

WILDLIFE DATA CENTRE

FEATURED SPECIES – CANADA WARBLER

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Late to arrive in the spring and early to depart in the autumn, Canada Warbler (*Wilsonia canadensis*) (Figure 1) visits British Columbia for less than three months a year to raise a family before returning to its winter home in South America. This remarkable journey, over 18,000 km round trip, is completed annually by a little bird that weighs less than a tablespoon of sugar!

Canada Warbler is a fairly recent addition to the avifauna of British Columbia. During the early 1900s, this eastern warbler slowly expanded its range westward across Canada. In 1970 the first record for the province was obtained at Clayhurst, near the Alberta border, about 45 km east of Fort St. John. Over the next three decades this wood-warbler expanded its range to include much of the boreal forest regions of the entire northeastern portion of British Columbia. Today, pioneering birds are still dispersing into available habitats resulting in an increasing population that is dynamic and still settling in.

Very little is known about the breeding biology of this active wood-warbler anywhere in its North American range, so determining conservation priorities is a challenge. The species is inquisitive and spends much of its time foraging among dense tangles of shrubs in the forest understory, hence the colloquial name “Shadow Warbler”. During the first half of June, however, males are more visible as they sing from branches of the lower forest canopy. While



Figure 1. The Canada Warbler, first found in British Columbia in 1970, has expanded its range to occupy much of the northeastern portion of the boreal forest in the province. Doig River, BC. 2 June 2007 (Michael I. Preston). BC Photo 3543.

some Canada Warblers in British Columbia may be found in suitable habitat along roadsides (and can be encouraged to show themselves by “pishing”), most of the population inhabits more inaccessible terrain, where mixed stands of mature trembling aspen (*Populus tremuloides*) with a dense understory occur. These sites are often found on slopes.

Over the past 30 years or so populations in eastern portions of the Canada Warbler’s range have steadily declined, suggesting a need for effective management, monitoring, and stewardship programs. In British Columbia, populations are still increasing and may reach peak levels over the next few decades as suitable habitats become occupied.

Timber harvesting and forest fragmentation, oil and gas exploration with seismic line and well-site developments, mining, habitat conversion, Brown-headed Cowbird (*Molothrus ater*) parasitism, linear corridor developments (e.g., roads, railway tracks, pipelines, and transmission lines), silviculture practices, livestock grazing, prescribed fires, and chemical spraying all pose threats to Canada Warbler in British Columbia.

To bring attention to the significance of old and mature trembling aspen forests and mixedwood

stands for a suite of forest songbirds in northeastern British Columbia, we suggest that several “Songbird Reserves” be established in areas where bird communities are diverse, populations are high and stable, forest patch sizes are large and can withstand natural disturbances, and where habitats are of little economic interest (e.g., steep slopes). Furthermore, establishing a specific “Canada Warbler Reserve” (Figure 2) would be unique in the world, and would reinforce the conservation message that British Columbia is a proactive and conservation-conscious province.



Figure 2. Creating a “Canada Warbler Reserve” in British Columbia would be insightful and timely as the species is still expanding its range in the province, and the mature forested habitat it prefers is locally distributed and threatened by a host of human activities. This triangular strip of habitat (centre of photograph), between Andy Bailey Recreation Area and Jackfish Road, about 28 km southeast of Fort Nelson, has little commercial or residential value because of its steep slope. It does, however, have recreational potential for naturalists, as it is one of the few areas where Canada Warbler occurs in high density, and can be easily observed in safety, along with other neotropical species. 22 June 2007 (R. Wayne Campbell).

Wildlife Data Centre Provincial Status – 2007

Canada Warbler (Figure 3 and 4) is *A Species of Conservation Concern* in British Columbia. Although widely distributed throughout the entire northeastern portion of the province, this warbler’s prime habitat, mixed mature trembling aspen forests with a dense shrub understory, is patchily distributed. Canada Warbler is considered a “species of special concern” and is “Blue-listed” by the British Columbia government due to lack of data on ecology, distribution, population size, and uncertainties regarding effect of anthropogenic habitat changes. Despite the potential effects of forest and range management activities on Canada Warbler populations, the species has not been listed under the Identified Wildlife Management Strategy or the Category of Species at Risk, meaning the species is ineligible for protection measures available under the Forest and Range Practices Act of British Columbia. The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) recently commissioned a status report based on decreasing trends in eastern Canada originating from data in the North American Breeding Bird Survey (see “*Research and Monitoring of Canada Warbler in British Columbia-Breeding Bird Surveys*” on page 132).

In British Columbia the range continues to expand, and the population appears to be increasing.

At a Glance

Other names: *Canada Flycatching Warbler*, *Canada Flycatcher*, *Shadow Warbler*, and *Necklaced Warbler*.

Similar species: In British Columbia, some dull-plumaged female Canada Warblers may resemble a Nashville Warbler (*Vermivora ruficapilla*) or female Magnolia Warbler (*Dendroica magnolia*). Male Canada Warblers are distinct.

Adult male (Figure 3)

- yellowish eye-ring
- black necklace on yellow breast
- black markings on face
- bluish-gray upperparts

Adult female (Figure 4)

- yellowish eye-ring
- faded necklace on yellow breast
- gray markings on face
- bluish-gray upperparts

Length

12.0-14.6 cm (4.7-5.7 in)

Wingspan

15.4-19.7 cm (6.1-7.8 in)

Mass

9.7-12.5 g (0.34-0.44 oz)

Where and When

World Range

Canada Warbler breeds exclusively in North America. The range extends from extreme southeastern Yukon, southwestern Northwest Territories, northeastern British Columbia, northern Alberta, central Saskatchewan, central Manitoba, northern Ontario, south-central Quebec (including Anticosti Island), New Brunswick, Prince Edward Island, and Nova Scotia south to central Alberta, southern Manitoba, northern Minnesota, southern Wisconsin, northern Illinois (local), southern Michigan, northern Indiana (local), and southeastern Ohio (local), through the Appalachians to eastern Kentucky, eastern Tennessee, northwestern Georgia, western North Carolina, western Virginia, western Maryland, and east-central Pennsylvania, and to northern New Jersey, southeastern New York, and southern New England.

It winters in South America (rarely or casually in Middle America to Costa Rica) from northern Columbia and Venezuela south, mostly on the east slope of the Andes, to southern Peru and the border of southern Venezuela and northern Brazil (Tepu region), primarily from Venezuela and Columbia south through eastern Ecuador to central Peru.

British Columbia

Historical Status and Range Expansion: Canada Warbler entered British Columbia during its westward expansion across the northern boreal forests



Figure 3. Adult male Canada Warbler showing the distinct yellow eye-ring and black necklace on its breast. Moosehorn National Wildlife Refuge, ME, 21 June 2004 (Bob Steele).



Figure 4. Adult female Canada Warbler showing the distinct yellow eye-ring and grayish markings on face. Tamaulipas: Rancho Los Ebanos. 2 May (©G. Lasley/VIREO).

of the Canadian prairie provinces from its range in eastern Canada. By the early 1930s there were vagrant occurrences in northwestern Saskatchewan and northeastern Alberta. P.A. Taverner, in his book *Birds of Canada*, described the species' distribution as "Eastern North America. In Canada west to Manitoba and northwest to Lake Athabasca. Occasionally in

southern Saskatchewan and Alberta.” Over the next four decades, and through the mid-1970s, the species became established in northern Alberta. Ray and Jim Salt, in their book *The Birds of Alberta*, reported Canada Warbler as breeding in “northeastern and north-central Alberta, mainly in the areas drained by the Peace and Athabasca Rivers, and south to about Glenevis and Cold Lake.” Vagrants were also being reported in summer in western Alberta near the British Columbia border.

During the 1970s Canada Warbler remained a local breeding species in northeastern and north-central Alberta, being scarce anywhere else in the province. By the mid-1980s, Earl Godfrey, in his updated edition of *The Birds of Canada*, extended the breeding range in boreal forest regions across northern Alberta and into British Columbia on the basis of new information from northeastern British Columbia.

Botanists reported the earliest record for British Columbia from the University of British Columbia during a summer collecting trip in trembling aspen communities on the slopes of the Peace River in June and July 1970. The following year the area would be established as the Clayhurst Ecological Reserve, the province’s eighth ecological reserve (Figure 5). Until this occurrence was uncovered in herbarium collections the first record for the province was



Figure 5. Inadvertently, field work by botanists working to create an ecological reserve that included eroding bluffs, grassland plant communities, and trembling aspen copses along the banks of the Peace River near Clayhurst, led to the first record of Canada Warbler in British Columbia in 1970. July 1978 (R. Wayne Campbell).

reported in 1974 by ornithologist Anthony J. Erskine in the vicinity of Fort Nelson. During the remainder of the 1970s Michael G. Shepard confirmed the warbler’s presence at Clayhurst, Chris Siddle found the species at St. John Creek near Fort St. John, and breeding was confirmed in the town of Fort Nelson and near Clarke Lake to the southeast (Figure 5).

During the 1980s Canada Warblers were being reported from many new areas that formerly did not have them. These included the canyons of the Pine River, Beaton Park, trembling aspen forests on the outskirts of Fort St. John, and along Johnson Road and Peace Island Park Road south of Taylor. In the late 1980s naturalists visiting from Alberta found Canada Warbler “regularly” in the vicinity of Swan Lake near the British Columbia-Alberta border, at that time the southern limit of the species’ range in British Columbia. Small pockets of warblers were also found in 1988 and 1989 near Hudson’s Hope, the western limit of their range expansion. In the Fort Nelson area the species was now regularly found in suitable habitat along the road to Kotcho Lake and Yoyo (Figure 6). Occurrences northward, towards the Yukon Territory border, were lacking despite field work by biologists and many birding trips by naturalists. The first vagrant occurrence was reported from Pitt Meadows on 23 May 1983.

Canada Warbler further expanded its range throughout the 1990s and locally began to saturate established ranges. It was found in the vicinity of Sikanni Chief River and Gutah and Kenai creeks in the Boreal Plains ecoprovince. The southern expansion now reached Sukunka River and Kelly Lake. By 1998 Canada Warbler had settled in trembling aspen forests near Liard River Hot Springs Park in the north but may have arrived earlier as the species was first recorded in the Yukon Territory in 1995. Canada Warbler was considered a vagrant summer visitor in southwestern Northwest Territories prior to 1997, but has since been recorded every year, with numbers varying annually on Breeding Bird Survey routes (C. Machtans pers. comm.). Additional vagrant occurrences in British Columbia were reported from the Bulkley River near Smithers (1999) and at Jordan River (1995) on the extreme southern end of Vancouver Island (Figure 7).

With increasing concern about the current status

of Canada Warbler in British Columbia among biologists and conservationists, intensive fieldwork from 2000 to 2007 revealed the species, as suspected, in many new pockets of its existing range (Figure 6). It had also reached the British Columbia-Yukon Territory border just southeast of Watson Lake. Another vagrant was captured in a mist net and banded near Mackenzie towards the south end of Williston Lake (see Figure 43 on page 120).

Current Status: In the 1970s, Canada Warbler was considered a “Peripheral Species” because there were so few records. Presently, populations are expanding and increasing in suitable habitat throughout northeastern British Columbia, including much of the Boreal Plains and Taiga Plains ecoprovinces. Here the species is a fairly common migrant and local summer visitant. Elsewhere in the province it is a vagrant.

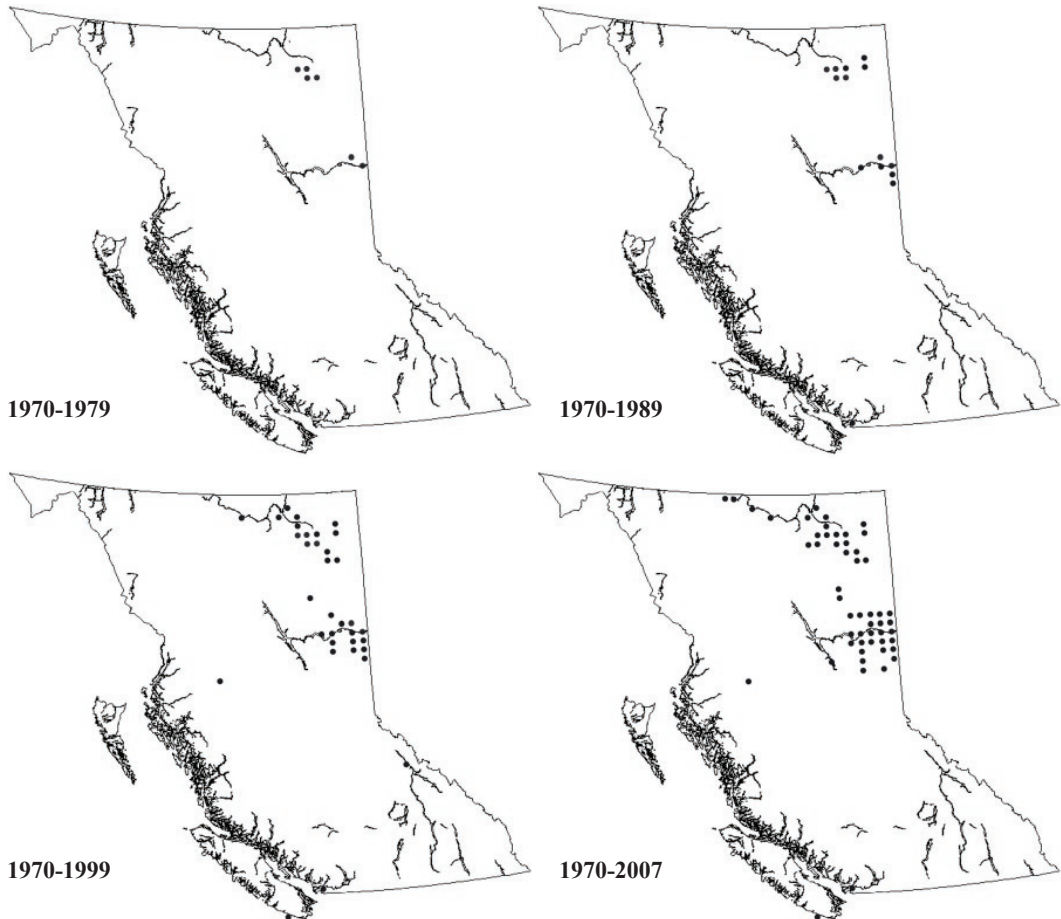


Figure 6. Range expansion, and local change in distribution, by decade, for Canada Warbler in northeastern British Columbia, 1970-2007. Records for each decade are cumulative.

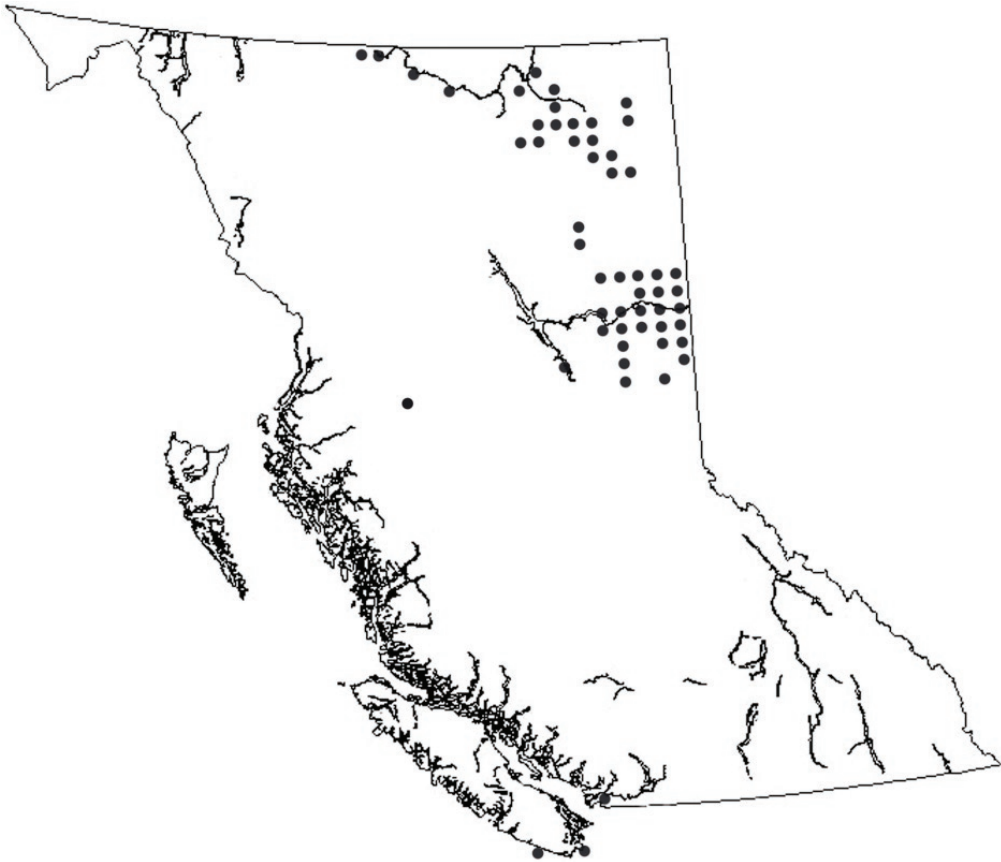


Figure 7. Locations (dots) of confirmed Canada Warbler occurrences in British Columbia, 1970-2007.

Occurrence: Canada Warbler is distributed widely, but patchily, in trembling aspen forest components, throughout most of northeastern British Columbia (Figure 7). This vast region includes Swan Lake (near the British Columbia-Alberta border), Dawson Creek, west to Chetwynd, north through Hudson's Hope, Fort St. John, Sikanni Chief River, Kotcho Lake, Fort Nelson, Liard Hot Springs, and Fireside to the British Columbia-Yukon Territory border. The distribution in the extreme northeastern portion of the province is unknown. It is known to occur from 237 to 1100 m (777 to 3,608 ft) above sea level.

The centre of abundance presently occurs in the vicinity of the Fort Nelson Lowland ecoregion.

There are four records of vagrants: Mackenzie (central interior), Bulkley River (near Smithers), Pitt Meadows (Lower Mainland), and Jordan River (southern Vancouver Island).

The monthly distribution for all records compiled for Canada Warbler in British Columbia, from 1970 through 2007, for the main period of occupancy in the province, is shown in Figures 8 to 11. The general status and distribution are discussed in each of the following figure captions.

Figure 8. May: First arrivals have been found on 22 May but most appear on their southern breeding grounds later in the month. In more northern regions, including the Taiga Plains ecoregion, many birds

have not yet arrived. Males are in full song soon after arriving on territories.

Figure 9. June: By June much of the Boreal Plains ecoprovince is occupied with territorial males and arriving females. In early June, warblers in southern areas are starting to nest and may have nestlings by mid-month which fledge later in the month. A few late migrants arrive to breed or move northward into the Fort Nelson and Liard River areas. Breeding here may start by mid-month. The widest distribution occurs in this month.

Figure 10. July: In southern areas nesting is usually completed and some southward migration, and local dispersal, probably occurs. Most adults are busy feeding young but family groups do not spend much time together. By the end of the month the nesting cycle is also completed in northern areas.

Figure 11. August: Southward departure occurs mainly during the first half of the month with few warblers remaining by the third week. Males are mostly silent during this period and departing birds are usually found foraging and moving along the riparian shrubby shores of streams and rivers, as well as the shrubby edges of corridors and forests. The breeding range is starting to look quite vacant.

