality of the call playback equipment.
- Establish transect routes with calling stations on maps and/or air photos. These may follow roads, trails, predetermined straight lines, contours or drainages. Systematically select random locations within each stratum for initiating transects (Refer to Section 2.3 — Sampling Design in the RIC *Species Inventory Fundamentals* manual).
- Determine Biogeoclimatic zones and subzones, Ecoregion, Ecosection, and Broad Ecosystem Units for stations.
- Obtain background information on target species (behaviour, habitat requirements, site-specific nesting chronology, activity schedules, characteristic calls or drummings, etc.)
- Obtain information on terrain structure/features of sampling area (slopes, aspects, gullies, cliffs, creeks, etc.) and select transect lines and sampling stations (plots) from maps.

Equipment

- A portable megaphone attached via a mono cord to a walkman is particularly useful for call surveys on foot. The machine should be able to broadcast sounds over a distance of 400 metres; one technical description of a recommended player has a frequency of about 40 Hz to 12 kHz and power output of 1.2 watts at 1 kHz.
- Tape cassettes / CD of calls of woodpecker species of interest.
- Equipment for imitating woodpecker drumming sounds such as two 1-inch hardwood dowels (18 and 7 inches long) used by Rushmore (1973) to imitate the characteristic two-beat drumming and feeding sounds of Yellow-bellied Sapsuckers. Taped recordings of these drumming sounds would make surveys more consistent and would help project the drumming sounds at equal distances between stations.
- Datasheets
- Field identification guides
- Binoculars
- Maps
- Compass
- Hip chain
- Altimeter

Field Procedures

- The time of year for commencing call surveys can be determined from knowledge of when egg laying will occur.
    - Studies have shown Three-toed and Black-backed Woodpeckers respond well to playbacks of their drummings during the cavity excavation period (approximately three weeks long) and most responses are obtained one to two hours after sunrise.
    - In general, Black-backed Woodpeckers are more responsive throughout the breeding season than Three-toed Woodpeckers (Goggans *et al.* 1987).

    - For sapsuckers, the highest proportion of responses were obtained during the pre-nesting period (87%), followed, in decreasing order, by the nesting (61%), post-nesting (54%), and pre-migration (41%) periods (Rushmore 1973).
    - Call surveys for Pileated Woodpeckers in Oregon were conducted from mid-March to mid-April, before birds began to incubate eggs and when birds were most territorial (Aubry and Raley 1994).
- Surveys should be conducted in the morning from one half hour after sunrise until noon.
- Stations along transects can be surveyed by driving along roads and getting out of the vehicle to play calls or by broadcasting calls while on foot.
- Although call surveys are known to be effective, there have been no standard distances determined for inventorying each species. Calling stations should be separated far enough apart in order to maximize distance covered and minimize duplication of called areas. Calling stations used to survey Pileated Woodpeckers in forested areas were separated by approximately 300 m. Distances will vary according to woodpecker species being inventoried (the smaller the woodpecker species, the shorter the distance between stations), density of habitat and survey equipment used (*i.e.*, broadcasting distance). For consistency, stations must be separated by a minimum of 200 m.

At each station:

- Upon arriving at a call/drumming station, surveyors should listen for one minute for calling birds, before broadcasting a call or imitating drumming. Use this time to record location and weather conditions. You may collect habitat data for the station at this time or on your route back after you have completed the call playback surveys on your transect.
- If no birds are heard, broadcast a call for a particular species at 60^0 from the transect line, turning left or right and continuing in the same direction during subsequent turns; listen and watch for 30 seconds. Turn 120^0 and repeat the procedure, then turn another 120^0 and repeat the procedure.
- For consistency, multi-species call playback surveys for woodpeckers should include three series of 20 s of calls/drumming followed by a 30 s break (*e.g.*, 20/30, 20/30, 20/30) for a total of 2.5 min. for each species, with a minimum two-minute pause between each species. Calls should be played in order from smallest to largest species. Once a response has been elicited, discontinue the call playback for that species. Wait one minute, and then continue with other species. If call playback of the additional species results in undue disturbance to other species, discontinue call playback entirely and continue on to the next point. Note at what species call playback was discontinued for each point on the data sheet. This will be important in an evaluation of survey effort (*e.g.*, to evaluate the total number of times or the total number of points at which call playback for particular species was conducted).
- When drumming to supplement call playbacks or as a follow-up to unsuccessful playbacks, follow the above procedures. A drumming sequence should last for approximately 5 seconds, followed by a 10 second pause and should be repeated three times as above (*e.g.*, 5/10, 5/10, 5/10).
- For Yellow-bellied Sapsuckers, Rushmore (1973) developed a method using two 1-inch hardwood dowels to produce a series of hard, short, rapid taps lasting one second, followed by a few slower, louder, spaced taps, illustrated as follows (taps = –; pause = ´):

  _´_´_´_´_´_´_´_´_´_´_´_´__´´´__´´´__´´´__´´´__´´´__

- Rushmore (1973) obtained even better results when he varied the drumming imitations with the sapsucker's softer, very rapid bark-feeding taps such as in the following sequence (taps = – ; pause = ´):

  _´_´_´_´_´´´´´´´_´´´_´´´´´´´_____´´´´´´´____

- If a woodpecker responds to the call or drumming sequence, stop playing the calls or drumming. Record the necessary information on the data sheet.
- If no response is received, move to the next call station and repeat the above procedures.

Completing a transect:

- Continue the above procedures until the transect is complete, looking and listening for birds between stations. At the last station, the surveyor should wait ten minutes after the calls have been played or drumming has occurred, before ending the survey and leaving the area.
- Following each call survey, woodpecker detections should be plotted on a master map.

