

# BLACK-THROATED GREEN WARBLER

*Dendroica virens*

*Original prepared by John M. Cooper  
and Suzanne M. Beauchesne*

## Species Information

### Taxonomy

The Black-throated Green Warbler is part of a superspecies complex with closely related *Dendroica* warblers (Hermit, Golden-cheeked, and Townsend's) (AOU 1983). Hybridization between Black-throated Green and Townsend's Warblers (*Dendroica townsendi*) has been reported from the Rocky Mountains of British Columbia where the breeding ranges of these two species overlap (Rohwer 1994). Two subspecies of Black-throated Green Warblers are recognized, of which only the nominate race, *D. virens virens*, occurs in British Columbia (Morse 1993; Cannings 1998). The other race, *D. virens waynei* occurs in the southeastern United States (Morse 1993).

### Description

A small songbird about 13 cm in length. In breeding plumage, the male has a black throat and sides of breast, yellow face with olive green ear coverts, unstreaked olive green crown and upper parts, two white wing bars, and a white belly. The female has similar markings but is duller, the chin is yellow, and there is less black on the lower throat and sides of breast. Juveniles are significantly duller still with very little or no black on the chin and throat, which is, instead, white or pale yellow (Pyle 1997).

### Distribution

#### Global

The Black-throated Green Warbler breeds from northeastern British Columbia, across boreal Canada east to Newfoundland and Labrador and south in the United States, from Minnesota in the

west across to Alabama and Georgia. This species winters primarily in Mexico and Central America, south to Panama although some birds may be found in the United States along the Gulf of Mexico, in the Caribbean, and in northern South America (AOU 1983; Morse 1993).

#### British Columbia

Black-throated Green Warblers were not known to occur in British Columbia during the first half of this century (Munro and McTaggart-Cowan 1947; Godfrey 1986). The first documented record for the province was in 1965 (Salt 1966). Morse (1993) speculates that it has undergone a recent range expansion into northeastern British Columbia where it reaches the northwestern extreme of its range.

The Black-throated Green Warbler occurs mainly in the Boreal Plains Ecoprovince, with most records coming from the Peace Lowland (Campbell et al. 2001). Enns and Siddle (1992) reported this species west to Moberly Lake, north to Blueberry Creek and south to near the headwaters of the Kiskatinaw River. Recent records from the Tuchodi River extend its known range significantly northward, into the Taiga Plains Ecoprovince. It has recently been found to occur rarely in the Fort Nelson Forest District of the Taiga Plains (Bennett et al. 2000). There is one known record in the Sub-Boreal Interior Ecoprovince (Cooper et al. 1997).