Two of the four vagrants have been reported in this month, a bird banded at Mackenzie (see Figure 43) and a single bird observed gleaning in birches along the Bulkley River. The latest departure date for British Columbia is 28 August.

Breeding: Canada Warbler probably breeds in suitable habitat throughout the Boreal and Taiga Plains ecoprovinces in northeastern British Columbia (Figure 12). Nests with eggs, recently fledged young, and adults feeding recently fledged Brown-headed Cowbirds, have been recorded near Swan Lake, Bear Mountain, Taylor, Brassey Creek, Arras, Wildmare Creek, Jackfish Lake, Moberly Lake, Farrell Creek, Clayhurst, Andy Bailey Lake, Clarke Lake, Fort Nelson, and Liard River Hotsprings Park. There are a few other sites where adults have been observed carrying food but nesting was not confirmed.

Habitat

Migration

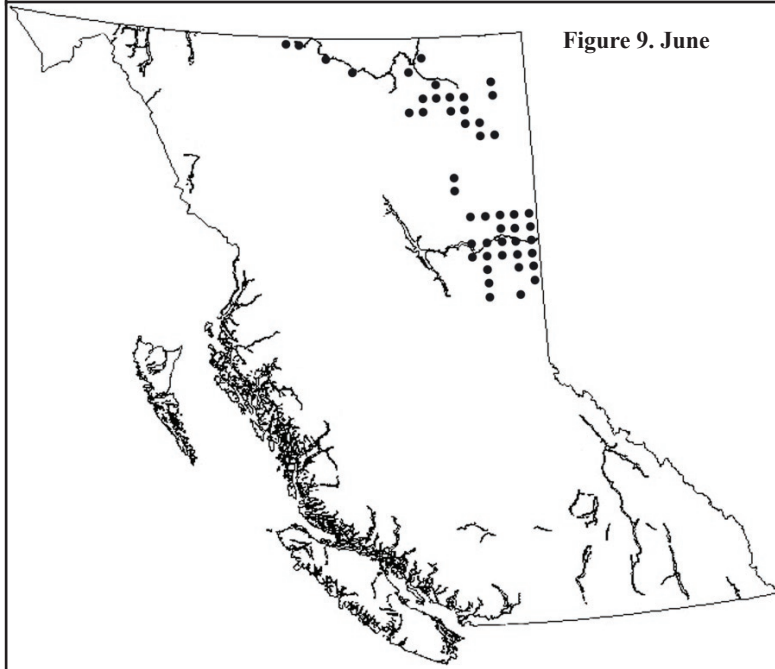
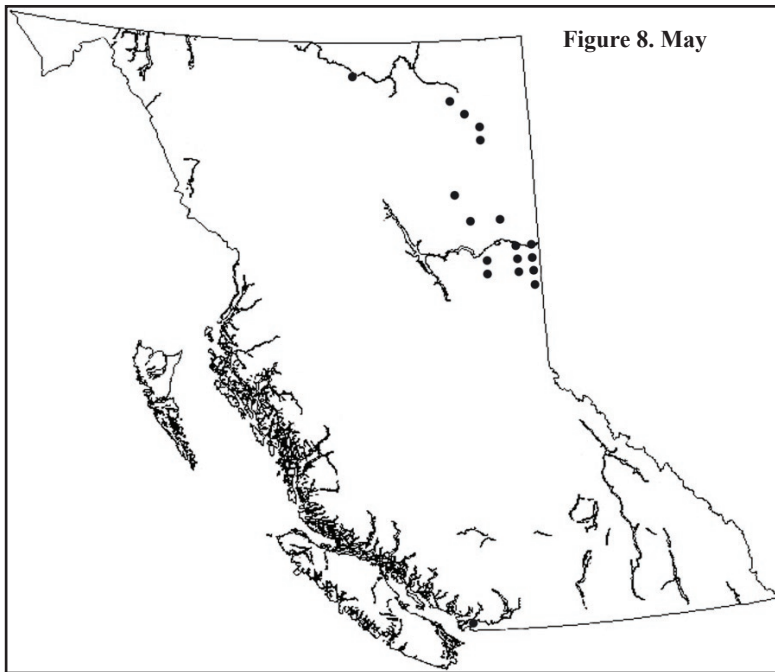
Habitats frequented by Canada Warbler entering the province during spring migration and departing after the breeding season are poorly documented. It is assumed birds enter the province from northwestern Alberta and leave using the same route, therefore spending little time in habitats that differ significantly from their breeding grounds.

Early spring and late summer habitats noted in British Columbia include the shrubby edges of pure and mixed stands of trembling aspen (including a coniferous component) sometimes associated with wetlands (*e.g.*, marshes and sloughs) and river banks. Other specific nonbreeding habitats include the shrubby edges of transmission corridors (Figure 13), parking lots, flood plains, seismic and pipeline corridors, roads, railway right-of-ways, and lakeshores.

Breeding

In 1957 Alexander Sprunt wrote, in *The Warblers of North America*, “*The Canada Warbler is a dweller in the mixed coniferous and deciduous forests. In the north, it lives right in the forest rather than at the edge, but it usually selects some little glade into which the sun’s rays penetrate to brighten the gloom of the more deeply shaded surroundings.*” This delightful description provides a vision of the bird’s summer home in northeastern North America, but it also might explain why ornithologists have overlooked this forest bird (*e.g.*, out-of-sight, out-of-mind) until recently.

In eastern Canada and the northeastern United States Canada Warbler inhabits a variety of lowland and upland habitats but prefers mixed forests rather than pure hardwood or conifer stands. In this region, wet forests, old and naturally disturbed forests, and regenerating forests are utilized for breeding. In Maine and Vermont, highest numbers were found in medium-aged mixedwoods (20-60 years old) more than in mid-to late-successional forest types. Lowest numbers were found in medium-aged and mature hardwoods (60-100 years old). The species reaches maximum abundance where there is a low (2-6 m) dense shrub layer.



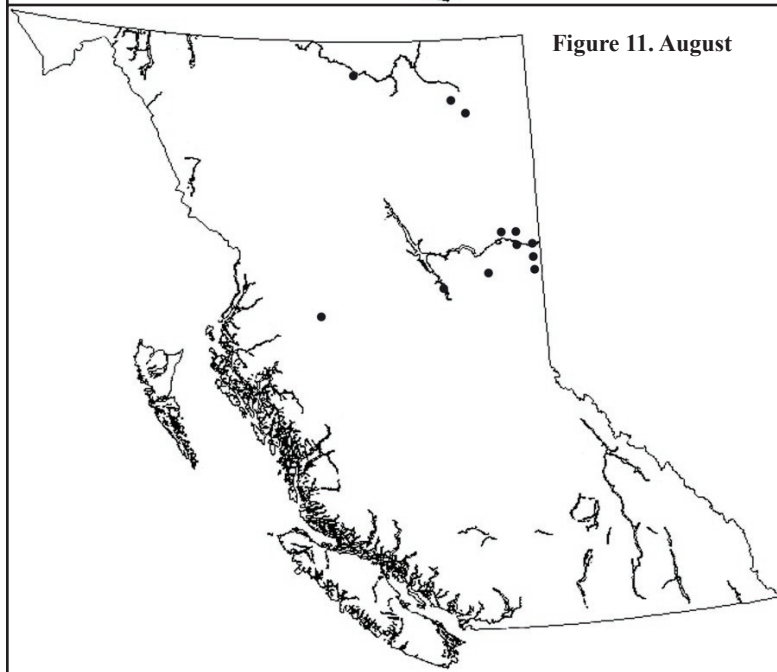
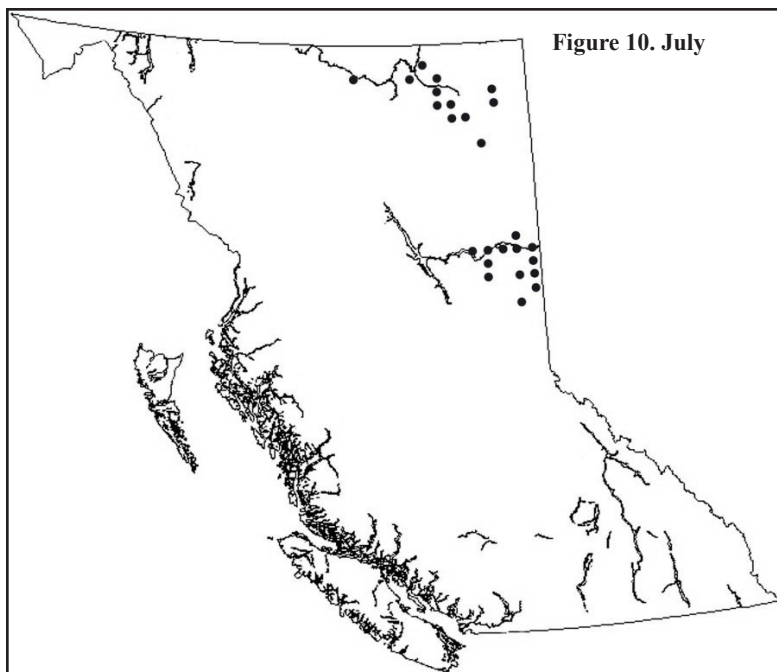




Figure 12. Breeding distribution (dark) of Canada Warbler in British Columbia.

In western Canada mixedwood breeding habitats appear to be less important. In Saskatchewan one study found Canada Warbler almost exclusively in pure trembling aspen stands while in Alberta the species was found in equal abundance in deciduous stands and in mixedwoods dominated by white spruce (*Picea glauca*).

In British Columbia, habitats also vary throughout the warbler's range (Figure 14). We have extracted descriptions from published works, and unpublished reports, and listed the important components below,



Figure 13. The mixed forested edges of transmission corridors are used by migrating Canada Warblers each year throughout the Peace River region. Near Gwillim Lake, BC. 5 July 2003 (R. Wayne Campbell).



Figure 14. In 1978, eight years after its arrival in British Columbia, Canada Warbler was found breeding at the garbage dump in Fort Nelson. 10 July 1978 (R. Wayne Campbell).

hoping that common characteristics may emerge to link some of the critical components of the bird's habitat. Each location and habitat description includes a reference since more detailed information may be available for regional management concerns.

1) British Columbia (Campbell et al. 2001):

"Most summer records of this warbler in the Boreal Plains and Taiga Plains are from stands of mixed paper birch, trembling aspen, balsam poplar, and alders with a minor amount of white spruce. These stands are usually on slopes or hillsides or in gullies [Figure 15]. Sites can be either wet or dry, but there is always a rich understory, often with red-osier dogwood."

2) Clayhurst Ecological Reserve (Mark Phinney, pers. comm.):

"...mature stand of willow and balsam poplar with tangle of undergrowth on bottomland within 100 metres of the bank of the Peace River."

3) Dawson Creek (Phinney 1998):

"...found in moist deciduous or, more often, mixedwood forests [Figure 16]. It is invariably associated with a tall, dense shrub layer."



Figure 15. In the 1970s, and early 1980s, slope seemed to be an important attribute of the habitat occupied by Canada Warbler each summer. Much of the bird's potential habitat, mature pure deciduous and mixed deciduous/coniferous stands, has not been explored. Gwillim Lake, 16 June 2003 (R. Wayne Campbell).



Figure 16. Moist, mixedwood forest, with a dense understory of green alder, is typical breeding habitat for Canada Warbler near the BC-Alberta border. Swan Lake (Road 201), BC. 2 June 2007 (R. Wayne Campbell).

4) Fort Nelson (Erskine and Davidson 1976):

“...all in dense subcanopy of a mature [balsam] poplar stand near Mile 320.”

5) Jackfish Lake near Chetwynd (Campbell 2005):

“The general habitat consisted of a young mixed-aged stand of black spruce (*Picea mariana*), trembling aspen (*Populus tremuloides*), balsam poplar (*Populus balsamifera*), and white birch (*Betula papyrifera*) on a gentle forested slope leading to a lake [Figure 17]. The nest itself was in the centre of a 3.4 m tall, very dense shrub patch composed of willow (*Salix* sp.), Saskatoon (*Amelanchier alnifolia*), red-osier dogwood (*Cornus stolonifera*), prickly rose (*Rosa acicularis*) and fringed with tall grasses and cow-parsnip (*Heracleum lanatum*). The nest was on the ground among woody debris and fallen leaves at the base of a small prickly rose shrub.”



Figure 17. A Canada Warbler nest containing eggs was discovered in this mixed deciduous forest with a nearly impenetrable understory of green alder, red-osier dogwood, and prickly rose. Jackfish Lake, BC. 25 June 2006 (R. Wayne Campbell).

6) Liard River or “Big-Bend” (Bennett and Enns 1996):

“Most records of Canada Warbler (78%) were in mixed deciduous upslope cover types with 40-90% aspen understory and a relatively tall (1.5-2.0 m),

thick understory layer consisting of prickly rose, high-bush cranberry, and alders. The density of Canada Warblers per 100 m was at least two times higher in the deciduous upslope cover type. Immature deciduous riparian had the next highest densities of Canada Warblers but these records may be misleading. The three records of Canada Warblers in immature deciduous riparian habitat were in young birch thickets at the edge of the Liard River. These records were approximately 200-400 m from aspen-dominated stands with a thick understory, where the majority of Canada Warblers were recorded. The records in the immature deciduous riparian cover type likely indicate vagrants from the mature stands or individuals moving between mature deciduous stands. The densities of Canada Warblers ... were the highest of the 10 species recorded in the deciduous upslope habitat and 19th highest out of the 39 species in the mixed upslope habitat.”

7) Prophet River Indian Reserve (Savignac 1998):

“...was one of the rarest birds sampled with only one singing male in an open mature aspen stand and one inside the Reserve near a house (probably a non-breeder).”

8) Sikanni Chief River (Greenfield 1998):

“The species displayed a very specific habitat preference. It was recorded only in the understory shrubbery on the steep slopes of the major watercourses.”

9) South Peace (south of the Peace River) (Mark Phinney, atlas in preparation):

“...most often found in mature or old mixedwood or deciduous forest, near gaps in the canopy. Invariably, a dense tangle of tall shrubbery (often alder or willow) defines the location. These sites were often (but not exclusively) on sloping ground and were nutrient rich and/or moist. Scattered white birch trees were present at many locations. Extensive agricultural landscapes were generally avoided, as were dry uplands and unbroken conifer forest.”

10) Taylor and Fort Nelson (Siddle 1992b):

“...occurs in the red-osier dogwood understory present beneath mixed mature forests of trembling aspen, balsam poplar, white birch, white spruce, and sometimes alder edge. White birch seems to be present. Usually such forests grow on north-facing slopes along the south bank of the Peace River [Figure 18]. The species occupies the same type of forest around the Fort Nelson airport.”



Figure 18. The wooded slopes along the banks of the Peace River, south of Taylor, BC, support populations of Canada Warblers, but the area has not been thoroughly investigated. West of Taylor, along the Peace River, some Canada Warbler habitat will be destroyed by the Site C dam being proposed by BC Hydro. 9 June 2007 (R. Wayne Campbell).

Quantifying “Suitable” Habitat for Canada Warbler in British Columbia

There is little quantitative information regarding the types and amounts of different forest structures required by Canada Warbler in British Columbia. In this section, we summarize new habitat data gathered from 103 of 108 sites occupied by Canada Warbler in 2007. The locations of data collection were mainly in the vicinity of Dawson Creek, Hudson’s Hope, Fort St. John, Fort Nelson, Laird Hot Springs, and the BC-Yukon border. The assessment was not meant to be an exhaustive evaluation of all vegetative characteristics. Instead, the focus was on estimating percentage cover of different tree species, tree diameter at breast height (dbh), canopy cover, prevalent shrub species, shrub cover, shrub height, percentage cover and species of small (< 50 cm) non-woody plants, coarse woody debris, and slope, and evaluating the potential importance of each. Measurements of these habitat attributes were recorded from where the bird was first observed, using circular plots with an approximate radius of 10 m.

While this overview helps toward understanding which general forest structures are most important for predicting Canada Warbler habitat requirements in British Columbia, rigorous and systematic research is needed. An important step forward will be to design focused studies that properly measure forest structures from fixed-area plots in sites that are both occupied and unoccupied by Canada Warbler. Only then will robust statistical tests be able to investigate which forest structures are most important, and at which scale (*e.g.*, site, stand, landscape) management may be most effective.

Size and Species of Tree

Hardwoods, primarily trembling aspen, and occasionally balsam poplar or birch, were the characteristic trees of sites occupied by Canada Warbler in northeastern British Columbia (Figure 19). Of the 103 sites measured, 78 were composed of 80-100% hardwoods, 19 sites had 60-79% hardwoods, and 6 sites had 40-59% hardwoods (Figure 20). Trembling aspen was recorded in every site, whereas balsam poplar ($n = 44$), and birch ($n = 33$) were



Figure 19. Mature hardwood stands, and less often mature mixedwood stands, are the preferred habitat of Canada Warbler in British Columbia. Andy Bailey Lake, BC. 16 June 2007 (R. Wayne Campbell).

recorded less often. White spruce, the dominant conifer in occupied sites, was measured from 84 sites, whereas lodgepole pine (*Pinus contorta*) was observed in only four sites (Figure 21).

Trembling aspen was almost always the primary canopy species (99.02%; Figure 22), having a mean diameter at breast height (dbh) of 24.7 cm (Figure 23) among sites. When white spruce was present, it was always as a secondary species, and always had a smaller diameter and lower crown height than trembling aspen (mean = 19.6 cm dbh; Figure 23). There were only four sites that were dominated by spruce (Figure 24), suggesting that as white spruce becomes the dominant species in the stand, the site gradually becomes less suitable for Canada Warbler. The youngest occupied site had a mean dbh of only 7.8 cm (~20-25 years; Figure 25), whereas the second youngest site was somewhat older (mean dbh = 11.8cm; ~30-35 years).

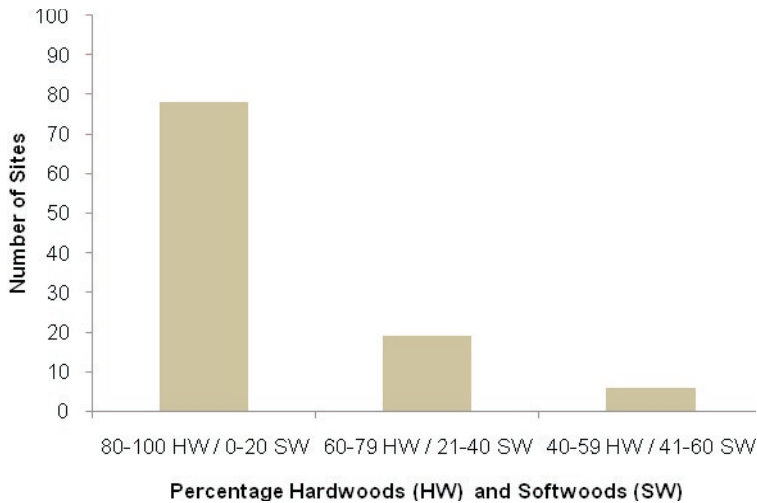


Figure 20. Percentage classes of hardwood (HW) and softwood (SW) trees characterizing sites occupied by Canada Warbler (n = 103).