Data Entry

The Design Component types for this survey are transects and call playback stations. However, in this case the station is used as the sample unit. Thus, you are only required to enter information about the call playback stations (not about the transects) when digitally entering your survey data into the provincial database. To do this, choose 'Station' from the 'Design Component Type' picklist.

3.3.2 Wildlife Tree/Sign Surveys

Wildlife trees are living or dead trees in various stages of decay. These trees are essential to woodpeckers for nesting, roosting, foraging and communication (*i.e.*, drumming). Therefore, the presence/not detected (possible) of this group in an area may be determined directly through sightings of woodpeckers on wildlife trees and indirectly, using evidence such as nesting or foraging excavations on wildlife trees. Recent excavations can be distinguished from old ones for approximately one year based on the presence, abundance and colouration of wood chips on the ground and on the colouration of wood at the cavity entrance (Bull 1981). Cavities of some woodpeckers can be identified to species based on their size and shape. Sapsucker cavities are difficult to identify to species and should therefore be combined as one group. Table 3 includes descriptions of characteristic woodpecker sign. It is important to recognize that many woodpecker cavities are not completed or used (Bull 1981). For example, in studies conducted by Bull (1981), between 40 and 60% of Pileated Woodpecker nests excavated in north-eastern Oregon were incomplete. Consequently, results obtained from sign surveys should be interpreted cautiously due to the variability associated with sign survey data.

To conduct an intensive wildlife tree/sign survey a simple encounter transect is recommended.

Table 3. Descriptions of feeding and nesting excavations made by selected woodpecker species.

Species	Foraging (F) / Nesting (N)	Description
Pileated Woodpecker (B-PIWO)	N	relatively large oval-shaped holes
Pileated Woodpecker (B-PIWO)	F	relatively large, rectangular holes into the heartwood of standing live/dead trees and stumps and logs
Northern Flicker (B-NOFL)	N	relatively large oval-shaped holes
Three-toed Woodpecker (B-TTWO)	N	round-shaped holes with bark often peeled-off around entrance
Three-toed Woodpecker (B-TTWO)	F	bark flakes removed or bark stripped from the lower bole
Black-backed Woodpecker (B-BBWO)	N	round-shaped holes with bark often peeled-off around entrance
Black-backed Woodpecker (B-BBWO)	F	bark flakes removed or bark stripped from the lower bole
Sapsucker spp.	F	rows of small, squarish holes in a vertical series in the bark of live trees

Using Encounter Transects for Wildlife Tree/Sign Surveys

A generalized method for conducting wildlife tree/sign surveys involves using simple encounter transects and distance sampling methods. Surveyors walk at a relatively slow pace along transects, recording information about woodpecker sign and species encountered *en route*.

Office Procedures

- Review Section 2 — Survey Design, of the RIC *Species Inventory Fundamentals* manual.
- Obtain maps, aerial photographs and other existing inventory material. Depending on availability, obtain the following:
  - topographic maps (typically 1:50,000 are used, but a larger scale such as 1:20,000 TRIM maps are ideal for identifying and then overlaying transects on to the map sheets)
  - forest cover maps (1:20,000)
  - aerial photographs (1:20,000 or 1:5,000)
  - cruise data, wildlife/danger tree assessment reports (Wildlife Tree Committee of British Columbia 1993)
- Compile a list of all potential woodpecker species in the study area
- Obtain background information on target species (behaviour, habitat requirements, site-specific nesting chronology, activity schedules, characteristic calls or drummings, etc.).
- Obtain information on terrain structure/features of sampling area (slopes, aspects, gullies, cliffs, creeks, etc.) and select transect lines from maps.
- Determine Biogeoclimatic zones and subzones, Ecoregion, Ecosection, and Broad Ecosystem Units for transects.
- Determine the distance between transect lines based on the intensity of the survey and on the density of the habitat.

Equipment

- Maps
- Datasheets
- Compass
- Flagging tape
- Binoculars
- Woodpecker sign identification guide
- Digital timer
- Altimeter
- Thermometer
- Hip chain

Field procedures

- Rotate observers among transects and sites to distribute observer bias evenly.
- Each transect should be of a size that can be surveyed in one morning.
- Record the transect description. This should include: observer(s); date; time start/end; distance travelled; weather; and a unique label which identifies the transect.
- As the transect is walked at a relatively slow pace (0.5 km/hr to 2 km/hr), scan for woodpeckers and for wildlife trees with woodpecker sign. Check around the base of trees for excavated cavity chips.
- For each wildlife tree that has a woodpecker on it or contains woodpecker excavations:

- Record the distance from the centre of the transect to the center of the tree (measured with hip chain). Measures of distance from the transect to the observation will allow for simple measures of abundance (or density).
- Record woodpecker species present on the tree (where the woodpecker was *first* observed).
- Record the woodpecker species associated with the sign (refer to Table 3) and sign type (active/old nest cavity, roost cavity, new/old foraging excavation).
- Record tree species.
- Record Wildlife tree classification code (refer to Inventory Technical Committee 1995: see Figures 1 and 2).
- Measure tree DBH (to the nearest ± 0.1 cm at 1.3 m height on the high side of the trees) and height.

Data Entry

The Design Component type for this survey is transects. They are the sample unit. When digitally entering your survey data into the provincial database, choose 'Transect' from the 'Design Component Type' picklist.