#### Forest regions and districts

Northern Interior: Fort Nelson, Peace

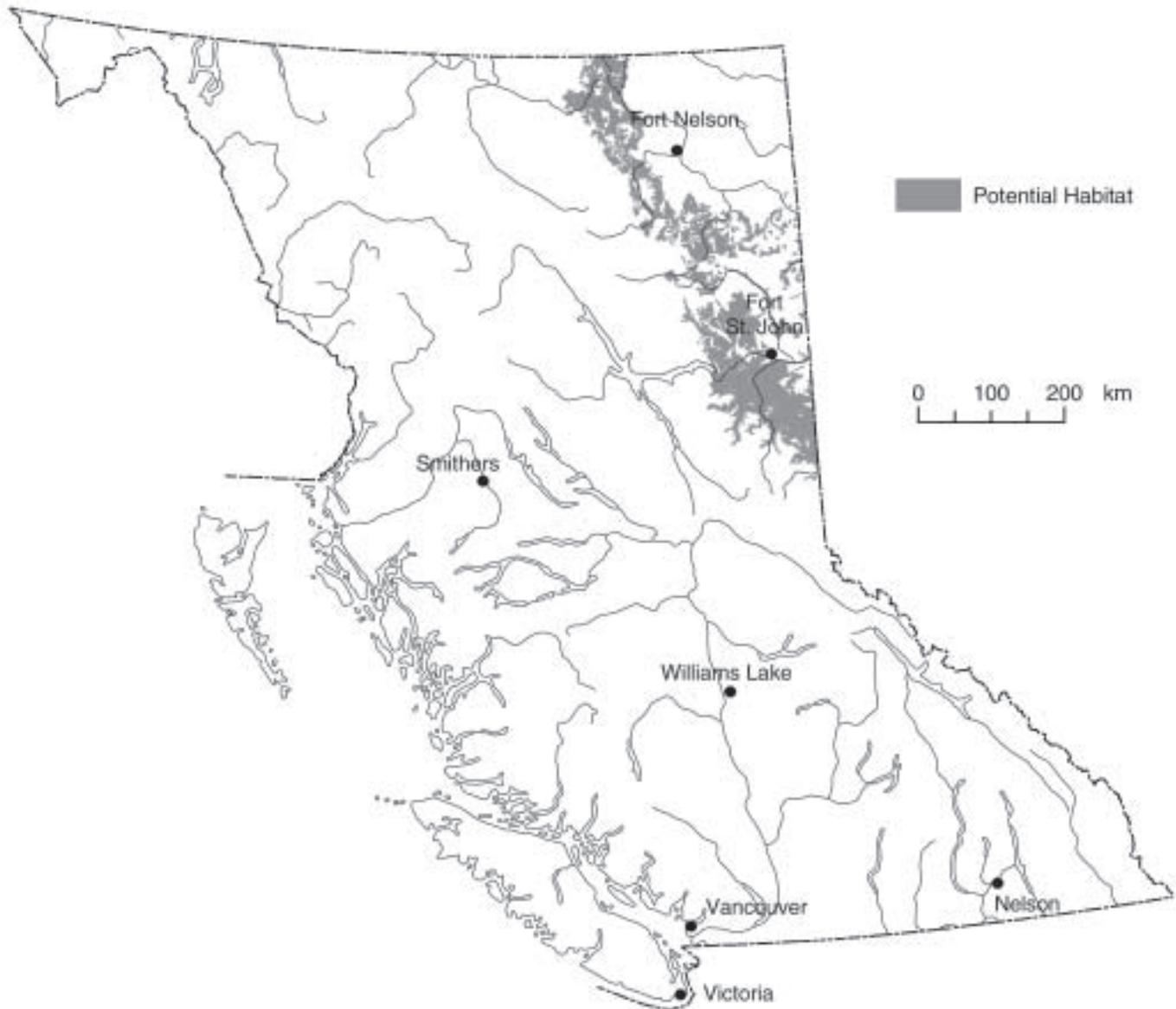
#### Ecoprovinces and ecosections

BOP: CLH, HAP, KIP, PEL

TAP: MUP

SBI: HAF

## Black-throated Green Warbler (*Dendroica virens*)



Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on several ecosystem classifications (Ecoregion, Biogeoclimatic and Broad Ecosystem Inventory) as well as current knowledge of the species' habitat preferences. This species may or may not occur in all areas indicated.

### **Biogeoclimatic units**

BWBS: mw1, mw2

### **Broad ecosystem units**

BA, PR

### **Elevation**

Breeding – 650–1100 m in the northeast

Migration – sea level to 1800 m (Campbell et al. 2001).

### **Life History**

Very little is known about the ecology of the Black-throated Green Warbler in British Columbia, therefore much of the following information is inferred from studies in other areas.

### **Diet and foraging behaviour**

The Black-throated Green Warbler is primarily insectivorous. Lepidopteran caterpillars contribute the greatest volume to its diet, but a wide range of prey is taken including beetles, bugs, gnats, ants, spiders, mites, and plant lice (Bent 1953; Morse 1976; Robinson and Holmes 1982; Morse 1993). Gleaning small branches and foliage of conifers is the main foraging technique although this species also hovers to glean the underside of foliage and terminal tips of branches and hawk insects in flight (MacArthur 1958; Morse 1968). In British Columbia, as elsewhere, most foraging is done within the mid- to upper canopy (Sabo and Holmes 1983; Morse 1993). In migration, berries are added to the diet (Morse 1993).