Figure 21. North of Lower Post, near the BC-Yukon Territory border, Canada Warblers were rarely found in mature mixedwood stands of trembling aspen, white spruce, and lodgepole pine. 19 June 2007 (R. Wayne Campbell).

Canopy Cover

Canopy cover, defined here as the amount of foliage covering the sky when looking upwards, has profound effects on understory vegetation. In newly seeded or planted sites, canopy cover is essentially zero. Depending on soil and drainage characteristics, these sites are quickly colonized by species adapted to abundant sunlight. As the stand matures, the amount of sunlight reaching the forest floor is reduced, often resulting in less moisture loss from the soil. Species such as white spruce, and a variety of shrubs and non-woody plants are adapted to these conditions, and so single-layer sites dominated by trembling aspen often become diverse, multi-layered mixedwood stands through time. Furthermore, as trees blow over, or die and lose their leaves, patches of sunlight reaching the forest floor contribute to new plant growth, further adding to a structurally diverse forest.

Among sites occupied by Canada Warbler, canopy cover was moderately-open (15-40% cover; Figure 26) to moderately-closed (60-80% cover; Figure 27). Mean canopy closure was 62.0%, whereas the median cover class was 71% (67.5-74.5%; Figure 28). While within-stand patchiness of canopy cover is difficult to measure (*i.e.*, some areas closed, other



Figure 22. Mature stands of trembling aspen, with tree diameters averaging 25 cm dbh ($n = 103$), were the most typical stands occupied by Canada Warbler. Near Tommy Lakes, BC. 11 June 2006 (Michael I. Preston).

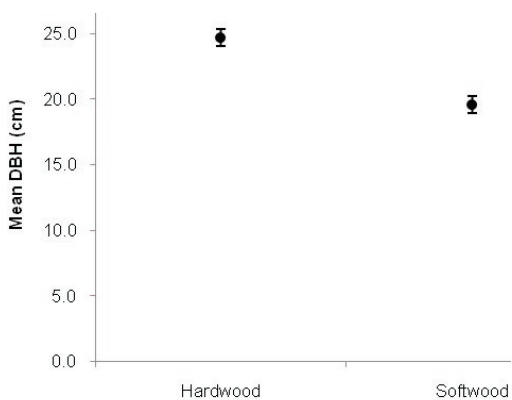


Figure 23. Mean diameter at breast height (dbh) of hardwood and softwood trees in sites occupied by Canada Warbler in northeastern British Columbia.



Figure 24. Only occasionally do Canada Warblers occur in mature white spruce-dominated stands interspersed with mature trembling aspen. Near Clarke Lake, BC. 23 June 2007 (R. Wayne Campbell).



Figure 25. Canada Warblers are usually associated with older forests, but this younger stand of trembling aspen and balsam poplar, with a fairly open understory of willow, was occupied in 2007. Doig River, BC. 12 June 2007 (R. Wayne Campbell).



Figure 26. Mature trembling aspen stand with low density white spruce with a moderately open canopy (~25-30% overall). Near Wonowon, BC. 30 May 2007 (Michael I. Preston).



Figure 27. Mature trembling aspen stand with moderately closed canopy (~60-65% overall), but more patchy than uniform. Doig River, BC. 2 June 2007 (Michael I. Preston).

areas open), stands with patchy canopies seemed to be used more often than stands with uniform or homogeneous canopies.

While canopy cover is a surrogate estimate of light accessibility to the forest floor, it often does not reveal much about the vertical complexity of stands. For example, younger hardwood forests often have a simple canopy structure with little to no lower or mid-canopy branches or trees (Figure 29). As the stand becomes more mature (and undergoes thinning through competition), shade-tolerant or gap-filling trees become established, thus adding to the vertical complexity of the stand. Canada Warblers appear

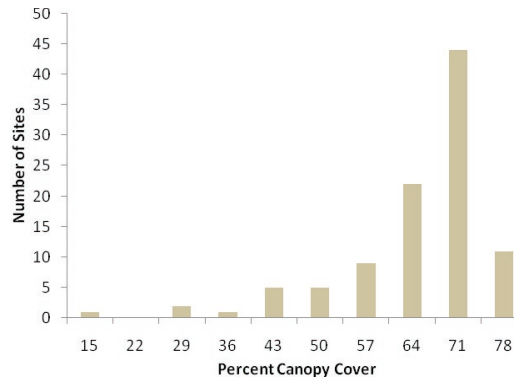


Figure 28. Frequency distribution of percentage canopy cover (mean) as determined by evenly distributed classes over the range of observed values (e.g., 71% class represents the number of sites with 67.5-74.5% cover).

to prefer stands that are simpler in terms of vertical structure. However, because increasing vertical structure is often correlated with the in-growth of secondary succession species in many of the sites we measured, it is difficult to ascertain whether Canada Warblers prefer stands with a simple vertical structure, or whether they avoid stands with an increasing prevalence of secondary succession white spruce.



Figure 29. The space between the lower leafy branches of trees and the upper limit of the shrub understory appears to be an important habitat characteristic for singing male Canada Warblers. South of Swan Lake (Road 201), BC. 2 June 2007 (R. Wayne Campbell).

Understory Shrubs and Plants

Shrub cover, height, and species appear to be important attributes in stands occupied by Canada Warbler in British Columbia. On average, shrub cover was 79% (min. = 20%, max. = 95%, median = 80%), with 80% of all sites having shrub height ranging from 2.5 to 3.5 m (Figure 30). Green alder (*Alnus viridis*) was the most common shrub species in Canada Warbler sites (Figure 31), and when viewed from the side, the stands often had a well-defined shrub layer that was distinctly separate from the upper canopy (Figure 32). In a separate study conducted by Michael Preston in 2007, mature trembling aspen stands with low density white spruce and no understory (n = 10; Figure 33) did not attract any Canada Warblers.

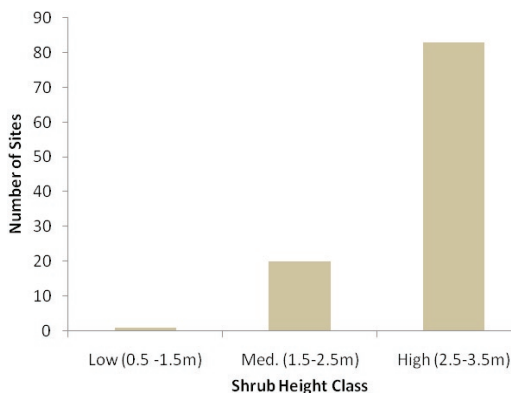


Figure 30. Prevalence of different shrub height classes among sites occupied by Canada Warbler in British Columbia.

Green alder was the most prevalent shrub species, occurring as a primary shrub in 76% of all sites, followed by willow, rose (*Rosa* sp.), tree saplings, and Saskatoon (*Amelanchier alnifolia*) (Figure 34). The presence of a secondary shrub species was common (n = 98 sites), with willow being the dominant secondary shrub (49%), followed by tree saplings, rose, red-osier dogwood (*Cornus stolonifera*), and mountain ash (*Sorbus* sp.). Green alder only occurred as a secondary shrub in 7% of all sites, and as a tertiary shrub in only 2% of all



Figure 31. Green alder, characterized by broadly elliptical leaves fringed with fine, sharp teeth, is the most common understory shrub associated with Canada Warbler occurrence in British Columbia. Andy Bailey Lake, BC. 22 June 2007 (R. Wayne Campbell).

sites. Overall, tertiary shrubs were found in 50% of all sites, but accounted for no new additional shrub species.

Non-woody plants < 50 cm tall were abundant, and on average covered about 73% of the forest floor. Typical plants included bunchberry (*Cornus canadensis*), kinnikinnick (*Arctostaphylos uva-ursi*), horsetail (*Equisetum* sp.), fireweed (*Epilobium angustifolium*), grasses, mosses, cow-parsnip (*Heracleum lanatum*), ferns, lily-of-the-valley (*Maianthemum canadense*), and twinflower (*Linnaea borealis*). Dead leaves and other decomposing material were infrequently recorded, likely owing to the short-lived visibility of these elements as they are broken down quickly.

Coarse Woody Debris

Coarse woody debris, also known as downed logs, down woody material, woody detritus, and logging residue, is utilized by many species of birds, mammals, reptiles, amphibians, insects, and plants in different ways, and is an important structural feature of forested ecosystems (Figure 35). For birds, coarse woody debris can be a source of food via the insects and plants it hosts, as well as a source for protective cover against weather (e.g., rain, hail, or temperature extremes) and predators, and provision of nesting sites.



Figure 32. Green alder, often appearing as a well-defined layer, was the predominant shrub species occurring in Canada Warbler sites in British Columbia. 300 Road off the Alaska Highway near Buick, BC. 6 June 2007 (Michael I. Preston).

In British Columbia it is unclear how important coarse woody debris may be for Canada Warblers. Very few nests have ever been found, but from the ones that are known, at least one was located under the edge of a fallen log (see Figure 41 on page 119). Individuals undoubtedly use fallen logs for foraging, and on occasion may use them as singing perches, sites for copulation, or for sources of nest material. Among 103 sites measured for structural attributes, coarse woody debris was observed in every site. The mean number of pieces per 10 m² was 7 (min. = 2, max. = 24), but data pertaining to the diameter and length (*i.e.*, volume) was unavailable. The characteristics of coarse woody debris (*i.e.*, stage of decomposition), and its importance to Canada Warblers for feeding and nesting, may be important in the development of an effective management strategy for this species in British Columbia.



Figure 33. Mature trembling aspen stand with low density white spruce and virtually no understory appear unsuitable for Canada Warblers in British Columbia. Haystack River, BC. 22 May 2006 (Michael I. Preston).

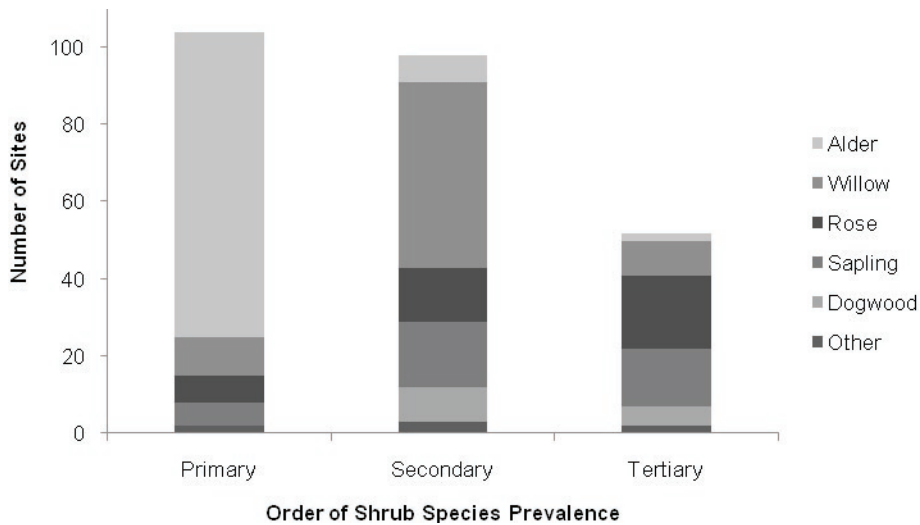


Figure 34. Order of within-site shrub prevalence, and number of sites with different shrub species. The “other” class includes mountain ash and Saskatoon, and accounts for < 5% of all shrub cover. Order of shaded bars follows the order in the legend, from top to bottom; there were no “other” shrubs in the primary category.



Figure 35. Fallen logs, branches, and other woody debris on the forest floor may be an important component of Canada Warbler habitat. Andy Bailey Lake, BC. 16 June 2007 (R. Wayne Campbell).

Slope

Northeastern British Columbia is characterized by extremes in topography, ranging from virtual flatness in areas around Dawson Creek and Fort St. John, to extreme slopes along the edges of deeply eroded river banks and where the Rocky Mountains dominate the northwestern edge of the boreal region. There is insufficient data to conclude that slope is of major importance to Canada Warbler site occupancy. Of the 103 sites measured in 2007, mean slope was 17 degrees. However, the range was large, and varied from 0 (n = 43 sites; 41%) to 75 (n = 1 site; 1%) degrees. Because the majority of sites had gentle slope, micro differences may be important (*i.e.*, one to five degrees). However, this could not be discerned from the 2007 dataset as slope was measured only to the nearest five degrees. Furthermore, it may not be the slope itself that is important, but rather the conditions created by sloping ground (*e.g.*, moist, nutrient-rich sites with lush understory growth).

Annual Occurrence

Canada Warbler is a migrant and summer resident in British Columbia and one of the latest birds to arrive in the spring and earliest to depart in the autumn. The summer period, mid-June through late July, is the main residence period, although most records are in June when the peak of singing activity occurs (Figure 36).

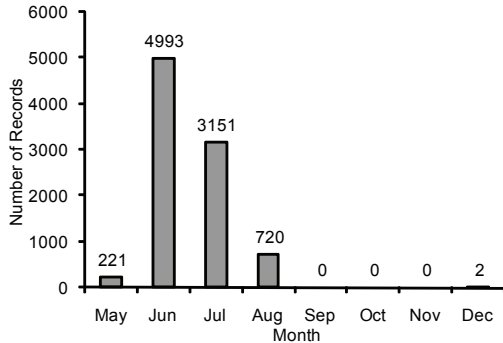


Figure 36. Total occurrence records, by month, for Canada Warbler in British Columbia, 1970-2007.

Canada Warbler has been recorded from 22 May (Taylor) to 28 August (Beaton Park), a total of 99 days, although in most years the length of stay in its summer range averages about two and a half months (Figure 37). There is a single winter record from Jordan River (2 and 3 December 1995) on southern Vancouver Island.

The breeding period, from first egg to latest fledging, occurs from 29 May to 25 July (Figure 37).

Figure 37. Annual occurrence and breeding chronology of Canada Warbler for British Columbia. Thick bars: common; Thin bars: uncommon; Dots: rare.



Migration

Canada Warbler is a long distance neotropical migrant arriving in British Columbia from wintering grounds in South America. The species is primarily a summer resident in the province arriving in spring and departing in autumn each year. Small numbers of birds probably migrate through northeastern British Columbia to reach the limits of their range in southern Yukon Territory and Northwest Territories. Arrival dates in spring are better recorded because of singing territorial males. In late summer, the species simply “disappears” and therefore is less recorded (and less searched for) so departure dates are poorly documented.

Canada Warblers appear in British Columbia during the last few days of May and the first few days of June each year. The earliest and latest arrival dates are 22 May and 4 June respectively (Table 1). The average arrival date for the 37 years the warbler has been recorded in the province is 30 May.

It is assumed that birds arrive in northeastern British Columbia from boreal forest regions in adjacent northwestern Alberta as southern areas of Alberta are by-passed by migrants. First spring arrival dates for the decade 1971-1980 in northwestern Alberta ranged between 25 and 29 May, consistent with arrival times in British Columbia (Table 1).

In autumn, Canada Warblers may frequent the shrubby edges of forests and corridors where they are visible but most birds remain difficult to spot or may depart in darkness because they are nocturnal migrants. Most warblers probably depart during the second and third weeks of August (Table 2). There are no September records. In Alberta the main passage occurs between 12 and 20 August.

Since most spring migrants arrive on their breeding grounds in a narrow window of time, changes in average arrival dates over 28 years vary little (Table 3). It appears that birds arrive on nesting grounds in far northern British Columbia slightly

Table 1. Early, late, and average arrival dates for Canada Warbler in select regions of northeastern British Columbia, 1981-2007. Locations are listed from south to north. The average date was calculated by using Julian days (1 Jan = 1; 31 Dec = 365) and then back-converting to a Gregorian (modern) calendar date.

Location	Period	Total Years ¹	Spring Arrival		
			Early	Late	Average
Swan Lake ²	1987-2007	14	26 May	2 Jun	29 May
Dawson Creek ³	1988-2007	10	26 May	2 Jun	30 May
Taylor ⁴	1981-2007	19	22 May	1 Jun	28 May
Fort St. John ⁵	1982-2007	9	25 May	1 Jun	29 May
Clarke Lake ⁶	1981-1995	12	28 May	4 Jun	31 May
Fort Nelson ⁷	1982-1995	8	29 May	2 Jun	31 May
Liard Hot Springs	1998-2001	4	31 May	4 Jun	2 Jun

¹Number of years first spring migration date was recorded.

²Includes BC/Alberta border, Highway 52, One Island Lake Road, Road 201, Swan Lake area.

³Includes Bear Mountain, Brassey Creek, Briar Ridge, Fellers Heights, Pouce Coupe, Dawson Creek area.

⁴Includes Johnson Road, Peace Island Park, Peace Island Park Road, and Taylor area.

⁵Includes Beaton Park, Beaton River, Charlie Lake, Fish Creek, St. John Creek, and Fort St. John area.

⁶Includes Clarke Lake Road from Highway 97 (south of Fort Nelson) east to Kotcho Lake and Yoyo.

⁷Includes Fort Nelson landfill and airport, Muskwa, Old Fort Nelson, Parker Lake, “Poplar Park” (Figure 38).



Figure 38. Infrequently Canada Warblers can be found in a dense tangle of underbrush in a mature stand of balsam poplars, locally known as “Poplar Park”, located off Highway 97 about 4.3 km south of Fort Nelson. 16 June 2007 (R. Wayne Campbell).

later than for southern areas. In autumn, however, departures are increasingly later over the 28 years but this may reflect the recent conservation interest in the species and the challenge to find the “last” bird of the year.

Length of Stay

The length of time Canada Warblers remain in northeastern British Columbia each year as summer visitors has ranged from 63 to 95 days with an average of 75 days or about two and a half months. (Table 4). This may be the shortest period of occupancy for any of the 312 species breeding in the province.

The average length of stay for seven locations by decade, from 1980-2007, generally showed an increasing trend (Table 5). The Swan Lake area, best represented for the 38-year period, showed an increase of seven days. Information has not been consistently gathered each year so the results should be interpreted cautiously.

Table 2. Early, late, and average departure dates for Canada Warbler in select regions of northeastern British Columbia, 1981-2007. Locations are listed from south to north. The average date was calculated by using Julian days (1 Jan = 1; 31 Dec = 365) and then back-converting to a Gregorian (modern) calendar date.

Location ¹	Period	Total Years ²	Early	Late	Average
Swan Lake	1987-2007	9	10 Aug	22 Aug	15 Aug
Dawson Creek	1988-2007	5	9 Aug	19 Aug	14 Aug
Taylor	1981-2007	15	7 Aug	22 Aug	14 Aug
Fort St. John	1982-2007	6	9 Aug	28 Aug	17 Aug
Clarke Lake	1981-1995	12	31 Jul	14 Aug	8 Aug
Fort Nelson	1982-1995	8	2 Aug	11 Aug	7 Aug
Liard Hot Springs	1998-2001	4	3 Aug	13 Aug	8 Aug

¹See Table 1 for sites visited frequently within each primary location.

²Number of years late autumn migration date was recorded.

Table 3. Spring arrival and autumn departure dates for Canada Warbler, for select areas in northeastern British Columbia, 1981-2007. Locations are listed from south to north. Date is the average for the decade. The average date was calculated by using Julian days (1 Jan = 1; 31 Dec = 365) and then back-converting to a Gregorian (modern) calendar date.