	LIVE		DEAD						
Decay Class	1	2	3	4	5	6	7	8	9

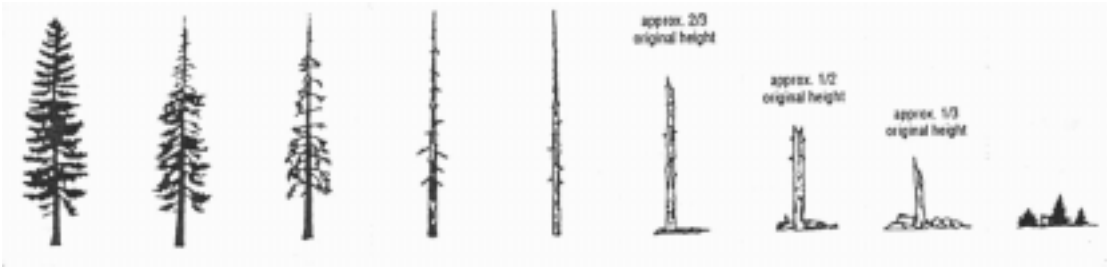
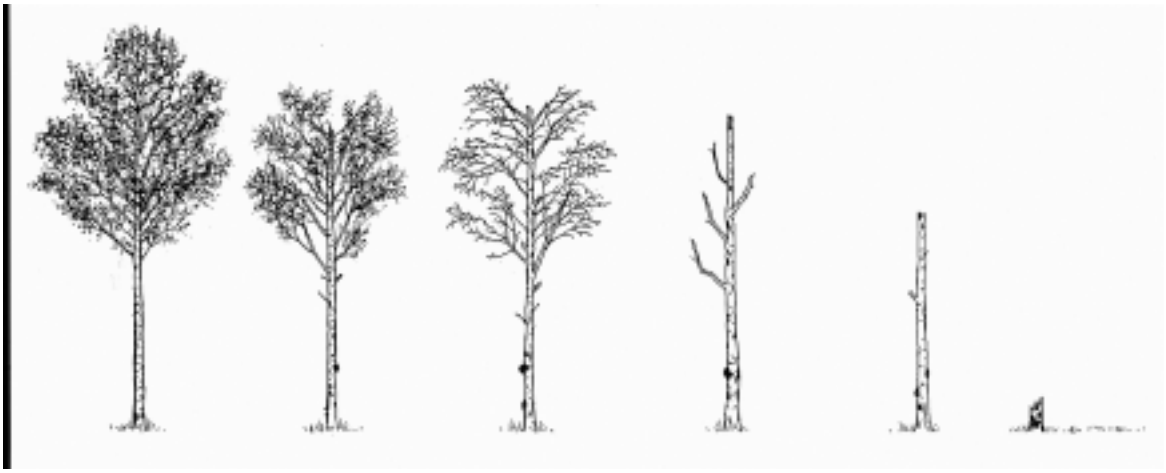


Figure 2. Wildlife tree classification system of evergreen trees (Figure from Inventory Technical Committee 1995).

	LIVE	DEAD				DEAD FALLEN
Decay Class	1	2	3	4	5	6



Description	Live/healthy: no decay.	Live with defects: dead or broken top, dead limbs, fungal conks. Dying tree.	Dead: most limbs intact, some internal rot, top usually broken.	Dead: most limbs gone, top broken, extensive heartrot.	Dead: top 1/3 or more broken off, no branches, extensive heartrot.	Dead, fallen: downed trees, coarse woody debris.

Figure 3. Wildlife tree classification system of deciduous trees (Figure from Inventory Technical Committee 1995).

3.4 Relative Abundance

Recommended method(s):

Call playback/drumming surveys during the breeding season may also be used to collect relative abundance data, especially for those species that are known to respond to call playback, occupy relatively large home ranges and/or are otherwise difficult to detect (refer to Section 2), but its uses are limited to obtaining an index abundance (Thompson *et al.* 1998).

Wildlife tree surveys for direct and indirect woodpecker sign are recommended for relative abundance data during the non-breeding season when birds are less conspicuous.

Measuring relative abundance is usually based on the number of detections of individual birds per unit of sampling effort (*e.g.,* sampling hours or kilometres walked while sampling). To achieve adequate accuracy and precision among samples, it is essential that: (i) sampling effort is equal among study areas; (ii) observers move at a constant rate; and (iii) that a sufficient number of surveys are conducted. Thus, assuming that no differences exist among observers in detection ability, the main factors that influence bird detectability include habitat structure, weather, season, and inherent behavioural differences among birds.

General considerations: The primary assumptions to consider when conducting relative abundance surveys include:

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

If these assumptions are addressed appropriately in survey design, then replicate surveys should show (on average) the same relative bias, thus allowing robust calculation of trends and comparison between areas.

Sampling design and sampling effort: To determine relative abundance, a systematic sampling design must be followed. The survey area should be stratified according to the objectives and hypotheses of the study. Refer to the RIC *Species Inventory Fundamentals* manual for sampling effort required to determine relative abundance.

When using call playback, the number of call stations will vary according to the home range size for the woodpecker species of interest, the density of birds within the habitat and the quality of the broadcasting equipment. Hartwig (1999), found that 15 - 20 call stations were required for Pileated Woodpeckers surveys to ensure an adequate sample size (*i.e.,* standard error began to stabilize) on south-eastern Vancouver Island in the Coastal Western Hemlock biogeoclimatic zone (CWHxm). Appropriate distances for spacing call stations have not been determined for each woodpecker species. A distance of 300 metres between call stations and 800 metres between transects was used by Aubry and Raley (1994) while surveying for Pileated Woodpeckers in Oregon forests. As a general rule, surveys for larger species have greater distances between call stations than small species inventories.