### **Reproduction**

Upon arriving on the breeding grounds, male Black-throated Green Warblers select breeding territories, defending them from conspecific males, then pair with a mate after females arrive. Both sexes contribute to nest building (Morse 1993). Clutches usually contain four eggs, however three to five egg clutches have been recorded (Bent 1953; MacArthur 1958; Peck and James 1987; Baicich and Harrison 1997). Egg-laying probably occurs mainly in mid- to late June in northeastern British Columbia (Campbell

et al. 2001). Eggs are incubated by the female alone for about 12 days (Baicich and Harrison 1997). Nestlings fledge after 9–11 days (Bent 1953; Morse 1993; Baicich and Harrison 1997). Both parents continue to feed young for several days, post-fledging, often separating at this point, each taking part of the brood (Morse 1993; Baicich and Harrison 1997). Siddle (1981) reported a fledgling being fed by an adult at Kiskatinaw Park on 30 June. A single brood is likely raised by each pair annually in British Columbia, as is usual for neotropical migrants (Morse 1989).

### **Site fidelity**

Unlike Bay-breasted (*Dendroica castanea*) and Cape May Warblers (*Dendroica tigrina*), the Black-throated Green Warbler is known to have a high degree of site fidelity to breeding and wintering sites (Morse 1971, 1993).

### **Home range**

Breeding territories are small (0.3–0.55 ha); and territory size is inversely related to density and food supply (Morse 1976, 1977). Densities of populations breeding in the eastern United States ranged from 0.6 to 2.2 pairs/ha (Morse 1976, 1989, 1993; Holmes 1986). Densities may actually decline during periods of budworm outbreaks, probably because of competition with the larger Bay-breasted and Cape May Warblers, which increase in density during outbreaks (Kendeigh 1947; Morse 1993). In west-central Alberta, densities of territorial males were 4.2–5.6/100 ha in 60- to 80-year-old aspen-dominated forest (Westworth and Telfer 1993). In British Columbia, one 19 ha island in the Peace River contained three territorial males (Penner 1976).

### **Movements and dispersal (migration)**

In British Columbia, male Black-throated Green Warblers reach the breeding grounds a few days earlier than females, consistent with a general pattern for many bird species (Francis and Cooke 1986; Morse 1993). This species enters northeastern British Columbia through northern Alberta, beginning in mid- to late May, with most probably arriving in late May and early June. After nesting is completed, adults probably begin to migrate south in

the second half of July, followed by juveniles in August (Cooper et al. 1997). The species has been recorded in northeastern British Columbia between 9 May and early September (Penner 1976; Campbell et al. 2001).

During migration this warbler uses a variety of habitats (Keast and Morton 1980) including, in British Columbia, willow/alder edge habitat (Enns and Siddle 1992).

## Habitat

### Structural stage

6: mature forest (80–140 yr)

7: old forest (>140 yr)

### Important habitats and habitat features

#### Nesting

Throughout its range, Black-throated Green Warbler nesting habitat varies from pure coniferous through to pure deciduous forests, although almost all sites have at least some conifer component (Collins 1983; Peck and James 1987; Morse 1989). This species prefers old forests but has also been recorded breeding in middle and late seral stage forests (Morse 1976).

In northeastern British Columbia, Black-throated Green Warbler nesting habitat includes mature riparian white spruce (*Picea glauca*) or mixedwood (spruce [*Picea* spp.], trembling aspen [*Populus tremuloides*], balsam poplar [*Populus balsamifera balsamifera*]) forests, similar to that documented in Alberta (Penner 1976; Enns and Siddle 1992; Siddle 1992; Lance and Phinney 1994). Stands tended to be mesic, with rose (*Rosa* spp.), baneberry (*Actaea rubra*), highbush cranberry (*Viburnum edule*), bunchberry (*Cornus canadensis*), fireweed (*Epilobium angustifolium*), kinnikinnick (*Arctostaphylos uva-ursi*), mosses, peavine (*Lathyrus* spp.), and American vetch (*Vicia americana*) in the understory (Cooper et al. 1997). Siddle (1981, 1992) stressed the importance of riparian forest along the south bank of the Peace River and along smaller streams. Pure deciduous forests are rarely

used in this province; however, even a small clump of mature spruce within an otherwise pure aspen stand attracts Black-throated Green Warblers (Cooper et al. 1997).