Location ¹	Average Spring Arrival Date			Average Autumn Departure Date		
	1981-1989	1990-1999	2000-2007	1981-1989	1990-1999	2000-2007
Swan Lake	31 May	29 May	29 May	12 Aug	15 Aug	19 Aug
Dawson Creek	1 Jun	29 May	30 May	10 Aug	13 Aug	19 Aug
Taylor	28 May	28 May	27 May	13 Aug	14 Aug	16 Aug
Fort St. John	27 May	29 May	28 May	17 Aug	13 Aug	19 Aug
Clarke Lake	1 Jun	29 May	-	7 Aug	11 Aug	-
Fort Nelson	31 May	31 May	-	6 Aug	10 Aug	-
Liard Hot Springs	-	2 Jun	1 Jun	-	8 Aug	8 Aug

¹See Table 1 for sites visited frequently within each primary location.

Table 4. Shortest, longest, and average length of stay for Canada Warbler in select regions of northeastern British Columbia, 1981-2007. Locations are listed from south to north.

Location ¹	Length of Stay (days)			
	Years ²	Shortest	Longest	Average
Swan Lake	7	73	82	77
Dawson Creek	5	71	82	77
Taylor	15	70	88	79
Fort St. John	5	78	95	84
Clarke Lake	12	63	79	70
Fort Nelson	8	64	73	69
Liard Hot Springs	4	65	73	68

¹See Table 1 for sites visited frequently within each primary location.

²Total years with both arrival and departure dates recorded.

Table 5. Average length of stay for Canada Warbler, by decade, for select areas in British Columbia, 1981-2007. Locations are listed south to north.

Location ¹	Average Length of Stay (days)		
	1980-1989	1990-1999	2000-2007
Swan Lake	74	79	81
Dawson Creek	71	77	77
Taylor	77	79	82
Fort St. John	88	78	83
Clarke Lake	68	75	-
Fort Nelson	67	73	-
Liard Hot Springs	68	69	-

¹See Table 1 for sites visited frequently within each primary location.

Family Life

Breeding

Little is known about the breeding biology of Canada Warbler anywhere in its summer range, although recent concern over declining numbers has stimulated research on reproductive success, home range, territory size, and site fidelity. Much of that fieldwork is being carried out in New York, Vermont, New Hampshire, and Maine. For example, recent research in Maine has shown that there is high site fidelity among males, with individuals returning to the same territory in subsequent years even when pairing was unsuccessful the year before.

Canada Warbler is mostly solitary outside its short breeding season and is considered socially monogamous. The age of sexual maturity is one year.

Males (Figure 39) are territorial and the average territory size varies regionally. In Ontario it averaged 0.2 ha, in Vermont 0.38 ha, while defended areas in New York ranged from 0.8 to 1.2 ha in size. In British Columbia, 9 territories averaged 0.31 ha in size. In one study in Vermont an unpaired male ranged over 7 ha in the course of a day.

Canada Warbler has only one brood per season. It is not known in British Columbia if a replacement clutch is laid in nests that have lost eggs or nestlings.

Nests with eggs, recently fledged young, or Brown-headed Cowbird fledglings being fed have been found at elevations ranging from 382 to 724 m (1,253 to 2,375 ft).



Figure 39. Basic information on the breeding biology of Canada Warbler in British Columbia is poorly known. Doig River, BC. 2 June 2007 (Michael I. Preston). BC Photo 3543.

Annual Cycle

In British Columbia, males arrive on the breeding territory first, up to five days before females, and immediately begin singing loudly from a variety of perches. Many of these are located on branches in the “gap” between the lower forest canopy and the top of the shrub understory.

The courtship period is short and does not last beyond a few days. The period between males arriving and establishing territory and mating occurs from 22 May to 11 June throughout the province, a total of 21 days (Figure 40). The female builds the nest and there is no evidence that the species is double-brooded or has replacement clutches in

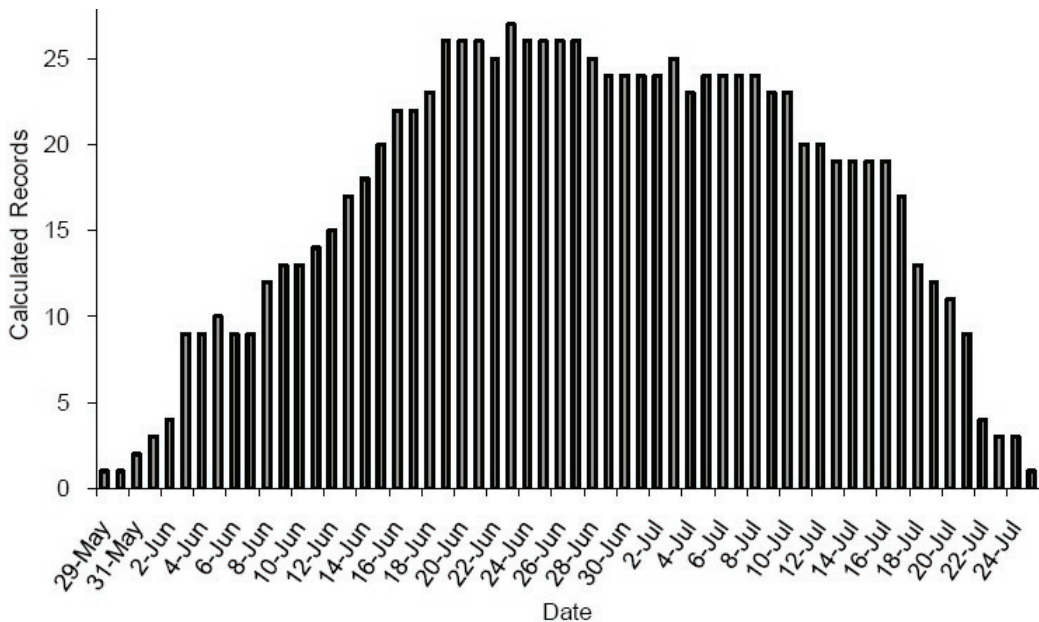


Figure 40. Breeding chronology of Canada Warbler in British Columbia, 1978-2007 (n=34). The range of dates represents the full range of breeding activity, from nest-building through fledging.

British Columbia. The nesting season, from nest building to fledging for individual pairs, is short and may be completed within 30 days. Peak egg-laying occurs from mid- to late June with young fledging from mid- to late July. The full breeding period for the province extends from 29 May (nest building) to 25 July (known fledging), a period of 58 days (Figure 40). Pairs in far northern regions nest about a week later than southern counterparts.

Both parents feed nestlings and recently fledged young.

Nests

The nest is constructed by the female and built on or near the ground. Only three nests have been found in British Columbia and all were near the middle of dense shrub thickets and well concealed by surrounding vegetation. Searching for nests requires a crawling “on hands and knees” approach until the incubating female is flushed. At one nest near Swan Lake a female did not flush until the observer was within nine inches.

The nests in British Columbia were in typical positions reported for the species. One was on the ground among woody debris and fallen leaves at the base of a small prickly rose shrub and another was well concealed by draping dead grasses over the trunk of a fallen mature trembling aspen (Figure 41). The third nest was also situated on the ground in a recess among branches and other forest debris (Figure 42).

All nests were loose, but were well constructed collections of dry grass stems and leaves, weed stalks, small leaves (*e.g.*, kinnikinnick) including fragments of dead trembling aspen and balsam poplar leaves, bits of mosses, rootlets, and other plant fibres. Each of the nests was lined with fine dry grasses and deer hair.

The dimensions for two nests were: outside diameter, 10 and 15 cm; outside height, 6.5 and 11 cm; inside diameter, 5.5 and 8 cm; and inside depth, 3 and 5.5 cm.



Figure 41. Finding nests of Canada Warbler is a challenge because of the bird's interior forest nesting habitat that is usually carpeted with dense tangles of shrubs and fallen woody debris. Also, the incubating female is difficult to flush. This nest is beside a fallen trembling aspen trunk. Along Road 201 southwest of Swan Lake, BC. 27 June 2007 (R. Wayne Campbell). BC Photo 3544.



Figure 42. When incubating, the grayish back of the female Canada Warbler provides camouflage for her white-coloured eggs. Clayhurst, BC. 12 June 1988 (British Columbia Forest Service). BC Photo 3542.

Eggs

Eggs are ovate, slightly glossy, creamy white, and well speckled with dots and small blotches of various shades and tints. These markings, which often form in a wreath around the larger end, may be reddish brown, purple, chestnut, gray, purplish gray, lavender, or violet.

The average size is 17.3 mm (0.68 in.) x 13.2 mm (0.52 in.). Eggs are probably laid one a day until the

clutch is complete. The incubation period is 12 days and only the female incubates, spending up to 85% of the time on the nest. When off the nest the male may join her in foraging forays.

In North America, the clutch size ranges from two to six eggs with a mean of 4.13 eggs. In British Columbia, two nests have been found with three eggs and another contained four eggs. One of the three-egg clutches was found early in the nesting season so that may have been incomplete.

Young

There is no information on hatching, growth, and development of young. Both parents feed the nestlings and the male may take a more dominant role than his mate. It is estimated that the nestling period lasts 10 days, and both the male and female remove fecal sacs. Young are unable to fly when first leaving the nest and parents may feed young for a week after fledging.

Brown-headed Cowbird Parasitism

Herbert Friedmann, in his classic works on host relations of the parasitic cowbirds, suggests that Canada Warbler is a regularly parasitized species. In Ontario, 5 out of 25 nests were parasitized by cowbirds. In British Columbia, 5 out of 34 breeding records include parasitism, as evidenced by adult Canada Warblers, both males and females, feeding recently fledged cowbirds.

The *Conservation and Management* section, featured on page 120, discusses concerns related to increased rates of parasitism for many songbirds in northeastern British Columbia, owing mainly to ranching activities of cattle and bison, the Brown-headed Cowbird's modern-day feeding associates.

Lifespan

The oldest bird on record in North America, from band-recovery information, is 7 years 11 months. In British Columbia, for the period 1995 through 2007 (13 years), a total of 34,781 birds were banded, and only one was a Canada Warbler (Figure 43).



Figure 43. Most information on longevity in birds comes from banding. This Canada Warbler was banded at the Mugaha Marsh Banding Station near Mackenzie, BC on 18 August 2004 (John Lambie). BC Photo 3063.

Feeding and Diet

There is no information on the feeding habits or diet of Canada Warbler in British Columbia. Elsewhere, the species feeds mainly on flying insects and spiders that it captures by flycatching, sallying, hover gleaning, foliage gleaning, and “ground gleaning”, usually in lower tree branches and shrubs.

Mortality

Finding dead Canada Warblers is a chance happening and not only is it rarely encountered but is less often reported. The causes of mortality for three birds in British Columbia were: collision (male) with a vehicle north of Liard River Hot Springs Park, and two males incidentally caught in museum snap traps set for small mammals during a museum collecting expedition.

Other potential threats are discussed in *Conservation and Management*.

Conservation and Management

The conservation of ecological systems is a challenge, because environmental impacts caused by humans are constantly changing and have far-reaching effects. The resources necessary to research and alleviate some of these concerns can

be very costly, and time-consuming, subsequently putting greater pressure on management decisions. Although this account deals with a single species, it is important to incorporate what we have learned from Canada Warbler, and to update and incorporate new information into managing communities and ecological processes.

The application of existing knowledge by industry, government resource personnel, environmental groups, and researchers in conserving Canada Warbler in British Columbia depends on a variety of issues that are complex and often inter-related. Some of these concerns include: timber harvesting and forest fragmentation, oil and gas exploration, mining, wind power developments, habitat conversion, Brown-headed Cowbird parasitism, linear corridor developments (e.g., roads, railway tracks, pipelines, and transmission lines), silviculture, livestock grazing, prescribed fires, and chemical spraying. All of these pose threats to Canada Warbler in British Columbia.

Timber Harvesting and Forest Fragmentation

The impacts of forest practices that alter composition and structure can affect wildlife in various ways. For some species there might be a gain, for others a loss, while some animals will not be affected at all. The primary issue surrounding habitat fragmentation is its effects on the viability of populations. Loss of habitat and habitat isolation and features such as patch size and the amount of edge and interspersions are concerns.

Unquestionably, timber harvesting (like other large scale disturbances) destroys Canada Warbler habitat; at least temporarily. Although forest companies ensure that trees are re-established on all cutblocks, the habitat will generally not be suitable for Canada Warbler for several decades. The challenge is to ensure that suitable habitat is maintained across the landscape over time. Although evidence suggests that the species is resilient to edge effects, there is little information to assist forest companies in designing wildlife tree patches or strips for Canada Warbler. Information on patch size requirements would be helpful.

While degradation of habitat continues within the range of Canada Warbler in British Columbia, little

is known about the general effects. Dr. Courtenay Conway suggests that the species “*probably responds favorably to habitat changes that increase density of understory vegetation within forests, but negatively to changes that decrease forest understory or severely reduce forest canopy*” (Figure 44).



Figure 44. Forest practices that maintain forest canopy and a dense, shrubby understory will benefit breeding Canada Warblers in British Columbia. Near Andy Bailey Lake, BC. 22 June 2007 (R. Wayne Campbell).

Under the *Identified Wildlife Management Strategy*, administered by the British Columbia Ministry of Environment, Canada Warbler is not listed in the “Category of Species at Risk” under the *Forest and Range Practices Act*. Despite obvious potential effects of these industries, lack of recognition renders the species ineligible for protection under the *Act*, such as that afforded by the designation of Wildlife Habitat Areas and General Wildlife Measures, which could work to protect known concentrations of Canada Warblers on Crown land. Furthermore, although measures in the *Act* would only legally apply to forestry and range activities, such designations are often acknowledged by the oil and gas industry.

Oil and Gas Exploration

The oil and gas industry in British Columbia is the second largest natural gas producer and fourth largest crude oil producer in Canada. The resource potential is enormous and much of the onshore (and

offshore) areas are still unexplored. According to the Geological Survey of Canada there were 1,600 wells drilled in the province in 2006, an increase of 182 wells over the 2005 total. Each well requires road access, and each producing well requires a pipeline to connect with existing infrastructure. Exploration is expected to grow significantly over the coming years with increased employment and production activity, all with attendant environmental impacts on forested and wetland habitats.

In addition, there are three major pipeline projects scheduled for British Columbia in the near future: the Alaska Highway Pipeline (Prudhoe Bay, Alaska along the Alaska Highway to Chicago, Illinois) to start after 2010, which will become the world’s largest capital project, the Gateway Project (Edmonton to Kitimat) to start in 2008, and the Trans Mountain Pipeline to start in 2008 that will transport crude oil and refined products from Edmonton, AB to Greater Vancouver and the Puget Sound region of Washington. At the present time, without considering future links between pipelines, only the Alaska Highway pipeline route would potentially affect Canada Warbler habitat in British Columbia.

Many of the land protection and management strategies listed below for forest practices in British Columbia are applicable to the oil and gas industry. In northeastern British Columbia forest clearing for pipeline developments (Figure 45) and seismic exploration, timing of these activities, and establishment of well sites and processing plants are of conservation concern.

Coal and Metal Mining

Mining and its associated activities impact wildlife habitats in British Columbia. In 2006 there were 10 metal mines and 10 coal mines operating in the province. Of these, three coal mines (*e.g.*, Trend, Willow Creek, and Wolverine; Figure 46) are located in the Peace River region in known and potential Canada Warbler habitat. Earlier productive coal mines near Tumbler Ridge (Quintette and Bullmoose Mines) are now closed (August 2000 and April 2003 respectively), and it is not known if the land previously supported Canada Warbler populations.

Recently coal mining exploration and development has increased significantly in the



Figure 45. At least nine male Canada Warblers were singing on territory along a 1.5 km stretch of prime habitat on Road 201, southwest of Swan Lake near the BC-Alberta border on 2 June 2007. At that time ribbons marked boundary lines for pipeline clearing, but by 25 June the area had been cleared and only a single nesting pair remained along the same survey route (R. Wayne Campbell).

southern Peace River region of the province. While environmental programs are established, such as reclamation, maintaining water and air quality, minimizing flooding, erosion and damage to aquatic and wildlife habitats, few consider the species approach (*e.g.*, specific ecological requirements) to management and reclamation of surface mining activities.

As with the forestry and oil and gas industries, many of the land protection and management strategies listed on page 129 are applicable to the mining industry.



Figure 46. Rekindled interest in coal mining in northeastern British Columbia in the 2000s may impact Canada Warbler nesting habitat locally. Along the Wolverine Forest Service Road northwest Tumbler Ridge, BC. 23 June 2005 (R. Wayne Campbell).

Wind Power

Most of the prominent ridges in northeastern British Columbia are the subject of “Investigative Use Permits” issued to various wind power companies. Most of the proposed wind farms are at relatively high elevation and construction of the facilities (if they proceed) would probably not impact a significant amount of Canada Warbler habitat. However, wind turbines have the potential to kill many birds, especially during migration. The real threat to Canada Warblers (and other species) and the effectiveness of any mitigation measures, remains to be seen.

The wind farm projects closest to construction include sites at Bear Mountain near Dawson Creek, Mount Wartenbe near Lone Prairie, Dokie Ridge west of Chetwynd, and several sites near Tumbler Ridge.

Habitat Conversion

About one-third of the world’s endangered birds and mammals are threatened by habitat conversion and over-exploitation. Balancing conservation and economic objectives is challenging and differs greatly throughout regions of British Columbia. The major concern of wildlife managers and conservationists is the conversion of forested habitats in British Columbia to urban, residential, industrial, agricultural, and

recreational uses. However, the conversion of forests locally for such developments as roads, boat ramps, campgrounds, roadside pullouts, parking lots, gravel pits, storage areas, garbage dumps, and gas plant developments (Figure 47) can impact species with narrow ecological requirements and low population levels such as Canada Warbler. Large hydroelectric reservoirs, such as the one planned for 'Site C' on the Peace River, will flood some of the best Canada Warbler habitat in the province and locally could have a significant impact on the warbler's population.



Figure 47. In the early 1990s at least two pairs of Canada Warblers occupied territories in trembling aspen forests where oil and gas buildings and structures now stand. Swan Lake (Road 201), BC. 25 June 2007 (R. Wayne Campbell).

The balance between various objectives is complex and despite the vastness of the boreal forest it is vulnerable. Scientist Richard Schneider and his colleagues suggest three features are lacking in current management incentives. These include a more meaningful stakeholder involvement, integrated planning, and an assessment of how management decisions will affect the forest (and oil and gas exploration) of the future.

Brown-headed Cowbird Parasitism

Concerns about the impact of Brown-headed Cowbird (Figure 48) parasitism on Canada Warbler, and other neotropical migrants in the province, has been increasing over the past two decades. It is well known that brood parasitism can reduce host



Figure 48. Since its arrival in British Columbia in 1890, the Brown-headed Cowbird has successfully expanded its range to occupy most of the province, including the larger offshore islands. Victoria, BC. 18 August 1999 (R. Wayne Campbell).

reproductive success and locally can threaten nesting populations.

Prior to European settlement the Brown-headed Cowbird inhabited the short-grass prairie region west of the Mississippi. With forests being cleared for farmland and livestock introduced by settlers, the opportunistic cowbird initially expanded its range eastward, becoming well established by the early 1900s. Westward settlement also provided open habitats for expansion. By the 1920s the species was well established in coastal southern California, then by the 1940s in Oregon, west of the Cascades, and by the 1950s in Washington and southern British Columbia.