Power Analysis procedures for calculation of sample sizes must be integrated into the study design of all techniques. As described in the RIC *Species Inventory Fundamentals* manual, Section 2.5 — Sampling Effort, programs such as MONITOR, POWER AND PRECISION, and NQUERY are user friendly, and can be easily used in an adaptive fashion to calculate sample sizes needed for the ultimate analysis questions. Many other software developers are developing Power Analysis packages.

For relative abundance data, the statistical problems will be those concerned with the analysis of count data. Consult the RIC *Species Inventory Fundamentals* manual, Section 5.3.1 — Distribution of count data, for a detailed discussion of count data analysis. The quantification of sampling intensity and effort is fundamental to the use of indices and relative abundance measures. This way the assumptions of equal bias of surveys between areas and over time can be met. In addition, the usefulness of indices depends on the precision of estimates and standard measures of variance. For further discussion, refer to the RIC *Species Inventory Fundamentals* manual.

Of particular concern with woodpecker surveys is obtaining adequate sample sizes to allow the monitoring of trends. If a species initially exists at a very low density then in general it requires a great degree of survey effort to ensure precision is high enough to detect trends. For this reason it is essential that biologists conduct a statistical power analysis to determine optimal sampling effort.

3.4.1 Call Playback Surveys

The call playback technique is also used for presence/not detected (possible) surveys. Measures of relative abundance using call playback can be calculated if call playbacks are conducted from call playback stations where birds are evaluated as the number of observations per point, or along transects, where birds are evaluated as the number of observations within a given length of fixed-width transect (or some other *index* of abundance). For details on call playback techniques, refer to the description of Call Playback surveys within the Presence/Not Detected section.

Refer to the **Sampling design and sampling effort** section and the **General considerations** section above for consideration of using Call Playback for obtaining measures of relative abundance. For comparing measures of relative abundance using call playback methods, it is especially important to ensure that the equipment and the use of that equipment (*e.g.,* volume and direction) are consistent between call playback stations.

3.4.2 Wildlife Tree/Sign Surveys

This technique is also used for presence/not detected (possible) surveys. For details on how to conduct this type of survey see Wildlife Tree/sign surveys under the Presence/Not Detected section. Similar methods of measuring the distance from the transect line or point to a wildlife tree or woodpecker activity area are used for measures of relative abundance. The methods as described in the Presence/Not Detected section, combined with changes in study design and data analysis are used for obtaining measures of relative abundance.

A generalized method for conducting wildlife tree/sign surveys involves using simple encounter transects and distance sampling methods. Surveyors walk at a relatively slow pace along transects, recording information about woodpecker sign and species encountered *en route*. To obtain measures of relative abundance of woodpecker sign, distance sampling procedures such as the widely used Point-to-object and Nearest neighbours methods as described in Buckland *et al.* (1993; pp. 292–294) should be considered. Refer to the **Sampling design and sampling effort** (3.4) section above for further reference.

3.5 Absolute Abundance

Recommended methods: Absolute abundance of woodpeckers can be determined through traditional territory mapping, or through potentially less labour intensive encounter transect distance methods. Spot mapping is similar to a total count of breeding individuals in a population. This is not a total count of all individuals since non-breeders or birds without territories can rarely be counted. Therefore, the results of spot mapping should be given as absolute abundance of *breeding* or *birds with territories* as opposed to the total bird population. In addition, spot mapping counts will be an unbiased and accurate estimate of absolute abundance of breeding birds only if all birds are sighted during a survey effort. This assumption might be violated if birds are sitting tight in the nest, or if heavy foliage influences sightability at some sites. The conditions also apply to applications of distance sampling and inherent problems of different probabilities of sighting different ages and sexes of birds. Detection of secretive woodpeckers can be improved through use of tape call playbacks (described in section 3.3.1). However, the observer must avoid attracting birds in towards the transect line, as may happen with frequent and prolonged use of call playback. If the tape call playback creates excessive disturbance, primary assumptions of distance sampling will be violated (see below).

Sampling design and effort: Proper stratification by habitat types is needed if the results are to be extrapolated to larger areas. For spot mapping, the optimal sampling effort would depend on how many birds change territories and would have to be determined adaptively. Also for spot mapping, sites must be visited six to ten times during the breeding season, with one week to 10 days between visits.

Appropriate sample sizes can be estimated using Power Analysis techniques for improving the sampling design of both relative and absolute abundance methods for woodpeckers. This kind of evaluation that makes use of previously collected data is an important first step in specifying the details of how to inventory woodpeckers in particular habitats.

3.5.1 Spot-mapping

The spot-mapping method, first proposed by Williams (1936), is widely accepted as the preferred and most accurate method for measuring absolute abundance of territorial species such as woodpeckers. It generates detailed knowledge of the absolute abundance, distribution, and potentially of the territory size of individuals or breeding pairs within a given area.

Spot mapping requires repeated surveys of measured plots, where each woodpecker detected within the plot is registered on a base map. The data recorded include exact location within the plot, species, sex, behaviour, and number. After each survey, registrations are transferred to a separate summary map for each species, and clusters of registrations are identified that are assumed to represent one individual territory. Each territory is assumed to contain one breeding pair. For a more detailed description of spot mapping refer to Franzreb (1974), Manuwal and Carey (1991) and Bibby *et al.* (1992).

The assumptions of the spot-mapping method are as follows:

- Populations are stable during the time of study and birds remain in territories during sampling periods;
- Birds are correctly identified;
- Territory owners are sufficiently conspicuous to be recorded on successive visits;
- Observers do not differ in their ability to detect birds. If this assumption is not met, refer to the section on Controlling for observer bias above.