No Black-throated Green Warblers nests have been found in British Columbia (Campbell et al. 2001). Elsewhere, nest site microhabitat is not highly specialized; however, mature rather than juvenile trees are preferred and nests are usually found in coniferous trees, although deciduous trees are also used (Baicich and Harrison 1997). Nests are usually 2–8 m above ground but have been recorded as high as 20 m (Bent 1953; Peck and James 1987). Nests are sometimes built in the lower canopy or understory. Nests are compact cups of grass, moss, and twigs, lined with hair and feathers, and are placed against the trunk on a supporting branch or further out on a branch fork.

#### Foraging

Birds probably forage mainly within the nesting habitat; therefore, feeding and nesting habitat requirements are the same.

## Conservation and Management

### Status

The Black-throated Green Warbler is on the provincial *Blue List* in British Columbia. Its status in Canada has not been determined (COSEWIC 2002).

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

BC	AB	WA	Canada	Global
S3B, S2N	S3S4B	S?	N5B	G5

## Trends

### Population trends

There are no population trend data for British Columbia, although some authors believe all northeastern warblers are currently in decline (Siddle 1992). This warbler appears to have expanded its range westward into northeastern British Columbia in the last few decades, suggesting that populations overall may have increased during that time (Morse 1993; Cooper et al. 1997). In a study of warbler habitat associations in northeastern British Columbia, where various habitat types were sampled from Pine Pass north to the Yukon border, Black-throated Green Warblers accounted for 15.1% of 332 songbird sightings (Enns and Siddle 1992). In British Columbia, Black-throated Green Warblers may be locally common in good habitat (Cooper et al. 1997).

In eastern and central North America, various analyses revealed no, or very slight, changes in population indicating an overall stable trend for this species (Morse 1976; Holmes and Sherry 1988; Hill and Hagan 1991, Hagan and Johnston 1992; Morse 1993). In southern Ontario, long-term trends were stable (1961–1988), but there was a significant decline (-8.2% annually) between 1979 and 1988 (Hagan and Johnston 1992).

Generally, neotropical migrants are thought to be suffering widespread population declines (Morton and Greenberg 1989; Terborgh 1989; Finch 1991). Morse (1993) and Rappole (1995) both forecast a population decline for this species due to loss of wintering habitat.

### Habitat trends

Late seral mixedwood stands, the preferred habitat of the Black-throated Green Warbler, are being harvested in the Peace Lowland, reducing the amount of habitat available to this species.

## Threats

### Population threats

Nest parasitism by Brown-head Cowbirds can severely impact neotropical migrant songbird populations (Brittingham and Temple 1983; Askins et al. 1990; Finch and Stangel 1993). In British Columbia, there is a single record of a Brown-headed Cowbird fledgling being fed by a Black-throated Green Warbler (Siddle 1992). Elsewhere, parasitism has frequently been reported with rates of up to 34% documented (Friedmann 1963; Peck and James 1987; Morse 1993). Parasitism is more prevalent along edge habitat (Morse 1993), which suggests that the rate of parasitism will increase in British Columbia with increasing fragmentation of northeastern forests (Cooper et al. 1997).

Forest fragmentation increases edge habitat favoured by predatory species such as jays, crows, and magpies. Because the probability of predation on forest songbird nests increases with increasing forest fragmentation (Wilcove 1985; Yahner and Scott 1988; Askins et al. 1990), Black-throated Green Warblers will likely face greater predation intensity as forests are cleared.

In other regions, large-scale spraying of insecticides in coniferous forest habitat, to control insect outbreaks, could reduce the insect prey base, and cause indirect mortality in this species (Morse 1993). Populations elsewhere are known to have declined after application of fenitrothion (Pearce et al. 1979).

This species also has a restricted range in British Columbia (Cooper et al. 1997; Fraser et al. 1999).

Migration is probably the period of highest mortality for both adults and juveniles. Migrating warblers suffer mortality from natural environmental factors such as inclement weather and from human-related factors such as collision with light towers (Morse 1993).