The cowbird's range expansion in British Columbia is dramatic. The species was first recorded in the province near Revelstoke in 1890. Over the next two decades it was reported from many new locations across far southern portions of the province reaching the coast, at Victoria, as early as 1893. The earliest record for northeastern British Columbia was in 1922, with birds probably arriving from the Peace River region of northwestern Alberta, because at that time, cowbird occurrence elsewhere in British Columbia was limited mainly to southern regions.

During the next eight decades or so, the Brown-headed Cowbird expanded its range to include suitable open and fragmented habitats throughout northeastern British Columbia.

The bird's successful occupancy is directly related to human activities that create landscapes where the species can find food and a host species for its parasitic habits. Also, Brown-headed Cowbird can breed and reproduce in a wider range of habitats that are less restrictive than for other passerines because it does not need to tend any young.

The distribution and abundance of cowbirds in northeastern British Columbia has been enhanced by open corridor developments including oil and gas seismic lines, hydro transmission lines, roads, highways, railway tracks, forest fragmentation from logging and mining, conversion of forests to agriculture lands, and livestock grazing and feeding. Recently, a more serious threat has been introduced that has greatly increased the numbers of cowbirds in the region. Prior to European settlement in North America, Brown-headed Cowbirds lived a nomadic life following herds of Bison (*Bison bison*) that roamed across the Great Plains. As Bison numbers fell cowbirds quickly associated themselves with livestock, feeding on insects and seeds stirred up by their feet.

Wood Bison (*B.b. athabascae*) have probably occurred in the Peace River area for at least 10,000 years, disappearing briefly for most of the 20th century. In northeastern British Columbia, small numbers of Wood Bison occurred in the early 1800s, but most were killed-off for their hides. The last animal was shot near Fort St. John in 1906.

For nearly 75 years Wood Bison remained extirpated in the province until 1980 when recovery programs were implemented. Wood Bison have successfully been reintroduced into British Columbia (Figure 49), and still remain in low numbers, in four populations: west side of the Liard River, north side of the Liard River, near the BC-Alberta border along the Hay River, and around Eththithum Lake. It is unlikely that these populations attracted significant numbers of cowbirds.

The Plains Bison (*B.b. bison*), the other subspecies in the province, accidentally escaped shortly after 1971 from a private collection that was brought to British Columbia from Elk Island National Park, Alberta. The population, estimated at 1,500 animals, is free-ranging and occupies an area west of Sikanni Chief and Pink Mountain, from just north of Trimble

Lake and the Sikanni River, south to the south side of the Halfway River. Each herd has its attendant small flock of Brown-headed Cowbirds. It seems likely that cowbirds follow these herds each summer, parasitizing songbirds along the way.

Of more concern is the impact that the British Columbia Bison industry, along with expansion of livestock farming, may be having on the distribution and abundance of cowbirds. In 2002, there were about 90 to 100 Bison game farms with about 9,000 animals in British Columbia. About 45% of the province's Bison are produced within the British Columbia range of Canada Warbler. Throughout the early 2000s it was not uncommon to see flocks of nearly 150 cowbirds feeding among herds of Bison on game farms. Because studies have shown that cowbirds may travel up to seven kilometres between feeding and reproduction sites each day, the impact of the BC Bison industry in attracting and maintaining populations of Brown-headed Cowbirds, and subsequently fostering their effect on host populations, is of concern.



Figure 49. The expansion of the livestock industry, combined with the reintroduction of native Bison into British Columbia, the free-ranging animals that escaped captivity, and the growing game-farming industry, all attract more cowbirds into the province each year. At this Bison farm, north of Fort Nelson, Brown-headed Cowbirds attend herds all summer, feeding only a few hundred metres from aspen forests where Canada Warblers nest. North of Fort Nelson, BC 2 July 2005 (R. Wayne Campbell).

Bison game farms are a major magnet for Brown-headed Cowbirds in the province, and therefore indirectly impact nesting neotropical migrants.

The primary differences between the threats posed by cattle and bison is in overall numbers and more importantly, the distribution of the animals. Bison farms occur on private land, in theory limiting the cowbird influence to about seven kilometres from the agricultural land interface. Cattle grazing on forested Crown land is pervasive, *especially* on the deciduous forest land base where all leases are granted. Thus, the cattle lead the cowbirds into the very heart of Canada Warbler nesting habitat just when the warblers are returning. This is the situation in the north and south Peace areas. Cattle grazing is less widespread in the Fort Nelson district.

Private land can be considered completely converted to agriculture or at best severely fragmented forest land.

There are many issues concerning the management of Brown-headed Cowbirds, and suggested control measures (*e.g.*, trapping and killing adults, shooting at roost sites, and egg removal), are controversial. While these may be effective “short-term” solutions locally, what is really required is research and discussion into the basic mechanisms driving cowbird range expansion, colonization, and establishment (*e.g.*, habitat fragmentation, corridors, conversion of landscape).

Linear Corridor Developments

Linear corridors (Figure 50) including railways, highways, roads, pipelines, high voltage transmission lines, and seismic lines, affect wildlife both directly (*e.g.*, loss of habitat, collisions) or indirectly (*e.g.*, increased rates of predation or parasitism). While there are many negative effects associated with other wildlife species, the main impact on Canada Warbler appears to be loss of habitat, fragmentation of continuous tracts of suitable breeding habitat, and noise and disturbance during the breeding season from late May through early August.

Silviculture

After timber harvesting (Figure 51), all forest licensees are required to regrow commercially viable tree species on a cutblock, and these trees must be



Figure 50. This corridor, being prepared for oil and gas exploration, has been constructed through prime Canada Warbler breeding habitat. Southwest of Swan Lake, BC. 2 June 2007 (R. Wayne Campbell).

well-established within a few years. A number of silvicultural techniques may be used to speed up this process, including mechanical site preparation, herbicide application, pre-commercial thinning, pruning, site conversion (changing the tree species composition from what originally occurred on the site) and others. In general, the rapid re-establishment of forest cover should benefit forest-dwelling birds. However, this benefit can be negated if the new forest lacks critical habitat components that the



Figure 51. Soon after timber harvesting, silvicultural activities must commence to regrow commercially valuable tree species on a cutblock. For Canada Warblers it is critical that the habitat components are similar to the original forest. Johnson Creek Forest Service Road, BC. 8 June 2003 (R. Wayne Campbell).

original forest provided. Canada Warblers require a deciduous component to the forest canopy, as well as a dense deciduous understory. These characteristics are more easily re-established in cutblocks scheduled for deciduous regeneration, and were probably absent from cutblocks containing pure conifer forest – thus re-establishment of pure conifer forest on the site does not result in a net loss or gain of Canada Warbler habitat.

Mixedwood forest management presents a more difficult issue. Depending on local site conditions, some mixedwood forest (especially white spruce-trembling aspen and white spruce-balsam poplar mixtures) contains excellent Canada Warbler habitat. These stands also have high economic value to the forest industry. However, current regulations in British Columbia do not support the re-establishment of mixedwood stands. Forest licensees are required to separate the regenerating forest into blocks of pure coniferous and pure deciduous trees, thereby ‘un-mixing’ the mixedwood forest. Mixedwood forest that is converted to pure coniferous forest will undergo intense silviculture treatments such as multiple herbicide applications and pre-commercial thinning in an effort to remove all deciduous vegetation from the regenerating forest. Such practices are counter-productive to maintaining Canada Warbler habitat on the landscape. Regulation changes that promote true mixedwood forest regeneration as well as allowing small gaps to exist within the regenerating stand (creating future canopy gaps) would be beneficial.

Livestock Grazing

The effect of domestic livestock grazing on deciduous tree growth and forest understory assemblages is a contentious issue between forest companies, ranchers, environmental groups, land managers, and sportsmen. In the Peace River region of British Columbia Crown cattle grazing leases are a common practice in the Boreal White and Black Spruce biogeoclimatic zone (Figure 52). The main environmental concerns include damage by cattle through browsing, trampling, and soil compaction. As well, cattle are a vector for Brown-headed Cowbird parasitism.

Herbivory by the nine species of native hoofed mammals in British Columbia (e.g., Mule

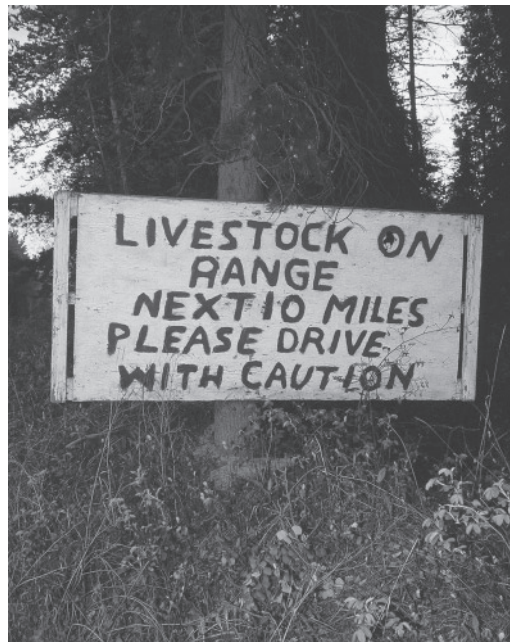


Figure 52. The long-term impacts of free-range cattle grazing on understory vegetation used for nesting and cover by many neotropical migrants in northeastern British Columbia remain unknown. Hasler Creek, BC. 27 May 2006 (R. Wayne Campbell).

Deer, *Odocoileus hemionus*; Moose, *Alces alces*; Woodland Caribou, *Rangifer tarandus caribou*) has always been a natural and ecological force. Increased domestic livestock grazing, however, has damaged some ecosystems on public lands where lease areas have been overstocked with cattle.

Avian responses to livestock grazing vary between species. Most birds do not respond to the presence of foraging mammals but some are impacted by damage to regenerating trees (e.g., trembling aspen), shrub understory, and herbaceous forest cover. Therefore, management practices for mixed deciduous forests in northeastern British Columbia must consider the habitat requirements for breeding neotropical migrants, because some will be species specific. Canada Warbler is one such species that requires special attention since it nests on the ground among a dense shrub understory with fallen

woody debris such as tree trunks and branches.

Recently, research has been carried out on the effects of timber harvesting and cattle grazing on trembling aspen regeneration, forage production, and soil compaction on trembling aspen cutblocks near Dawson Creek. While the results showed that cattle grazing and trembling aspen harvesting can be complementary, the focus was economical rather than ecological. Future studies should consider the ecological requirements of nesting Canada Warblers, especially in mature aspen forests.

Potential Hazards of Pesticides and Herbicides

Canada Warblers may be exposed to the effects of chemical contamination on their breeding and wintering grounds and during migration. It is well documented that birds are affected directly and indirectly by being associated with the use of organochlorine insecticides, such as DDT, dieldrin, and aldrin, as well as organophosphorus compounds. Some of the potential effects of these environmental contaminants include a host of observed incidences. These may include direct mortality, eggshell thinning, endocrine impairment, aberrant reproductive behaviour, feminization of reproductive organs, decreased body weight, lethargic behaviour, reduced territorial behaviour, reduced parental attentiveness, decreased nestling growth rates, increased post-fledging mortality, reduced return rates in subsequent years, and fluctuations in prey abundance or diversity. The latter may include shifts in the proportion of insects in the diet or enlargement of foraging territories due to elimination of prey.

Most of the research on effects of chemical contaminants has involved nonmigratory species like some raptors and gallinaceous birds, although Environment Canada has initiated programs to look at the effects of spraying fenitrothion on passerines in eastern hardwood forests. Chemicals adversely affect all wildlife and as newer generations of pesticides and herbicides are produced it will become critical for toxicologists and ornithologists to establish regular, open lines of communication. On the other hand, field biologists must be alert for subtle changes in a species' life history and behaviour and report relevant information for attention. In the meantime, baseline field studies should be carried out to address

toxicant effects on neotropical migrants in British Columbia.

Although chemicals such as DDT, Alachlor, fenitrothion, and 2,4,5-T are now banned in Canada, pesticides and herbicides are still used in British Columbia. The economic impact of insect-caused losses upon forests in British Columbia is not fully understood and less is known on the impacts of insectivorous birds. All pesticides must be registered with the federal government, under the *Pest Control Products Act*, before they can be used in Canada. Although pesticides and some other chemicals cannot be used in British Columbia if they have not been registered, the province can ban the use of any chemical in its own jurisdiction even if it has been approved by the Government of Canada.

Insect Outbreaks

Natural disturbances, such as fires, insect outbreaks, floods, windstorms, and diseases are an essential part of forest renewal. Of these, fires and insects are the major natural events. Insect outbreaks are generally extensive, cyclic, and tree mortality can be as much as 1.5 times that due to fires. Over time, insect outbreaks can have a significant impact on the vigor of trees, including reduced growth, increased decay, and tree deformities. This in turn affects the age structure and species composition of a forest. While most insects are beneficial, extensive outbreaks of tree-killing and defoliating insects can also influence timber supply and habitat availability for wildlife.

The two major groups of insects that may affect populations of Canada Warblers in northeastern British Columbia are the bark beetles and defoliators.

Bark beetles, primarily attacking coniferous forests, kill trees by boring through a trunk and laying eggs in the inner bark. Once hatched, the larvae eat the inner bark, killing the tree, then mature quickly as adults fly to new trees to continue the cycle. In British Columbia, the spruce beetle (*Dendroctonus rufipennis*) attacks mainly large-diameter mature white spruce in the Peace River region. While this conifer is a minor component of the forest structure for breeding Canada Warblers, the death of a single large spruce tree can have a positive effect

as the overstory is opened. In south-central Alaska researchers found that “*understory-nesting birds as a group were more abundant in forest stands with high levels of spruce mortality*”. Shrubs, like alder (*Alnus* spp.), an important cover species for nesting Canada Warbler, become more abundant as the forest canopy is opened, as do shade-intolerant herbs and grasses. The mountain pine beetle (*Dendroctonus ponderosae*) has recently invaded the forests of northeastern British Columbia, where it feeds mainly on mature lodgepole pine trees. Pine is typically an even smaller component of Canada Warbler habitat than is white spruce, but the same ecological response holds true if single trees are killed by pine beetles.

In mixedwood forests, however, efforts to combat the spread of bark beetles through extensive burning or clearcutting can destroy pockets of good Canada Warbler habitat, until the forest is regenerated.

Defoliators, (at least 140 species in British Columbia), have a very different life cycle from the bark beetles. The adults are small moths that lay their eggs in the buds of trees. The eggs hatch into caterpillars that feed on the leaves of deciduous trees and needles of coniferous trees in spring and summer. When the forest pest is abundant, trees can be defoliated completely.

Deciduous forests, the primary habitat for Canada Warblers in northeastern British Columbia, can be defoliated by forest tent caterpillars (*Malacosoma disstria*) and the large aspen tortrix (*Choristoneura conflictana*).

The forest tent caterpillar (Figure 53) is native to North America, has periodic outbreaks at intervals of 10 to 12 years that are extensive, and its preferred host is trembling aspen. It has one generation per year. The eggs overwinter as a band on the twigs of trembling aspen, or occasionally balsam poplar, and hatch in early spring about the same time as aspens leaf out and prior to the arrival of Canada Warblers in late May. The caterpillars grow quickly and in mid-to-late June they migrate widely, en masse, to other aspens and broadleaf trees, and if all of the foliage is consumed they will also feed on understory deciduous shrubs. By mid-July they reach maturity and pupate between the leaves. About 10 days later the adult moth appears, mates, lays eggs and dies.

Canada Warbler may continue to breed during



Figure 53. The forest tent caterpillar is the most significant defoliator of hardwood trees in boreal forest regions of British Columbia. Dragon Lake, BC. 5 June 1995 (R. Wayne Campbell).

tent caterpillar outbreaks, providing the understory shrub and herb layers deep within large woodlands remains in tact.

The large aspen tortrix moth defoliates both trembling aspen and balsam poplar and usually precedes outbreaks of the forest tent caterpillar. Overwintering larvae emerge and begin mining tree buds in early spring. During severe infestations their feeding activities may delay the opening of buds, or in some cases may completely destroy bud development. This results in no foliage. Pupation occurs in mid-June, when Canada Warblers are at the height of their egg-laying activities, and 10 days later the adult moths appear. By mid-August, when many warblers have migrated south, the insects stop feeding

and commence hibernation activities. Outbreaks of this species are generally patchier and less extensive than those of the tent caterpillar, although they occur more often.

Although startling in appearance, the defoliation caused by these two species rarely causes extensive tree mortality. Moths are generally dispersed to new areas by prevailing winds. Occasionally, however, an area will be hit two or three years in succession and this can result in a high death rate among affected trees.

Management Recommendations

J. Daniel Lambert and Steven D. Faccio, in their report *Canada Warbler: Population Status, Habitat Use, and Stewardship Guidelines for Northeastern Forests* issued by the Vermont Institute of Natural Science, developed a well-researched, thorough, and effective list of stewardship guidelines for breeding habitat. Their strategies include techniques that both protect and maintain critical habitats while considering human activities such as forest fragmentation (logging), conversion of landscapes for agriculture and urbanization, silvicultural activities, recreational developments, as well as other threats.

With permission, we are following their recommendations modifying some to meet land protection and habitat management conditions in British Columbia.

Land Protection Strategies

A variety of land protection strategies could be employed to help maintain Canada Warbler populations.

1) Designate Canada Warbler as a “Category of Species at Risk” under the Forest and Range Practices Act. This will allow the creation of “Wildlife Habitat Areas” for protection of Canada Warbler concentrations on Crown land.

2) Identify Canada Warbler population centres with the aid of a comprehensive database that incorporates all historical and current sources of published and unpublished information.

3) Focus preservation efforts on natural habitats with high Canada Warbler densities (*e.g.*, near Swan Lake along Road 201, Andy Bailey Lake Road, Jackfish Road, and Clarke Lake Road).

4) In the absence of Canada Warbler location and abundance data (Figure 54), identify parcels that feature one or more of the following habitats:

- mature mixedwood forests with a strong deciduous component, especially trembling aspen; and
- moist mature mixedwood forests on slopes.



Figure 54. Canada Warblers inhabit the forested slopes of many rivers in northeastern British Columbia, such as the Peace River, but most such areas are difficult to access. Taylor, BC. 5 June 2007 (R. Wayne Campbell).

5) Target areas characterized by the following attributes, listed in presumed order of importance:

- high shrub density (woody stems measuring 2-6 m in height, < 8 cm dbh);
- high volume of understory foliage (including forbs, grasses, and mosses);
- low level of threat of cattle browse;
- low or semi-open canopy;

- standing trees, or tree clumps, used for territorial display;
- structurally complex forest floor (hummocks, coarse woody debris, etc.);
- extensive forest cover (especially important in developed landscapes);
- connectivity to other forested areas;
- proximity to a continuous supply of 60 to 80 year-old stands to provide additional nesting and post-fledging cover; and
- a compact configuration (*e.g.*, circles or squares to reduce the amount of interior forest susceptible to negative edge effects).

6) To locate potentially suitable habitats (and access knowledge) refer to the British Columbia Ministries of Forests and Environment, Land and Water Protection and major forest companies in the region (*e.g.*, Canadian Forest Products Ltd., Louisiana-Pacific Canada Ltd., Tembec, West Fraser etc.).