Office procedures

- Obtain maps, aerial photographs and other existing inventory material. Depending on availability, obtain the following:
  - Topographic maps (typically 1:50,000 are used, but a larger scale such as 1:20,000 TRIM maps are ideal for identifying and overlaying transects on to the map sheets).
  - Forest cover maps
  - Aerial photographs (1:20,000 or 1:5,000)
  - Cruise data, wildlife/danger tree assessment reports (Wildlife Tree Committee of British Columbia 1993)
- Based on the maps and other knowledge of the study area (previous reports, local resource specialists) identify strata which are of most interest for surveying;
- Determine Biogeoclimatic zones and subzones, Ecoregion, Ecosection, and Broad Ecosystem Units for spot mapping areas;
- Obtain information on terrain structure/features of sampling area (slopes, aspects, gullies, cliffs, creeks, etc.);
- Identify spot mapping plots in areas of homogeneous habitat;
- Mark gridlines for plots on maps according to protocol outlined in the Preliminary fieldwork section;
- Prepare data collection base maps of each plot on which detections will be registered. One map/plot/survey is required;
- Prepare one map/species/plot to serve as cumulative maps of detections;
- Compile a list of all potential woodpecker species in the study area;

- Obtain background information on target species (behaviour, habitat requirements, site-specific nesting chronology, activity schedules, characteristic calls or drummings, etc.).

Equipment

- Maps
- Compass
- Flagging tape
- Binoculars
- Datasheets
- Field identification guides
- Digital timer
- Altimeter
- Thermometer
- Hip chain

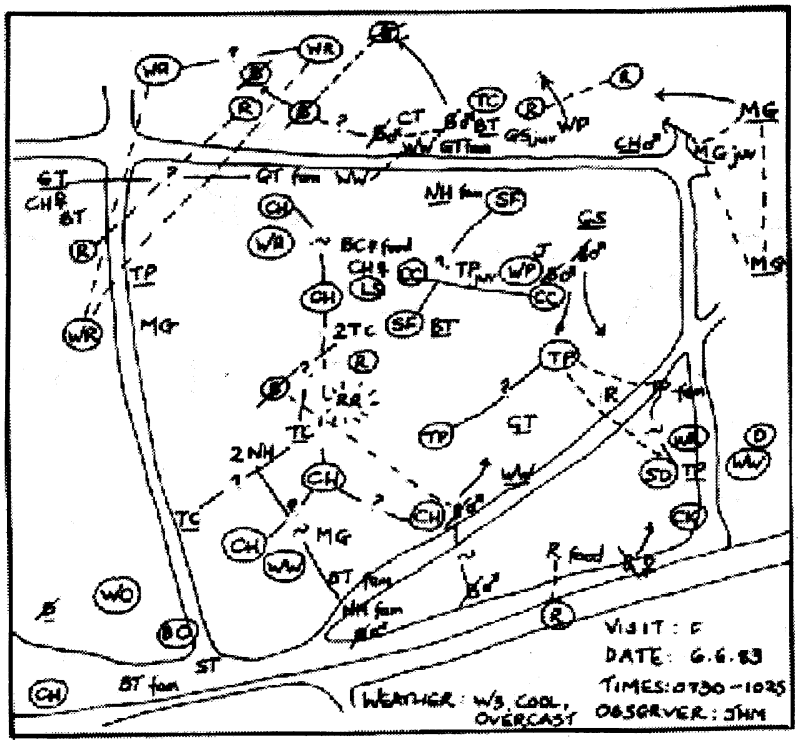
Preliminary fieldwork

- Conduct reconnaissance walks throughout the sampling area to confirm terrain and habitat features predetermined from maps.
- Locate plot(s) in areas of homogeneous habitat.
- Plots should be 20 ha in size and rectangular or square in shape to facilitate gridding. Smaller patches of habitat down to 10 ha can be mapped, but several biases may begin to influence results and should be accounted for. Larger plots can be mapped as well, but plots over 30 ha often can not be adequately surveyed because of time constraints, and are not recommended.
- Multiple plots should be of similar area and spaced so that there is little chance of individual territories overlapping between plots.
- Plot borders should be >50 m from the edge of a different habitat type to reduce the likelihood of residual edge effects.
- Mark edges of plots with flags or stakes.
- Mark gridlines, 25 m apart in forested habitats, and 50 m apart in more open habitats, with flags or stakes along one axis of the plot.
- Run a number of practice trials to reduce possible differences in surveying ability among observers.
- Randomly choose the order of observers and gridlines walked.

Field procedures

- Censusing should be conducted during peak activity periods (*e.g.,* first four hours after sunrise).
- A 20 ha grassland plot requires about two hours to survey. A 20 ha forest plot requires about three hours to survey. Duration of surveys should be consistent within and among plots.
- Select a gridline adjacent to a plot boundary and a direction of travel along the gridline.
- Walk the series of gridlines in an ‘S’ pattern until all gridlines have been traversed.

- Walk at a rate of 0.5 km/hr, stopping when appropriate to record data, identify birds, or listen.
- On each successive survey vary the pattern of walking gridlines to ensure even temporal and spatial coverage of the entire grid. Rotate observers among grids or among different parts of the same grid.
- Record all woodpecker observations on a pre-drawn map of the grid pattern. Use a separate map for each species on each observation day.
- On the spot-maps, accurately record with symbols and codes not only the location (X) and species of a bird detected but also the sex, age (adult versus fledgling), nest location and any territorial behaviour of individuals observed (*e.g.*, calling, drumming, aggressive encounters with conspecifics, etc.). Behavioural observations are critical in determining the number of territorial birds on a grid. Note the direction of movement of individuals (with arrows) when possible and link consecutive observations of a single individual.
- Do not register an individual more than once unless that factor is noted.