Late snowstorms are known to cause severe mortality of migrants and breeders, and July rainstorms kill many fledglings, both events that may depress local breeding populations for several years (Morse 1976). Populations in Wisconsin and Michigan declined precipitously during years of drought (Hagan and Johnston 1992), suggesting a response to presumed lower food supplies during dry springs. Populations are not known to increase in response to spruce budworm outbreaks; in fact, they may decline, probably due to competition with other warbler species that increase in number dramatically (Morse 1993).

### Habitat threats

The primary threat to Black-throated Green Warbler populations in British Columbia is the harvesting of late seral mixedwood stands within its restricted range in the Peace Lowland. Loss or deterioration of forest habitat has been widely blamed for declines in breeding populations of many warbler species (Titterton et al. 1979; Burgess and Sharpe 1981; Askins and Philbrick 1987; Terborgh 1989; Saunders et al. 1991; Hagan and Johnston 1992; Maurer and Heywood 1993). There is no evidence to suggest that Black-throated Green Warblers will respond differently (Cooper et al. 1997).

In northeastern British Columbia, clearcutting of mature to old-growth white spruce and mixedwood forests removes suitable nesting habitat for this species. Selective logging also severely reduces habitat quality if forests are thinned by 40–75% (Webb et al. 1977; Freedman et al. 1981). Strip cuts of 20–30 m are also known to negatively impact habitat in the short to medium term (Freedman et al. 1981).

Local extirpations of this warbler have been documented in severely fragmented forests (Askins and Philbrick 1987; Hagan and Johnston 1992) and forests where mature conifers have been removed (Salt 1973). Other studies have documented this species nesting in middle seral stage, second-growth forests in eastern North America where this warbler is known as a pioneering species, rapidly occupying new habitats as they become suitable (Morse 1993).

However, these traits have not yet been observed in British Columbia where virtually all reports are from mature and older forests. Additional research is needed to determine the use of younger-aged forests before the impact of timber harvesting in British Columbia on use can be adequately addressed (Cooper et al. 1997).

The trend in northeastern British Columbia toward intensive silviculture for short rotations of mixedwood (Peterson et al. 1989) prevents regeneration of good quality Black-throated Green Warbler nesting habitat after it has been lost to harvesting. Techniques that alter the shrub component, debris structure, and the eventual plant species distribution in mixedwood stands may also reduce habitat suitability of habitat (Cooper et al. 1997).

Habitat is also lost or fragmented by other activities such as clearing for agriculture, road building, transmission lines, and oil and gas exploration (Askins 1994). In the Dawson Creek Timber Supply Area, many of the pure stands of large aspen and cottonwood occur on private land adjacent to agricultural fields. Harvesting is currently taking place on private land with an unknown area being converted to agricultural fields. This area is unlikely to revert to a mixedwood forest in the future (Cooper et al. 1997). In addition, potential hydroelectric projects on the Peace River (e.g., Sites C and E) would flood substantial amounts of good Black-throated Green Warbler habitat (Penner 1976).

Grazing may reduce the quality of habitat for this warbler through damage to the understorey and because Brown-headed Cowbirds are attracted to livestock. In the northeast, livestock grazing is more prevalent in mixed aspen stands, which have higher forage production, than in pure coniferous stands (Pitt 1984).

Within its wintering range, deforestation for timber production, agricultural clearing, and urban development continue to reduce the quantity of habitat available (Rappole 1995). The Black-throated Green Warbler may be less affected than many other neotropical migrants by deforestation of tropical regions because this species has a relatively large wintering range, uses a broad range of winter

habitats, and is a generalist in foraging (Hagan and Johnston 1992). However, there is cause for concern for any species with a concentration of migrants from a huge breeding distribution funnelled into a relatively small winter range (Keast and Morton 1980).

## Legal Protection and Habitat Conservation

The Black-throated Green Warbler, its nests, and its eggs are protected from direct persecution in Canada by the *Migratory Birds Convention Act*. In British Columbia, the same are protected under the provincial *Wildlife Act*.