7) Work with federal, provincial, and municipal governments and forestry, oil and gas, and mining companies to support land use regulations that:

- curb sprawl (*e.g.*, return abandoned public lands to original landscape);
- concentrate human growth (*e.g.*, establish commercial and residential zones);
- protect wetland and riparian habitat (*e.g.*, require adequate buffers; Figure 55);
- maintain natural forest hydrology (*e.g.*, best engineering and construction practice);
- conserve forest lands; and
- reduce stocking rates to avoid over-grazing by cattle.



Figure 55. Most cities and towns, when developing urban and industrial areas in northeastern British Columbia, designate parcels of land for specific purposes. Environmental impact assessments should consider the habitat needs for Canada Warblers. Charlie Lake, BC. 27 June 2002 (Linda M. Van Damme).

8) Protect large tracts of working forest with the intent to pursue one or more of the management strategies described below:

Forest Management in British Columbia

Nearly 65 percent of British Columbia is forested, and within the boreal forest region of the province trembling aspen is the most important deciduous tree ecologically, and is becoming an increasingly important commercial species. It is also the preferred habitat for Canada Warbler. While reduced growth and dieback of aspen forests has been reported in northwestern Alberta since the 1990s, mainly attributed to insect damage, fungal pathogens, and climate change, forests in British Columbia remain relatively healthy. In fact, aspens from northeastern British Columbia, especially the Fort Nelson Timber Supply Area, exhibit phenotypic superiority to aspen elsewhere in the province.

Forested lands can play a significant role in maintaining Canada Warbler populations because:

1) they reduce the threat of habitat loss and fragmentation by keeping the landscape forested; and

2) they present an opportunity to create habitat where it does not currently exist.

We recommend consideration of the following forest management practices for the conservation of Canada Warbler in British Columbia:

1) Ensure a continuous supply of mature to old, mixed-aged stands. Even-aged forests < 60 years old appear to be of low value to Canada Warblers (Figure 56).

2) Maintain large, continuous area of unmanaged forest. Such areas are more likely than age-class mosaics to experience large natural disturbances that could benefit Canada Warbler. These areas also harbour unique biological communities in northeastern British Columbia and serve as valuable benchmarks for assessing forest management effects.



Figure 56. Even-aged forests, including mixedwood stands, are rarely occupied by nesting Canada Warblers. Beaton Park, BC. 25 June 1996 (R. Wayne Campbell).

3) Plan for, and tolerate, natural disturbances that create gaps in the canopy (*e.g.*, severe storms, beaver activity) and/or increase invertebrate food supply, such as that provided by spruce budworm and tent caterpillar outbreaks.

4) Maintain or restore mixed forest cover at the stand level. To retain/restore hardwoods in conifer-dominated sites:

- avoid management practices, such as herbicide and thinning, that reduce the broad-leafed component of regenerating softwoods;

- retain young and mature hardwoods well dispersed throughout the harvest zone (preferably in clumps); and

- take extra care to retain hardwood seed trees.

5) Maintain or restore mix of forest types at the landscape level.

6) Promote reforestation of isolated forest tracts. This can be achieved by replanting or through natural succession.

7) Maintain a well-developed woody and herbaceous understory by observing the following practices:

- retain/encourage vigorous understory growth including herbaceous plants and shrubs/saplings (2-6 m tall, < 8 cm dbh);

- if thinning can not be avoided, delay it until the stand reaches a mid-successional stage (> 6 m high);

- limit removal, and avoid damage to understory vegetation during commercial operations; and

- control browsing by cattle.

8) Maintain or enhance forest floor structure for Canada Warbler nests:

- when harvesting/clearing avoid compaction

of hummocks, fallen logs, rotting stumps, and root masses that add structure to the forest floor; and

- leave woody debris on site.

9) Apply silvicultural treatments known to provide nesting habitat. Clearcuts with residual tree retention appear to have the greatest potential to create temporary habitat. Clearcutting without residual tree retention fails to provide song perches for territorial display and elevates the risk of converting a mixed forest to a pure stand. Remove all hip chain after fieldwork (Figure 57).

10) Evaluate Canada Warbler response to lighter prescriptions (e.g., single tree and small-group selection cuts) in order to ascertain their value to this species.



Figure 57. Over 70 species of ground-nesting and feeding birds in British Columbia have died in hip chain used during industrial operations, including silvicultural activities, in British Columbia. After use, all hip chain should be salvaged. Germansen Landing, BC. 5 June 1998 (R. Wayne Campbell).

11) When logging, or establishing seismic lines, control damage in the understory by:

- directional felling/clearing;
- working around shrubby patches; and
- when possible carry out activities during a heavy snow pack period.

12) Restrict tree removal, road construction, and bulldozing activities between the dates of Canada Warbler territory establishment (May 28) and final fledging (July 31).

13) Employ the best management practices to safeguard water quality, maintain natural hydrological regimes, and protect the structural and nutritional integrity of the soil.

14) Take a landscape perspective when managing songbird habitat. Consider the availability and configuration of habitat both within the management unit and beyond its boundaries.

15) Plan for the long term in order to build on gains made in the short term.

16) Balance the goal of providing Canada Warbler habitat with other ecological considerations, including the needs of other songbirds that require large tracts of mature trembling aspen forest.

Research and Monitoring of Canada Warbler in British Columbia

In 1995, a review of wood-warbler research in Canada revealed that among all 36 breeding species, Canada Warbler ranked 17th (12th if ties included) in the number of research papers it appeared in. Most papers discussed only one aspect of the species' biology, although a few discussed more than one aspect. The topics, and number of papers published on each (in parentheses) were: Distribution (n = 5), Abundance (n = 17), Habitat (n = 7), Breeding (n = 1), Feeding (n = 1), Other behaviours (n = 3), and Other (n = 14). Relative to Yellow Warbler (*Dendroica*

petechia), the species appearing in the most number of papers ($n = 83$), Canada Warbler had less than half the amount of research, clearly revealing that much more research is still needed.

In this section we summarize methods and new results from three research and monitoring projects conducted in British Columbia. These include:

- 1) the Breeding Bird Survey as a large scale monitoring program;
- 2) Point Counts and Transects as a habitat specific study, and;
- 3) Call Playback as an intensive, site-specific, single-species, approach.

Breeding Bird Surveys

The North American Breeding Bird Survey (BBS), administered by the United States Geological Survey (USGS), and more recently co-operated in Canada by the Canadian Wildlife Service (CWS), is the second-longest running systematic volunteer-based survey of birds in North America. Only the Christmas Bird Count, now with more than 100 years of data, has a greater history. While Christmas Bird Counts are designed to sample early winter bird populations in fixed area plots (*e.g.*, 12 km radius), the Breeding Bird Survey is a method that samples birds during the breeding season at specific sampling stations, along a linear route (Figure 58). Conventional USGS/CWS methods have routes with 50 survey stations spaced at 800-m intervals. Typical surveys occur from mid-May through early July, and generally coincide with peak, regional, breeding activity. Each survey begins 30 minutes before sunrise, and all birds seen or heard in three minutes, within a 400 m radius of each station, are counted.

Since inception of the USGS/CWS BBS, more than 125 routes have been established in British Columbia (Figure 59). Most have short histories (< 10 years), and many fewer have long consecutive sets of data (> 20 years). Most USGS/CWS BBS routes in British Columbia occur south of Prince George, and are concentrated in the Okanagan Valley, Lower Mainland, Vancouver Island, and the East and West Kootenays. In northeastern British Columbia, where



Figure 58. Chris Siddle recording birds heard and seen at a sampling station during a Breeding Bird Survey for Canadian Forest Products Ltd. in northeastern British Columbia. Falling Creek, BC. 7 June 2006 (R. Wayne Campbell).

Canada Warbler resides, only six USGS/CWS BBS routes have been established, the first being in 1974. Most of these routes are sporadically sampled, as is often the case in remote regions where only one or two keen birdwatchers may be available to complete the survey in any given year. In northeastern British Columbia (Figure 59), the longest running routes were those surveyed by Chris Siddle (Fort St. John route; 1981-1990) (see Figure 58) and Mark Phinney (Tupper route; 1994-2007); the remainder of the routes have comparatively little data.

A common characteristic of the USGS/CWS BBS, as a consequence of convenience and safety for the volunteers, is that many of the routes occur on well-maintained roads. Subsequently, most BBS stations tend to be at lower elevations, and often include urban and rural habitats, pasture and grazing lands, agricultural lands, and grasslands. Forested regions, especially those that are extensive and managed for forestry, are less well sampled and recent concern has been raised on the efficacy of these surveys to accurately predict abundance and trends of some forest-dependent species. For example, in eastern Canada and the United States, where forests are fragmented and gradually converted to agriculture or urbanization, declines in forest songbirds largely correlate with habitat loss. But in managed forests of the western boreal and coastal forests, declines are more difficult to ascertain because:

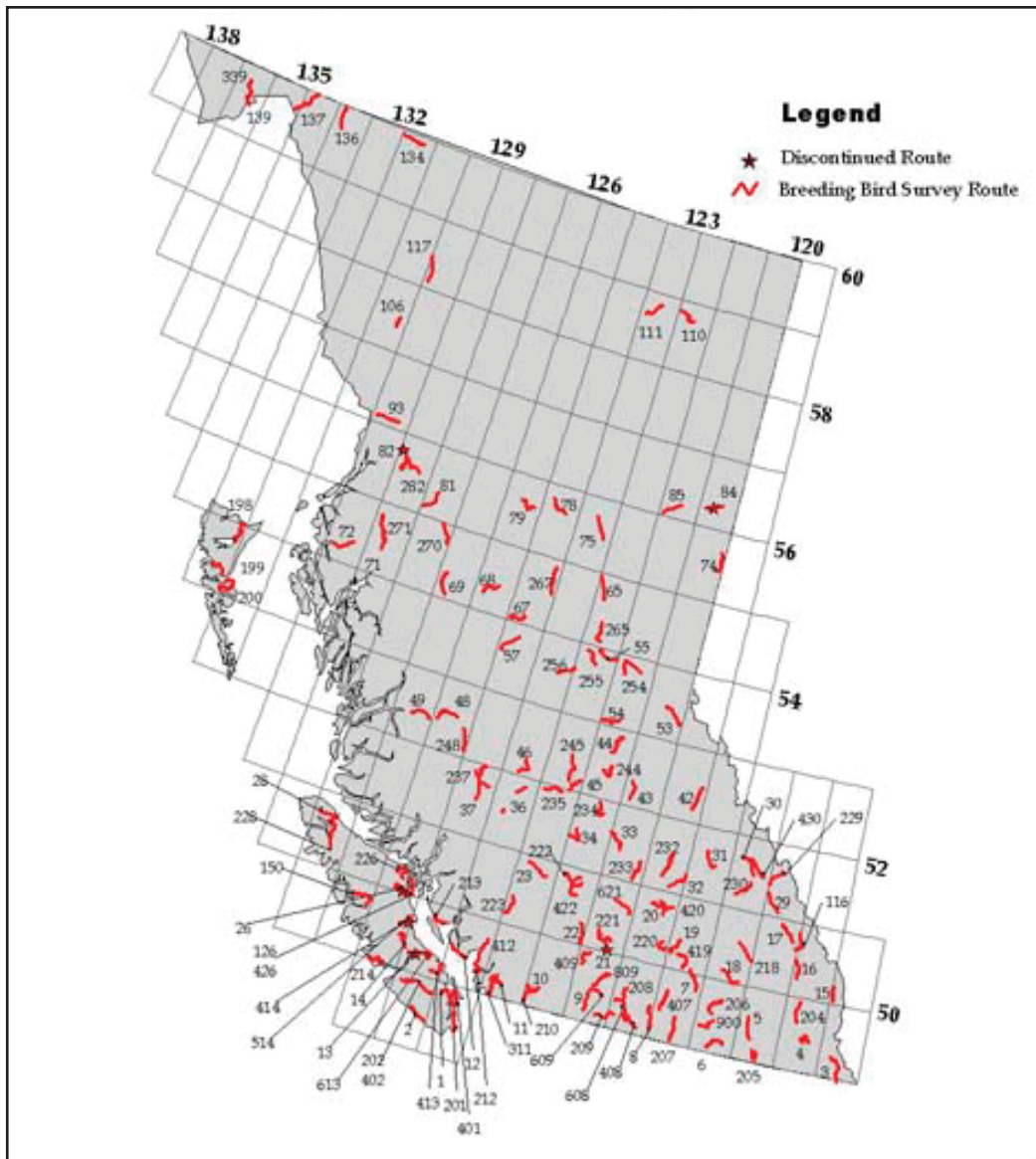


Figure 59. Distribution of USGS/CWS volunteer-based Breeding Bird Survey routes in British Columbia. (source: www.cws-scf.ec.gc.ca).



Figure 60. Distribution of Breeding Bird Survey routes coordinated by Canadian Forest Products Ltd. in northeastern British Columbia (2002-2007).

1) many of the routes occur in low-lying areas that are gradually deforested for urban, rural, and farming purposes, and are thus not a reflection of the larger landbase, and;

2) managed forests regenerate and have greater potential for maintaining stable population levels than areas permanently converted to non-forest habitats.

In British Columbia, these problems are all relevant to the censusing of Canada Warbler when using the BBS method.

Despite its limitations, the BBS is a useful tool (Table 6) for monitoring many species, and recently, several forest companies in British Columbia have adopted variations of the BBS protocol to address specific sustainable forest management questions. For example, beginning in 2002, and continuing through 2007, Canadian Forest Products Ltd. implemented BBSs in the vicinity of Tumbler Ridge, Chetwynd, Hudson’s Hope, Fort St. John, and Fort Nelson (Figure 60). Collectively, the areas represent several-millions of hectares of forest, and virtually all of the established BBS stations are representative of areas managed for sustainable forestry (*i.e.*, away from maintained public roads and permanent habitat-conversion areas). Of the 5,349 three-minute point counts that have thus far occurred in those areas, only 49 Canada Warblers have been observed. Thus, relative to survey effort, the probability of finding a Canada Warbler among the three major management areas was < 0.04% (Table 7), likely owing to the

species’ patchily distributed habitat along the survey routes. Only in the Fort Nelson study area were Canada Warblers observed on more than two consecutive survey stations of a given route, attributed mainly to a large block of mature hardwood-leading forest with a well developed understory of tall shrubs and a gently-sloping topography. Similar results were found for the six USGS/CWS routes within the British Columbia range of Canada Warbler. Of 44 surveys conducted between 1974 and 2006, or 2,200 station counts, only seven birds were observed (Table 7). Collectively, these BBS routes have shown that although they are primarily in managed forests, and overlap the known range of Canada Warbler in British Columbia, they are largely ineffective at detecting and monitoring Canada Warblers (*i.e.*, the BBS method is poor for patchily distributed species; Table 6).

Despite limits for monitoring long-term trends of Canada Warbler in British Columbia, the new BBS routes implemented by Canadian Forest Products Ltd. did result in a substantial increase in the known distribution of the species. Using the 1:50,000 scale (the scale of maps produced on pages 95-96), the known distribution of Canada Warbler in British Columbia increased by 26.3%. Understanding the extent of distribution is an important first step toward developing effective management plans.

From a monitoring standpoint, any proposal suggesting that the BBS method is the best, or most cost-effective, approach for monitoring Canada Warbler in British Columbia should be carefully scrutinized. Such an approach should consider

Table 6. A comparison of advantages and disadvantages of the Breeding Bird Survey from a species sampling perspective.

Advantages	Disadvantages
Good for abundant, widespread species	Not good for rare, or patchily-distributed species
Good for habitat generalists	Not good for habitat specialists
Good for species with small home ranges	Not good for species with large home ranges
Good for very vocal species	Not good for quiet, non-vocal species
Good for species that is active in morning	Not good for nocturnal or crepuscular species
Generally good for forest and grassland songbirds	Generally poor for all other species
Good for low to mid-elevation species	Not good for high elevation species (access)

Table 7. Numbers of Canada Warblers (CAWA) observed on Breeding Bird Survey routes relative to survey intensity (*i.e.*, survey duration, number of routes, number of individual counts) in northeastern British Columbia (1974-2007).

Survey Groups	Survey Period	Total # of BBS Routes	Total # of Surveys	Total CAWA Detections	Birds per Station
USGS/CWS BBS	1974 - 2007	6	2,200	7	0.003
TFL 48 (near Chetwynd)	2002 - 2007	15	3,442	13	0.004
Fort St. John TSA	2005 - 2007	16	1,349	4	0.003
Fort Nelson TSA	2006	20	558	32	0.036

* USGS/CWS = United States Geological Survey / Canadian Wildlife Service; TFL 48 = Tree Farm License 48; TSA = Timber Supply Area.

how well survey stations are likely to align with “suitable” habitat (see *Quantifying “Suitable” Habitat for Canada Warbler in British Columbia*, page 107-113), and how likely it is that the bird will be detected compared to other methods designed to sample specific habitats more intensely (see *Habitat Specific Point Counts and Transects*, below).

Habitat Specific Point Counts and Transects

When dealing with single-species management, it is often appropriate to use methods that allocate more time searching those locations with habitats most suited to the species of interest, than to randomly sample the larger suite of habitat types distributed across the landscape. Unfortunately, little is known of the habitat requirements of Canada Warbler in British Columbia, and so it is difficult to determine beforehand what the upper and lower extremes of habitat variation are acceptable for Canada Warbler site occupancy. Even seemingly suitable habitat may be unoccupied if, for example, there is insufficient food in the area required to maintain a territory and raise a family. Thus, while this section focuses on the use of point counts or transects in specific habitat types, it is imperative, given our current state of knowledge on habitat use by Canada Warbler in British Columbia, that researchers systematically record habitat attributes for “suitable” plots that are both occupied, and unoccupied, by this species. This will help greatly in the identification of specific habitat attribute limits, and allow for better stewardship of the species’ habitats.

Point counts are stand-alone survey stations

used to compare bird species and relative abundance between habitat types (Figure 61). Ideally, the habitat within the entire point count radius is homogeneous (*i.e.*, of one type). If this is not the case, then the specific habitats must be carefully noted to account for the birds that are tallied. Usually, point count

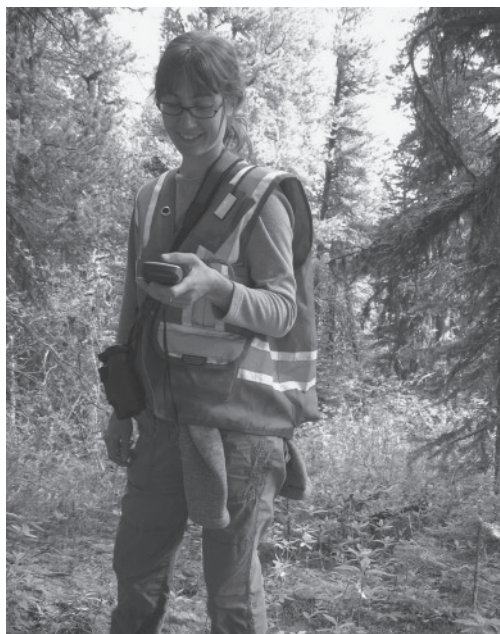


Figure 61. Habitat-specific point counts can be used to compare species presence and abundance among pre-defined habitat types. Ivorline Creek, BC. 22 June 2007 (Colin Bailey; Jacques Whitford-AXYS).

stations are situated within the habitat(s) of interest. Alternatively, the stations can be established at periodic intervals and the habitat(s) documented afterward (similar to the BBS protocol). The latter technique is generally used to document birds found within a large area and detailed association with habitat types is of secondary importance. Point counts typically have a fixed radius, are non-overlapping, and do not occur on or near abrupt edges (e.g., roads, seismic corridors, and pipelines), unless edges are part of the study question. For a study to be considered reasonably robust, there often needs to be at least 20 point counts in each broad habitat type. This imposes limits on how many stations can be censused in a given season, because transportation between point count stations (driving and hiking between suitable habitat locations) consumes considerable amounts of time. The study design becomes more time-consuming when individual stations are sampled more than once, a common technique used to estimate within site variability and to reduce effects of chance events (e.g., the bird is present, but is not detected).