W W	An aggressive encounter between two birds of species W.*	W	A simple contact with a bird of species W. This includes sight or sound contact. In the case of a sound contact, this symbol is used when the sound cannot be classified as belonging to any category below or when the sound is not believed to have a high territorial significance, or when activities not covered by the standard symbols should be registered. The sex symbol may be added where appropriate.*
W——W	Two contacts with the same bird of species W. The addition of an arrow can be used to indicate observed movement.*	W	A contact with a bird of species W, giving any vocal utterance (except song) thought to have territorial significance.*
W------W	Contemporary contact of two different birds of species W. This is used to indicate separate singing males or separate pairs rather than members of the same pair or same family group. In the last two cases, the symbols may be ringed or underlined, or any non-standard symbol may be added.*	(W)	A contact with a singing bird of species W which has been seen or previously located by song.*
W*	A nest of species W. The number of eggs or young or other information on the nest may be added.*	(W)	A song contact with a bird of species W not precisely located (useful only in the case of birds with large territories or birds heard at a distance).*

Figure 4. Sample spot-map and associated symbols for delineating bird territories during the breeding season (from Bibby *et al.* 1992; Arbib 1970*).

Determination of locations and number of territories

- After each survey day, add data from the maps used for that day to the composite map for each plot.
- Use as many cumulative maps as required, particularly if there are many species and individuals. Ensure that registrations for any given species occur on one map only.
- After the survey program is completed, circle clusters of registrations for the same species that are considered to represent one territorial individual, based on the map data and your field observations.
- Clusters with two or three registrations (depending on the number of valid visits) can be considered to represent one territorial male.
- For territories that occur along the edges of the plot, estimate the proportion of the territory enclosed within the plot.
- Abundance of birds per unit area is calculated by adding the total number of territories/species of territorial males within the plot (include whole and fractions of territories), multiplying by two (which assumes that each male is associated with one female) and dividing by the area of the plot. This assumption may not be valid for some species.
- To obtain a mean abundance from multiple plots, sum abundance estimates for each species in each plot within a homogeneous habitat type and divide by the number of plots.
- Note the number of visits to sites, and the duration of sampling when reporting estimates. Long sampling period might inflate density estimates if birds change territories etc.…
- For statistical purposes, the abundance/species/area for one plot represents only a single data point, regardless of the number of registrations.
- Statistical comparisons can only be made when multiple plots are sampled.

3.5.2 Distance Methods

This is intended only as a brief description of distance methods. Due to the potential complexity of these surveys it is recommended that a biostatistician be consulted prior to conducting this (or any other) survey. An experienced biostatistician will provide assistance with estimating sample size (*e.g.*, transect line length or number of points) based on the desired level of precision of a project. They may also be able to suggest specific field protocol that will be necessary for appropriate data collection and analysis to meet the objectives of a project.

Encounter transect distance methods may be a viable alternative to labour intensive spot territory-mapping in some situations. As discussed in Section 5.4.1 of the RIC *Species Inventory Fundamentals* manual, distance methods allow for estimates of absolute density from transects. Encounter transect distance methods requires that the distance from the observer on the transect be recorded, which might be less time consuming then recording coordinates for spot mapping. The advantages of distance methods are:

1. Encounter transects are much less labour intensive than spot mapping, and therefore will allow a greater number of replicates to be collected per unit time.
2. Breeding and non-breeding birds can both be counted which may provide a less biased overall population density estimate.
3. The decrease in sightability as distance of bird from observer increases can be accounted for statistically using the methods in program DISTANCE.

The disadvantage is the complexity of the analysis, which can be overcome if a statistician is consulted in the design of studies, and for the analysis of data. Another difficulty is the large sample size required (*e.g.*, number of individual woodpecker observations) and difficulties related to estimating distances in dense forests.

The primary assumptions of distance sampling methods, in order of greater to lesser importance are: all woodpeckers present on a transect line or point are detected; woodpeckers do not move prior to being detected; and linear distances form a transect line or point to detected woodpeckers are accurately measured (Buckland *et al*. 1993). Further to the assumptions, further restrictions to using distance sampling include the number of observations necessary for appropriate analysis. Within a given strata, the number of individual woodpecker observations may have to be at least 60–80 (Buckland *et al.*, pp. 296). However, recent studies have shown that a minimum of 30 observations may be sufficient for abundance analysis (J. Boulanger, Integrated Ecological Research, pers. comm.).

The following is a synopsis of suggested methods for line transects and point counts using distance sampling methods (Buckland *et al*. 1993, pp. 313–316):

Line transects — Well marked and straight lines are required for line transect surveys. Upon detection of a woodpecker, the observer must know the exact position of the line in order to determine the distance from the line or point to the observation. Lines should be walked slowly, emphasizing search efforts on and near the line, and search effort or efficiency should decrease smoothly with increasing distance from the line. The observer is allowed to walk slowly in dense cover and faster in open or less suitable cover, and can stop frequently to observe. Surveyors can leave the centerline, provided they record the distances to observations from the centerline of the transect. Observers should occasionally look behind

in case a hidden object was not observed. Even though it will be difficult in dense forest, observers can ensure that they are collecting reliable data by moving as quietly as possible to avoid creating disturbance. If this is not possible, consider using point surveys (described below). Methods for calculating sample sizes are provided in Buckland *et al*. (1993, pp. 301–308).

Point counts — Many of the considerations discussed above for line transects apply to point counts. To avoid disturbance to animals prior to conducting a point count, in some instances it may be useful to observe a point from some distance and record observations. Another option, as described for call playback technique, is to wait at the point for a few minutes to allow any disturbed woodpeckers to settle prior to conducting the count. The longer that observers remain at a point, the greater the probability of detections. However, for standardization, point duration should be limited to 10 minutes unless another duration is agreed upon among a study group.

All detections of woodpeckers should be recorded with estimated distance to the observation, and the sex, age and behaviour of the bird. If the distance can not be reliably estimated during the point count, the distance can be measured more accurately at the end of the count session (not during as this may create further unnecessary disturbance). Birds first detected flying over a point should either be ignored, or counted only if they land within detection distance (Buckland *et al.* 1993, pp. 342).

General Considerations — Distance estimation will be difficult for multiple-species surveys in dense forest habitat. As an alternative to estimating the distance to each observation, the use of 5–7 distance categories is recommended (Buckland *et al*. 1993, pp. 328), but distances assigned to just one of two distance intervals may also be possible (Buckland *et al*. 1993, pp. 316). However, an experienced biostatistician should be consulted prior to developing field protocol of grouping distance data. Generally, for flexibility in analysis procedures, it is best to estimate distances as accurately as possible in the field (Buckland *et al*. 1993), and to let the data analyst group and truncate observations as required.

3.6 Data Analysis

3.6.1 Presence/not detected (possible)

Analysis of presence/not detected data depends on the objective of the inventory effort. Suggested analysis methods for the given RIC objectives which will apply to most project-specific objectives are highlighted in Table 4. Each objective is discussed in further detail below.

Table 4. Survey objectives and analysis methods for presence/not detected data

RIC Objective	Analysis methods	Program
Document species range	• Analysis to ensure adequate effort. • Negative binomial model[1]	• Generic statistical analysis software
Determine habitat associations	• Logistic regression	• Generic statistical analysis software
Detect change in distribution over time	• Use relative abundance methods and regression techniques.	• Generic statistical analysis software

[1] See *RIC Species Inventory Fundamentals* manual for discussion of the negative binomial distribution.

Quantifying probability of detection of woodpeckers: The main purpose of these methods is to document species geographic ranges. From a statistical point of view it is important to attempt to quantify the detection probability (as a function of population density, population spatial distribution, detection probability, sampling effort, and other covariates) for each woodpecker species to allow a general estimate of the optimal amount of effort needed for surveys. Also, if an attempt is made to quantify probabilities of detection, a more statistically conclusive statement can be made about possible reasons for not detecting a woodpecker species as opposed to a simple "none were found" conclusion. A simple way to estimate probability of detection is through the use of the negative binomial distribution with data from relative abundance surveys. This procedure is detailed in the RIC *Species Inventory Fundamentals* manual, Section 5.

Documenting changes in woodpecker species distributions: If the objective is to detect changes in geographic distributions over time, we recommend a more intensive survey regime using relative abundance methods. This will allow a probability level to be associated with changes in distribution or apparent local extinction. A conclusion that species have become extinct in an area using presence/not detected methods will be difficult given that no estimate of survey precision is possible using current methods. More exactly, it will be difficult to determine that if a woodpecker species is not detected, whether it was due to lack of sample efficiency or actual demographic extinction.

Documenting habitat associations: If determining habitat associations is an objective, it will be important to document habitat types at the scale of woodpecker home ranges. This topic is addressed further in the RIC *Species Inventory Fundamentals* manual.

3.6.2 Relative Abundance

Detection rate may be used as an index of abundance, expressed either as the number of birds per visit (total of all call stations, total of all transects) or number of birds per call station (number of excavations per visit, number per transect). To account for observer bias, refer to suggestions made in the Controlling for observer bias section of this manual

If studies are designed appropriately the following general analysis methods can be used (Table 5).

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

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

[1]See the RIC *Species Inventory Fundamentals* manual for more details on analysis techniques

[2]See the RIC *Species Inventory Fundamentals* manual for more detail on software packages

As discussed below it may be possible to use program DISTANCE with encounter transect data to allow estimate of absolute density. Refer to Data Analysis of Absolute Density section in this manual and Section 5.4 — Absolute Abundance in the RIC *Species Inventory Fundamentals* manual for further discussion.

Difficulties with count data: One inherent problem with count data is that it is rarely normally distributed, which makes the application of parametric statistical methods risky, especially if sample sizes are low. Before data are used in parametric tests the assumption of normality should be tested. Transformations may make frequencies nearly normal in some cases. If data does not appear to be normally distributed then alternative data based methods using the negative binomial distribution (Program NEGTEST) exist. These newer methods also allow inference into population spatial distribution. A detailed discussion of analysis of

count data is presented in Section 5.3 — Relative Abundance, of the RIC *Species Inventory Fundamentals* manual.

Trend analysis: The basic methodology for determination of population trends is linear regression. There are a variety of refinements to linear regression that can be used with data depending on sampling assumptions and other characteristics of the data. Refer to the RIC *Species Inventory Fundamentals* manual, Section 5.3 — Relative Abundance, for further discussion.

Comparison between areas: Parametric tests and other methods can possibly be used to compare areas if surveys are conducted concurrently. If surveys are conducted non-concurrently (such as in different years), then the results might be biased by population fluctuations. Refer to the RIC *Species Inventory Fundamentals* manual, Section 5.3 — Relative Abundance, and associated references for a thorough discussion of analysis of count data. Note particularly the potential for survey bias between habitat types and the potential problems that this may create in abundance comparisons. Different forest types and differences in vegetation density may affect both aural and visual detection of woodpeckers, creating perceived differences in abundance when there actually are no differences. Refer to Thompson *et al.* (1998) for further discussion.