Habitat-specific transects are similar to the BBS, but on a much smaller scale. Typical transects range from 100 to 1000 m in length (e.g., they fit within the habitat type of interest), with observations being recorded either: 1) continuously, noting the location of each bird along the transect line, or 2) at specific stations along the transect line, similar to the BBS method. Transects are usually completed on foot, and move at a reasonably slow pace that allows for detection of most species. Continuous transects sample more of the habitat than do a series of independent stations along a transect line. Thus, continuous transects are often a preferred method for species occurring in low densities of suitable habitat. If several transects are to be used in a relatively small area, care should be taken to ensure that they are non-overlapping, thus reducing the chance of counting the same bird more than once.

In 2007, in the Fort St. John TSA, Michael Preston and Amber Robinson conducted point counts in hardwood-leading and mixedwood stands to answer questions pertaining to BBS effectiveness (i.e., on-road versus off-road survey effects on bird abundance and detectability). Similar to most USGS/

CWS BBS routes in northeastern British Columbia, no Canada Warblers were detected, despite knowing that some very nearby locations were occupied. These findings add to the growing conclusion that in British Columbia, Canada Warblers are very patchily-distributed, and likely require very specific habitat conditions, and more intensive survey coverage, such as that afforded by the habitat-specific transect method.

In the vicinity of Dawson Creek, Mark Phinney used the habitat-specific transect method to survey four large blocks of forested habitat. Counts were done in 1993-1995 (Canadian Forest Service), and repeated in 2003-2005 (Louisiana-Pacific Canada Ltd.). This survey yielded 82 Canada Warbler detections, indicating that the method was clearly adequate in terms of finding birds. Interestingly, the habitat covered by the survey was generally unchanged between the two time periods and the number of Canada Warblers remained relatively stable (Figure 62).

Call Playback Surveys

The call playback method is a technique that uses pre-recorded sounds, typically breeding songs or calls, to elicit responses from species that are generally quiet, occur at low densities, or have songs that are difficult for people to identify from other similarly sounding species. The sounds are usually broadcast from a portable CD player or other electronic device, and are most commonly used to census species belonging to the owl, rail, and woodpecker families. Robust call playback studies often attempt to mimic natural singing frequencies, loudness, tone, and pitch, using specialized recording and playback equipment. However, the most common problem is that song structure (or dialect) often determines whether the playback method will be effective. For example, songs recorded in eastern Canada or the United States often do not elicit responses from the same species in western parts of the continent.

In 2007, Wayne and Eileen Campbell used the call playback method in many areas throughout northeastern British Columbia, from Swan Lake near the BC-Alberta border, to near Watson Lake on the BC-Yukon border (Figure 63). The call playback experiment was not designed to test any specific

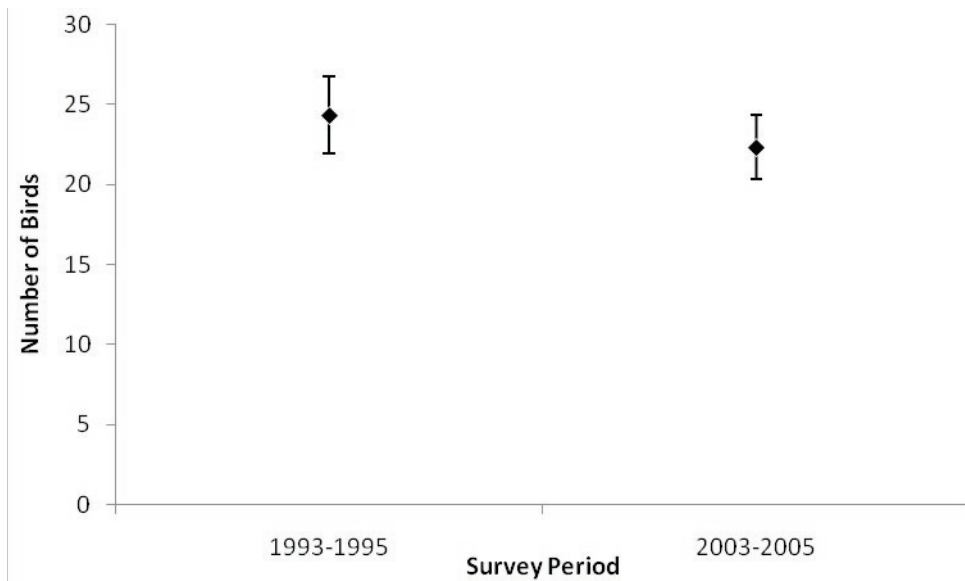


Figure 62. Comparison of mean number of Canada Warblers from the same four habitat-specific transects surveyed a decade apart in the vicinity of Dawson Creek, BC. Bars represent standard error (Data courtesy M. Phinney).

hypotheses about Canada Warbler distribution and occurrence in British Columbia. Rather, it was used as a method to quickly locate birds in new, and known, areas so that many sites could be identified and habitat assessments could be made (see *Quantifying Suitable Habitat for Canada Warbler in British Columbia*, page 107-113). Results of the fieldwork produced 151 (137 males, 14 females) individual birds from 108 call playback sites (Figure 64). Most sites had only one bird, typically a male, but one site had as many as five birds, including a female. Birds that were not singing prior to tape playing usually did not begin to sing. Instead, they flew toward the player, often landing at the edge of the forest. Birds that were previously singing typically stopped, and flew toward the player.

Results of this experimental approach for locating Canada Warblers in British Columbia suggests the method has considerable potential for a single species monitoring program. However, because it can be a fairly time consuming method, a good study design should include additional parameters to make



Figure 63. The call playback method is a technique that can be used to elicit a response from Canada Warblers if they are not spontaneously singing. Near Andy Bailey Lake, BC. 16 June 2007 (Eileen C. Campbell).

it worthwhile. For example, sites should be chosen randomly from a pool of potential sites, similar to the habitat-specific point count methods discussed earlier. This could be done using forest cover maps, but visual



Figure 64. Locations of Canada Warbler occurrences (dark dots) resulting from call playback fieldwork conducted throughout northeastern British Columbia in 2007. The western limit of the known range now includes the Lower Post region of the province just southeast of Watson Lake in the Yukon Territory.

inspection by species' experts might help narrow the selection pool prior to study commencement. Once sites are identified, call playback methods should include a listen-and-look period, such as three minutes, so that if the bird is singing or moving about spontaneously, then the call playback would not be necessary. If after this three minute period no birds are detected, then the pre-recorded sound could be broadcast for the same duration (three minutes). The listen-and-play process could be repeated more than once at each site, but this is a matter of study design preference (increases time and reduces number of sites) and the possible reluctance of the species to respond immediately. The results of the call playback method could then examine the question of whether birds are more likely to be detected using the call playback method, compared to listening only. More importantly, it would be worth asking how often Canada Warbler is detected after the call playback has been administered, thus providing an estimate of how many false or negative results may potentially occur from listen-only studies conducted in suitable habitat. Call playbacks can also be administered at a finer scale than the BBS method, and stations in areas of good habitat could be as little as 50-100 m apart. Regardless of results, measures of habitat attributes should be taken from all sites, including those where birds were not detected (Figure 65).

Databases

This account is based on 9,087 single occurrence records and 34 individual breeding records that include nests with eggs, recently fledged young, or



Figure 65. Measures of habitat attributes are central to our understanding of species-habitat relationships. Significant findings are commonly included in the development of management, stewardship, and recovery plans. Here, Mark Phinney measures the diameter of a mature trembling aspen, to gain further understanding on the importance of stand age on Canada Warbler occupancy. Arras, BC. 20 October 2007 (Joanna A. Phinney).

Brown-headed Cowbird parasitism (Table 8).

Developing the databases for this species was unlike any other to date. A lot of searching was required, often with little result, for a species that was locally distributed and considered rare. About 90% of our dataset was developed through a detailed search over the past four months of the Wildlife Data Centre library. Information here included historical diaries, field notebooks, breeding records, museum catalogues, conference proceedings, scientific publications, early consultant reports, naturalist newsletters, sightings from naturalists (Figure

Table 8. Differences in total text (excluding Tables, Captions, and Literature Cited), distribution information, and size of databases used in the Canada Warbler account published in *The Birds of British Columbia* (BBC) in 2001 with the current account from updated databases housed in the Wildlife Data Centre (WDC) in 2007.

	Information	Distribution ¹		Database	
	Total Words	Occurrence	Breeding	Occurrence	Nest Records Cards
BBC	1,781	15	2	127	5 ²
WDC	17,843	53	11	9,087	34
% Increase	902	253	450	7,055	580

¹Based on the total number of 1:50,000 National Topographic System grids occupied.

²Total cards available in the British Columbia Nest Record Scheme.

66), correspondence, banding records, telephone messages and recordings, e-mails, and unpublished literature.

Compounding the search were issues now concerning the lack of availability of information resulting from the Species at Risk Act (SARA), the refusal to release information by government, industry, and consultants for confidentiality reasons, the difficulty of obtaining specific details from



Figure 66. Incidental observations, from well known naturalists like David Stirling, contributed to the historical and current distribution maps and migration dates for Canada Warbler in British Columbia. Taylor, BC. June 1979 (Richard R. Howie).

provincial government databases, and the growing concern from some birdwatchers that others are making financial gains from their information without contributing to the conservation of the species.

We think the baseline information we have assimilated will be useful in assessing future research needs and management options for Canada Warbler in British Columbia. The range of Canada Warbler, with its first arrival in 1970 and subsequent expansion through 2007, now includes much of the northeastern portion of the province – a remarkable change in just 38 years! But it is only now, through a dedicated effort to focus on just one species, that we can truly appreciate what is required to produce a comprehensive species account.

Did You Know?

A Warbler of Distinction

Newfoundland was the first to put a bird on a stamp, a Willow Ptarmigan, in 1897. The earliest issue containing a bird image on a Canadian stamp was the 1946 airmail featuring a Canada Goose. Since then, another 27 species of birds have appeared on Canadian stamps, but Canada Warbler is the only wood-warbler to be recognized and was first seen in post offices on February 24, 1999 (Figure 67).



Figure 67. Images of wildlife on postage stamps, especially birds, is a growing trend and popular with collectors around the world.

A Lexicon of Our Warbler

The scientific name for Canada Warbler, *Wilsonia canadensis*, has two origins. The genus was named after Alexander Wilson, the son of a part-time weaver and smuggler, who emigrated from Scotland to the United States in the late 1700s. He met the great American naturalist, William Burtram, who introduced him to the ornithological literature. Alexander's interest in birds grew quickly and soon he was teaching himself how to paint and write. He suggested an idea for an "American Ornithology" that was supported by the publisher Samuel Bradford. In 1808, Wilson's first book of a proposed 10-volume set on the ornithology of the eastern United States was published. Wilson died in 1813 having just

completed the eighth volume. A ninth volume was completed by his friend George Ord.

The species name, *canadensis*, is Latin for “of Canada” where the original specimen was collected and used to describe the warbler.

Huge Effort for Little Return

Banding birds is a useful tool for ornithologists studying individual behaviour and other parts of the life of birds. It is a huge investment in time and resources. One of the motivations for all banders is to recapture a previously banded bird or have one recovered from some exotic location. Some of the highest band returns (sometimes reaching 10%) are from waterfowl and gulls. The recovery rate for songbirds, however, is very low. For example, through the early 1980s a total of 46,973 Canada Warblers were banded in North America. Of these only 20 (0.04 %) have been recovered.

The Internet

With recent concern about declining numbers of Canada Warblers in parts of its range in northeastern North America there has been a plethora of new information available to web surfers over the past decade.

Additional information useful to British Columbians concerned about Canada Warbler, and other boreal forest birds, can be found at:

Biodiversity Centre for Wildlife Studies
(www.wildlifebc.org)

Birdlife International
(www.iucnredlist.org)

Boreal Songbird Initiative
(www.borealbirds.org)

British Columbia Ministry of Environment
(Conservation Data Centre)
(www.env.gov.bc.ca)

Canadian Boreal Initiative
(www.borealcanada.ca)

Canadian Forest Service
(Pacific Forestry Centre)
(webmaster@pfc.cfs.nrcan.gc.ca)

Canadian Wildlife Service
Bird Trends web-site
(www.cws-scf.ec.gc.ca/cws-scf/birds)

Committee on the Status of Endangered Wildlife
in Canada (COSEWIC)
(www.cosewic.gc.ca/eng/sct5/index_e.cfm)

Environment Canada – Wildspace Range Map
(<http://wildspace.ec.gc.ca/intro-e.html>)

Forest Stewardship Council
(www.fsccanada.org/documents2.htm)

NatureServe
(www.natureserve.org/explorer)

North American Breeding Bird Survey
(www.mbr-pwrc.usgs.gov/bbs/bbs.html)

Partners in Flight
(www.partnersinflight.org/pubs/)

Patuxent Wildlife Research Centre
(<http://bna.birds.cornell.edu/Bna>)

Warbler Watch
(<http://birdsource.cornell.edu>)

Finding Canada Warbler in British Columbia

Canada Warbler is one of the easier birds of the northeastern specialties for birdwatchers to find. While it is widely distributed throughout the entire Peace River region in appropriate habitat of mature mixed trembling aspen forests with a dense tall shrub understory, it occurs in discontinuous forest patches (Figure 68). Its song is loud and unmistakable but at times it has to be encouraged to come out of the shadows to the edge of the forest. Not all individuals, however, respond to pishing. Please refrain from the use of recorded songs to find Canada Warblers at these locations. These are amongst the best places to



Figure 68. Eileen Campbell searching trembling aspen forests for Canada Warblers near Worth, BC. 11 June 2007 (R. Wayne Campbell).

observe the species so disturbance to the birds should be minimised to ensure their continued presence.

There are many sites that can be visited to search for this colourful warbler but only a handful are guaranteed with high populations, safe access, good all-weather roads, and generous pullover spots. Please remember that all dirt roads, and some with gravel, are treacherous to travel on after thunderstorms or during prolonged wet weather. Also, bears are common throughout northeastern British Columbia.

If you are adventurous and want to explore more remote regions along active logging roads or on roads to oil and gas sites, be informed about road user procedures. These have been summarized in *The Birds of Chetwynd... with Popular Birdwatching Sites* and are available free from tourist@gochetwynd.com.

Dawson Creek

Bear Mountain: Only a few kilometres from Dawson Creek, the Bear Mountain area has plenty of Canada Warblers. Most of the birds are well away from roads, however. Two areas that are easily accessible

by road and fairly dependable for Canada Warbler are Km 2 on Radar Lake Road and middle sections of the Bear Mountain tower road (Road 233). To reach Radar Lake Road, take the 'Dangerous Goods Route' (DGR) (bypass) which joins Highway 2 at WalMart, and with Highway 97 at the Petro-Canada cardlock station (either way will work). At the only curve in the road along the DGR, follow signs for the Bear Mountain community forest and turn west on (gravel) Adams Road. After 1.6 km, turn south on Road 223. A further 1.6 km along will be a crossroad, which marks the beginning of Radar Lake Road. Although the road is marked as radio-controlled, recreational traffic is overwhelmingly more common. Occasionally there is some heavy truck traffic related to gravel hauling or oil/gas activity, so be cautious. Continue up the hill to Km 2 where a road takes off to the right. Pull off here (if there is no gravel truck activity) and investigate the hillside along the main and side roads. Alternatively, continue past the road to the right for another 300 m on the Radar Lake Road and pull off to the left. Investigate the hillside along the main road. The habitat is mature deciduous forest with a thick understory, and Canada Warblers are normally present every year. To reach the Bear Mountain towers, take the Old Hart Highway west from Dawson Creek for approximately 9.8 km, and turn south on Road 233. As the road begins to wind up the hill, watch for good habitat on either side of the road. The middle to upper sections of the road offer the best chance of finding Canada Warblers. Currently, the road is used mainly by residents and recreationalists. For a spectacular overview of the area, park at the top of the hill and follow the obvious walking trail southward along the ridge for 3 km until reaching the rimrocks – a prominent escarpment and future site of the Bear Mountain Wind Farm.

Other birds of interest that can be found here include Ovenbird, Mourning Warbler, Black-and-white Warbler, American Redstart, Philadelphia Vireo, Rose-breasted Grosbeak, and Yellow-bellied Sapsucker. Radar Lake Road continues for several kilometres before dead-ending (or becoming impassable). There are many good birding spots, and the area is very dependable for Black-throated Green Warbler and Blue-headed Vireo in mature spruce/trembling aspen forest.

Brassey Creek: The Brassey Creek area includes a good variety of habitat types and elevation range. It is a popular destination for many visiting birders. Unfortunately, the main road has become much busier with industrial traffic in recent years. To reach Brassey Creek, go west from Dawson Creek on Highway 97 (towards Chetwynd). At Km 20 (just past the Kiskatinaw River bridge) turn south onto the Heritage Highway (Route 52) towards Tumbler Ridge. Continue south for 26 km, and watch for a major dirt road leading off to the right. There will be numerous oil/gas signs including one for the Brassey Plant. This road is radio-controlled and can be busy. Weekends and early mornings are your best bets to avoid traffic. Starting at the first cattle guard (0 km sign) drive six kilometres and then take the side road that leads straight as the main road turns right. The side roads are usually much quieter than the main Brassey Road. Cross a small bridge and take the first left. This road goes uphill, then flattens out. Park near the crest (400 m from the fork) and search both sides of the road (downhill side is easier) in the general area. Park off to the side and walk along – it is a very birdy area. It will be necessary to walk to the edge of the forest to see the birds. Several Canada Warblers establish territories in this area every year. The aspen forest between Km 1 and Km 3 of the Brassey mainline is good for Connecticut Warblers. Yellow-bellied Flycatchers can be found near the bog at Km 0 and on the ridge at the end of the Brassey Road.

Swan Lake (Road 201): This is a popular site to see Canada Warblers because access is easy and a deactivated side road allows visitors to enjoy the bird without worrying about traffic, noise, and dust. Early in the season warblers can be found singing from aspens but by mid-to late June they are more often encountered in the shrubby understory (Figure 69).

The narrow grassy corridor is occasionally used by Black Bears (sometimes with cubs) to feed and travel, so be alert for fresh droppings and suspicious noises. Also, the road can be very slippery and dangerous during and immediately after thunder showers so caution is advised.

Directions (Road 201): Travel from the centre of Dawson Creek (the roundabout) south along



Figure 69. Typical Canada Warbler habitat along Road 201 southwest of Swan Lake, BC. 25 June 2007 (R. Wayne Campbell).