Habitat based inference: Logistic regression or similar methods can be used to test for habitat associations, but this approach requires that habitat units be the primary sample unit as opposed to population units. Further modifications required for habitat inference are discussed in Sections 4.3 — Habitat Use and Selection and 4.4 —Making Habitat Inferences from Species Inventory of the RIC *Species Inventory Fundamentals* manual.

3.6.3 Absolute Abundance

Absolute abundance provides a population estimate expressed as number of individuals per unit area. As previously mentioned, this method requires species-specific detection coefficients or probability functions obtained from the relationship between number of detections and distance from observer. Since differences in species-specific detectability are accounted for, absolute abundance estimates may be compared among species within the same or different habitats (see Carey *et al*. 1991 for examples of statistical analyses used in a comparison of cavity-nesting bird densities in stands of different age classes and moisture regimes).

The statistical analysis of spot mapping data critically depends on two factors: First, the fractional territories at the boundary of the plot must be estimated carefully, since the edge effect will be substantial on small plots. Given that many woodpeckers have territories of 10 ha or even more, very large plots (B-BBWO and B-TTWO, B-PIWO) would have to be spot mapped. Second, at least two plots will have to be spot mapped in each habitat to obtain a measure of variation for statistical tests.

Absolute abundance estimates from spot-mapping are calculated by counting the number of complete and fractional territories per grid area. To do this, superimpose all detections of each species from successive censuses on a composite map. Delineate detection clusters (centers of territorial activity) based on the locations of nests, border disputes, concurrent territorial behaviour, etc. For fractional territories (*i.e.*, territories in which the boundaries do not lie entirely within the grid system), estimate the proportion of the total territory which is

within the grid boundaries. The estimated population size (P) per grid area is calculated by P= (C + FC) x 2, where C = the number of complete territorial clusters and FC = the sum of the proportions of each fractional territory located within the grid boundaries; the factor 2 represents a breeding pair. For example, if there are five complete territories and two fractional territories detected, with 0.5 and 0.75 of the territory area located within the grid system, respectively, then add these to generate 1.25 fractional clusters (FC) and five complete territories (C), for a total of 12.5 individuals per grid area. This calculation assumes that a population consists exclusively of mated pairs. If, from the composite map, it is obvious that there were one or more unmated territorial individuals repeatedly detected during censuses, modify the calculation accordingly.

There are possibilities of using individual territories as the sampling unit for absolute abundance measurements. If territories cover most of the landscape, the reciprocal of territory size may be an estimate of population density. The advantage of this approach is that sample sizes could be increased for a given amount of effort so that higher precision could be achieved. The disadvantage is the difficult assumption that woodpecker territories are spread evenly over the landscape, and this may require larger landscape evaluations to assess the validity of this assumption. In addition, this method might be sensitive to how well a territorial area was delineated.

If encounter transect distance methods are used, then program DISTANCE can be used for the analysis of absolute abundance. Encounter transects used with distance methods might provide better statistical data then spot mapping and this would have to be checked empirically. Refer to the RIC *Species Inventory Fundamentals* manual, Section 5.4.1 — Distance Methods, for further explanation.

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.

ABUNDANCE: a population estimate relative to area.

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.).

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

BIOGEOCLIMATIC VARIANT: a subdivision of a subzone that is slightly drier, wetter, snowier, warmer or colder within a subzone.

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

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

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

CALL STATION: a unique location from which woodpecker calls are broadcasted. These are usually spaced at equal distances along a encounter transect.

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 British Columbia; in addition, six supporting manuals.

DENSITY: the number of units per unit area.

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.

DIAMETER AT BREAST HEIGHT (DBH): tree diameter measured at 1.3 meter height on the high side of a tree.

DRUMMING: characteristic sounds broadcasted by various woodpecker species during courtship or territorial disputes.

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

ECOREGION: an area with major physiographic and minor macroclimatic oceanographic variation; there are 43 ecoregions in B.C., 39 of which are terrestrial

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

EWG (Elements Working Group): A group of individuals that are part of the Terrestrial Ecosystems Task Force (one of 7 under the auspices of RIC) which is specifically concerned with inventory of the province's wildlife species. The EWG is mandated to provide standard inventory methods to deliver reliable, comparable data on the living "elements" of BC'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.

GRIDLINES: systematically located straight lines within a study area.

GUILD: a group of species having similar ecological resource requirements or foraging strategies.

HAWKING: when a bird sallies from a perch on short flights to capture flying insects.

HOMOGENOUS HABITAT: habitat with similar physical or vegetative characteristics and species composition.

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.

KEYSTONE SPECIES: a species that influences other members of its community far out of proportion to its abundance.

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

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.

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).

PRISM: a fixed angle gauge instrument used to determine which trees are to be tallied and which are to be ignored in a wildlife tree variable radius plot survey.

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.

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

RELASKOP: a fixed angle gauge instrument used to determine which trees are to be tallied and which are to be ignored in a wildlife tree variable radius plot survey.

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

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

SECONDARY CAVITY NESTERS: birds species that nest or roost in tree cavities but are unable to excavate cavities themselves.

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.

STRUCTURAL STAGE: one of seven predefined successional stages of an ecosystem.

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

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

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

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

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

TRANSECT: a linear sampling unit that is traversed systematically on foot or with some other form of transport.

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

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