Highway 2 towards the BC/Alberta border through Pouce Coupe and Tomslake for about 39 km. Just before the provincial border turn right (south) onto Road 201 and travel about 6.2 km, passing the Northwest Tel microwave tower, to a small pullout on the left. The deactivated road angles off from this spot.

Canada Warbler can also be found for another two kilometres or so on the main gravel road, but this location is often busy with traffic from a gas operation site near the end of the road.

In early June up to 14 Canada Warblers, both males and females, have been recorded in the area during a single visit. One of the three nests with eggs was found here.

Other species of interest include American Redstart and Yellow Warbler, both in very large numbers, and also Mourning Warbler, Black-and-white Warbler, 'Red' Fox Sparrow, Tennessee Warbler, Philadelphia Vireo, and occasionally Blackpoll Warbler.

Taylor

Although Canada Warbler had been reported in the vicinity of Taylor in the late 1970s, it was Chris Siddle (Figure 70) who let the birding community know in 1980 that the species could easily be found in two areas just across the bridge from Taylor. Since then, the trembling aspen woods along Johnson Road and in the vicinity of Peace Island Park have been visited more than any other site in British Columbia.

Both areas are easily accessible by wide, all-weather gravel roads that are well maintained and usually have little traffic.



Figure 70. When Chris Siddle found Canada Warblers near Taylor, BC in the 1980s he alerted bird watchers and today this is a popular location to see the species. 12 June 1990 (R. Wayne Campbell).

Directions (Peace Island Park): Travel south for about 3.3 km on Highway 97 from the centre of Taylor across the suspension bridge over the Peace River. The bridge, the longest on the Alaska Highway at 650 m (2130 ft), was opened in 1943. Just south of the bridge exit right onto Big Bam Road and drive another 0.8 km to Peace Island Park. This campground has 60 sites and is open from May to

August.

Continue past the park to avoid traffic and noise and look for older trembling aspen woods with lots of shrubs. Canada Warblers are regularly found on the forested slopes but some effort is required to locate singing males. Birders often visit the park to search for other neotropical migrants, especially Connecticut Warblers, and infrequently Canada Warblers can be found in mixed aspen poplar stands.

Other species of interest include Barred Owl, Blue Jay, and Rose-breasted Grosbeak. American Redstart, Yellow Warbler, and Least Flycatcher are abundant along brushy edges. Calliope Hummingbirds are likely around any feeder along the road. An occasional Ruby-throated Hummingbird be spotted, making this road one of the few sites in the province where a birder has a chance of encountering this rare stray from east-central Alberta. Other "eastern" warblers that occur here include Black-throated Green Warbler around the tall spruce and balsam poplars at the end of the road, Cape May Warbler occasionally in the spruce stands, Mourning Warbler along brushy edges, Ovenbird and Black-and white Warbler in old-growth balsam poplar stands, and Magnolia Warbler in thick mixed woodlands. Red-osier dogwood thickets at the park attract flocks of migrants feeding on berries prior to departing for the south from mid-August to early September. Swainson's and Hermit thrush, Ovenbird, White-throated Sparrow, Evening Grosbeak, and Eastern Kingbird are among the regular species, but this is a good time to look for more unusual species such as Philadelphia and Blue-headed vireo.

Directions (Johnson Road): Travel south for about 3.3 km on Highway 97 from the centre of Taylor, across the suspension bridge over the Peace River and start up the hill. Exit the first road on the left, Johnson Road, and drive to where aspen forest occurs. Initially, some of these forests are difficult to reach because they occur on steep slopes that can only be reached through private property, but over the next few kilometres, Canada Warbler habitat is easily accessible (Figure 71). Up to seven territorial males have been counted along the treed road in late June.

The earliest record for Canada Warbler in the province, 22 May, was recorded along Johnson



Figure 71. Canada Warbler frequents dense tangles of shrubby habitat on slopes along Johnson Road overlooking the Peace River south of Taylor, BC. 21 June 2006 (R. Wayne Campbell).

Road.

Other species of interest include virtually all of the species mentioned for Peace Island Park, as well as Yellow-bellied Sapsucker, Gray Jay, Northern Goshawk, and “Red” Fox Sparrow.

Fort Nelson

The Fort Nelson area is the Canada Warbler capital of British Columbia. Although the species was first discovered in the area in 1976 it was nearly two decades later before birders fully appreciated the commonness of the species. Part of this was due to access roads being built into new regions by the oil and gas industry, and also by the presumed expansion or colonization of areas east of the town limits. While Canada Warbler has been found nesting near the town’s garbage dump, the best places to find them is on the outskirts of the airport, and along two

well-maintained gravel roads south of the town.

Directions (Fort Nelson airport area): Town maps can be obtained from the Tourist Information Centre. To get to the airport, drive down Airport Drive from the centre of town and follow signs. Do not turn into the airport. Access is from the west side of the airport, along a narrow side road (Figure 72). The road can be very slippery in wet weather.

Directions to Clarke Lake Road: This busy industrial road, on the southern edge of town, is well marked. From the Tourist Information Centre in Fort Nelson, travel south along Highway 97 for 10 km. Turn left (east) from Highway 97 and travel until the



Figure 72. The first reliable spot to find Canada Warbler in the Fort Nelson area was discovered by Jack Bowling in the mid 1980s. Small numbers still occur along the dirt side road near the airport that ends at the Muskwa River. Fort Nelson, BC. 23 June 2007 (R. Wayne Campbell).

wide, dusty road narrows. This may be anywhere from 20 to 30 km. Although Canada Warblers are found in suitable habitat along this entire stretch, traffic is disruptive and noisy. There are many pullouts along the way (see Figure 24) and several are surrounded by mixedwoods. Canada Warblers can often be heard singing and a short walk to the edge of the woods will allow good looks.

Directions to Andy Bailey and Jackfish Roads:

From the Tourist Information Centre in Fort Nelson travel south along Highway 97 for 29.4 km. Turn left (east) onto Andy Bailey Road and travel 0.8 km, for the first Canada Warbler. The habitat appears atypical, but the brushy slopes have had singing males since the late 1970s. Canada Warbler is common over the next 3.1 km (Figure 73) at which point the road divides into the lower Andy Bailey Park Road that leads to the park and the lake, and the upper route that is marked as Jackfish Road. Both roads have warblers but the upper road is the least traveled.



Figure 73. Typical Canada Warbler habitat along Andy Bailey Road near Fort Nelson. 16 June 2007 (R. Wayne Campbell).

Trembling aspen mixedwoods along these roads have the highest known density of Canada Warbler in the province. On 16 June 2007, 43 birds, mostly males, were attracted during a playback survey along portions of the Andy Bailey and Jackfish roads. At one stop on Jackfish Road, five males appeared at the forest edge, three on one side, and two on the other side, of the road.

Liard River Hot Springs Park

Small numbers of Canada Warblers can be found along the Alaska Highway (Highway 97) for about five kilometres north of the park entrance. A favourite spot is near an abandoned cabin on the west side of the highway, where there is ample room to park a car. Other locations require parking on the side of the highway and walking 100-150 m across grass and low shrub areas to the edge of the forest.

Acknowledgements - Your Data at Work

Canada Warbler is a sought after species by birders for their annual and life lists, and they have to travel to the Peace River region to assure seeing the bird in British Columbia. While many of the incidental records of Canada Warbler in our databases are from these birdwatching trips, most of the information is from field work and surveys carried out by wildlife consultants, university researchers, biologists, and industry personnel. Another major source of records was from participants in the *South Peace Breeding Bird Atlas* project being coordinated by Mark Phinney that is scheduled for publication in 2008.

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Figure 74. Sandra Kinsey (left) and her partner Laird Law (right) have been investigating the bird life in the Peace River region of British Columbia since 1992. During that period they have discovered many new locations for Canada Warbler during field surveys and have helped develop habitat requirements for the species in the Dawson Creek area.

the warbler's status in the Northwest Territories.

Anthea Farr, Sandra Kinsey, and Laird Law critically reviewed the account for content and completeness.

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Unavailable Data

Individual records with specific information (*e.g.*, location, date, observer(s), behaviour, number, sex, age, elevation, habitat, etc.) that we requested from public databases including the British Columbia Conservation Data Centre, Canadian Wildlife Service, Bird Studies Canada, and British Columbia Hydro were not received, and consequently are not incorporated into this account.

Useful References

The following list of citations is only a sample of the hundreds of articles that were used to develop our databases and write this account. We have included only literature that was a main source of records and provincial information or a significant contribution to developing the conservation and management section.

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Figure 75. Fallen logs, branches, and other forest debris teem with life, and provide foraging and breeding sites and protection for Canada Warblers in British Columbia. Southwest of Swan Lake, BC. 27 June 2007 (R. Wayne Campbell).

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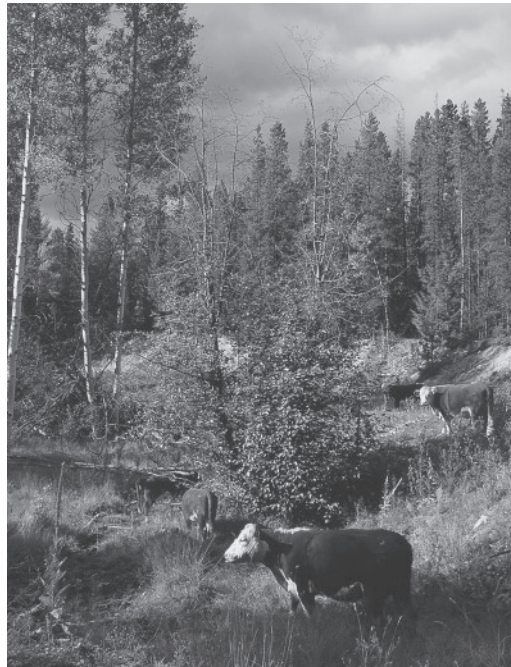


Figure 76. The cumulative effects of free-range livestock grazing on forest ecosystems in British Columbia, including boreal forest regions, is unknown. Elsewhere in North America there is widespread concern about its ecological impact, especially in grassland habitats. Stemwinder Mountain near Hedley, BC. 5 July 1989 (R. Wayne Campbell).

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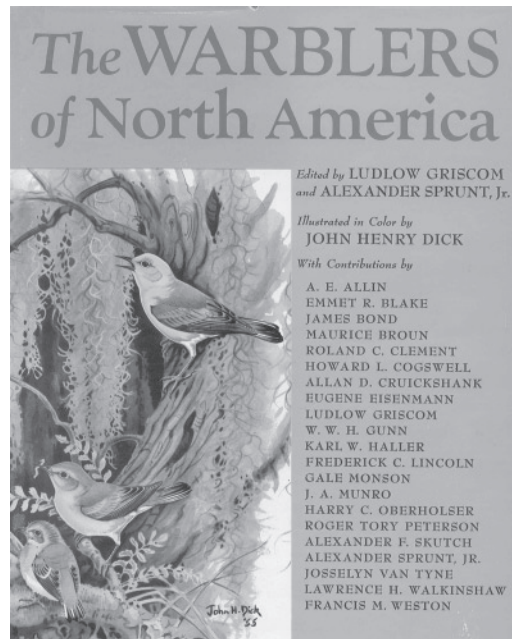


Figure 78. Twenty-one noted ornithologists pooled their collective experience to write a classic work on the life history of 60 species of warblers that occurred in North America through the mid-1950s. What is often overlooked is a delightful chapter in the book entitled *The Warblers in British Columbia* written by James A. Munro, published in 1957. He summarized migration routes and times for 20 species in the province, suggesting for example, that the Columbia River valley is an important migration route into the interior of British Columbia for the American Redstart. Canada Warbler was not found in the province until two decades later.

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Figure 79. In the Taiga Plains ecoprovince, native herds of roaming Bison attract small numbers of feeding Brown-headed Cowbirds each summer that parasitize nearby nesting songbirds. 30 km north of Liard Hot Springs, BC. 30 June 2006 (R. Wayne Campbell).

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Figure 80. The conversion of forests to agricultural land in the boreal forest region of northeastern British Columbia is a direct threat to Canada Warblers. Tea Creek, near Charlie Lake, BC. 22 June 1996 (R. Wayne Campbell).

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Figure 81. Seismic lines, the result of oil and gas exploration activities, crisscross boreal forest regions and often invade Canada Warbler nesting habitat. Fort Nelson, BC. 25 February 1995 (R. Wayne Campbell).

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Figure 82. The single most significant impact on migratory songbirds in this century will be climate change and its impact on ecological processes. Add to this a rapidly changing human-altered landscape and over the next 100 years, birds will continue to be discovered in new places in British Columbia. Some populations are already showing northward shifts. Fort St. John, BC. 2 June 2004 (R. Wayne Campbell).

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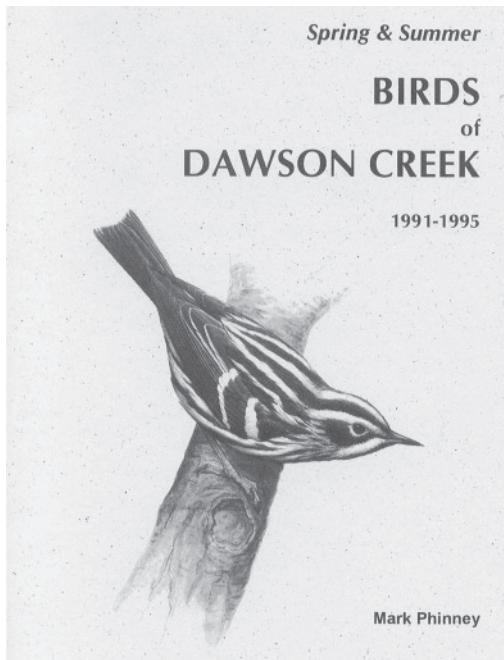


Figure 83. Regional bird books, like *Spring & Summer Birds of Dawson Creek*, were important sources of introductory information on Canada Warbler in northeastern British Columbia.

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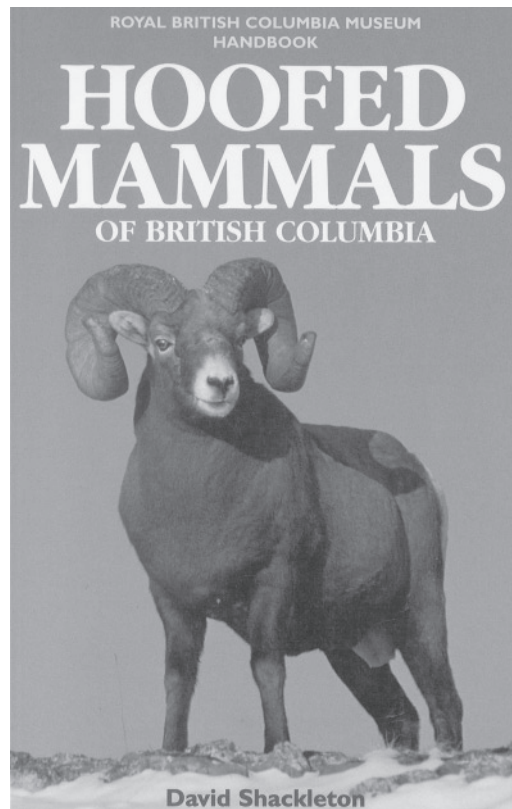


Figure 84. Summary and historical information on hoofed mammals in the province was invaluable in assessing the effect native and introduced Bison might have on populations of Brown-headed Cowbirds and their parasitic habits on songbirds in British Columbia.

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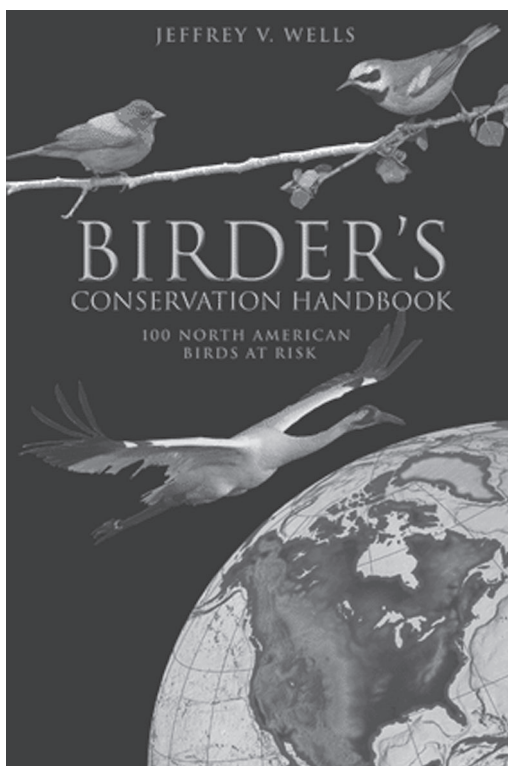


Figure 85. The Birder's Conservation Handbook, which features Canada Warbler among its 100 North American species covered, is the latest of a growing number of bird conservation references. A strength of the species' accounts is that they provide an overview of management concerns for both breeding and wintering areas.

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About the Authors

Wayne was the driving force, and the senior author, of the four-volume set *The Birds of British Columbia*. He has authored over 50 books and 480 articles on British Columbia's higher vertebrates. He has received numerous awards for lecturing, writing, and conservation activities including the "Order of British Columbia" from the Government of BC in 1992 and the "Award of Excellence in Biology" from the Association of Professional Biologists of BC in 1989.

Although retired, he volunteers some of his time as an Associate Editor of *Wildlife Afield* and maintains his 37-year passion as the provincial co-ordinator of the British Columbia Nest Record Scheme.

Michael is a wildlife biologist with a passion for studying species-habitat relationships for better understanding of how conservation and management plans may be more effective. His time is tightly divided between his consultancies to industry, collaborative research with academic institutions, public lecturing, science and natural history writing, and being editor and publisher of *Wildlife Afield*, as well as database manager for the Biodiversity Centre for Wildlife Studies.

Mark is the District Biologist for Louisiana-Pacific Canada Ltd. in Dawson Creek, where he

is responsible for all aspects of forestry-wildlife management. He has worked in the south Peace area since 1991, and moved to Dawson Creek in 1999. He is also the President of the South Peace Bird Atlas Society, and sits on the steering committee for the recently formed British Columbia Breeding Bird Atlas project.

Chris, a retired high school English teacher, is currently in Australia for the year. From 1975 to 1989 he lived in Fort St. John, and his passion for birdwatching and note-taking resulted in many new locations and dates for Canada Warbler in northeastern British Columbia. By publicizing “hotspots”, such as Johnson Road and Peace Island Park south of Taylor, birders began to flock to the Peace River to see Canada Warblers. Their records helped fill in gaps on arrival and departure dates. Chris has been a long-time participant in many provincial programs including the British Columbia Nest Record Scheme, Christmas Bird Counts, Breeding Bird Surveys, and regional reports published by the National Audubon Society. While in Australia Chris stepped down temporarily as a Director of the Biodiversity Centre for Wildlife Studies.

John is a Registered Professional Biologist and Forester who has worked for industry as a wildlife biologist and biological planner since 1989. He started with Canadian Forest Products Ltd. in 1992 on northcentral Vancouver Island and in 2004 moved to Prince George where he served as wildlife and biodiversity manager. John’s current focus is “Species at Risk” planning as well as planning to keep common species common. John recently received Wildlife Habitat Canada’s award for his “Forest Stewardship Recognition Program” and the Bill Young Award from the Association of Professional Biologists of British Columbia for “Excellence in Integrated Resource Management”.