In British Columbia, Beatton Park (312 ha), Moberly Lake Park (98 ha), Kiskatinaw River Park (154 ha), Peace Boudreau Protected Area, and Peace River Corridor (2014 ha), all relatively small provincial parks, are the only existing reserves where Black-throated Green Warblers have consistently been recorded (Siddle 1992). Other Class A parks, such as Taylor Landing (2.4 ha), are within the known range and habitat type of this species, although records may be lacking. Prophet River Wayside Park (113 ha), Andy Bailey Park (196 ha), Sikanni Old Growth Park (1439 ha), and Butler Ridge Park (6024 ha) may protect suitable habitat.

Most other nesting habitat is on Crown land; therefore, habitat conservation may be partially addressed by old forest retention targets (old growth management areas), riparian reserves, and wildlife tree retention areas or other wildlife habitat areas required under the results based code.

## Identified Wildlife Provisions

### Sustainable resource management and planning recommendations

- ❖ Maintain suitable nesting habitat.
- ❖ Incorporate suitable nesting habitat into (1) old growth management areas; (2) areas constrained for other management objectives (e.g., visual quality, recreation, ungulate winter range, terrain concerns); or (3) stand level reserves such as wildlife tree retention (WTR) areas and riparian management areas.

- ❖ In general, the shape and size of forest reserves should be designed to minimize edge habitat and isolation of populations. In addition, habitat corridors that connect patches of forest are proving to be an important factor in retaining bird community diversity in isolated patches (MacClintock et al. 1977). Creating such corridors of forest habitat suitable for Black-throated Green Warblers between mature mixedwoods may reduce the impact of timber harvesting on this species (Cooper et al. 1997).
- ❖ Consider greater WTR area retention levels in mature and old spruce or mixedwood forest where this species is known to occur. Blocks should be assessed to identify potentially suitable WTR areas. Table 1 provides attributes that should be used to design suitable WTR areas for this species.
- ❖ Restrict salvage or harvest and avoid insecticide use.
- ❖ Maintain WTR areas over the long term.

**Table 1.** Preferred WTR area characteristics for the Black-throated Green Warbler

Attributes	Characteristics
Size (ha)	≥2–10 ha
Location	BWBSmw1, BWBSmw2
Features	patches of mature spruce within deciduous-leading.
Tree species	white spruce or mixedwood (spruce, trembling aspen, balsam poplar)
Age/structure	≥80 years; structural stages 6–7

## Wildlife habitat area

### Goal

Maintain suitable nesting habitats. Consider size and shape of the WHA to minimize edge habitat.

### Feature

Establish WHAs within highly suitable nesting habitat (mature or old mixedwoods) where concentrations (>3 pairs) of Black-throated Green Warblers regularly occur.

### *Size*

Typically between 10 and 30 ha but will depend on site-specific factors.

### *Design*

Consider locating adjacent to other reserves such as riparian management areas wherever possible. If stands are deciduous leading types, they must include clumps of mature spruces. Minimize edge habitats wherever possible and minimize/avoid agricultural areas (M. Phinney, pers. comm.)

### **General wildlife measure**

#### *Goals*

1. Ensure windfirmness.
2. Maximize interior forest conditions.
3. Maximize mature riparian forest reserves.
4. Minimize disturbance during the nesting season (15 May–31 July).

#### *Measures*

##### *Access*

- Do not construct roads, trails, or other access routes.

##### *Harvesting and silviculture*

- Do not harvest.

##### *Pesticides*

- Do not use pesticides.

##### *Range*

- Plan livestock grazing (i.e., timing and browse utilization) to minimize negative impacts to this species. The “desired plant community,” including seral stage mix, species composition, and structural characteristics (i.e., understory vegetation) should be maintained.
- Grazing after the nesting season (after 31 July) is preferable.
- Do not place livestock attractants within WHA.

### **Additional Management Considerations**

Avoid prime Black-throated Green Warbler habitat when planning seismic explorations, oil and gas development, transmission lines, and other access routes.

### **Information Needs**

1. Inventory to identify local concentrations of this species and monitor known populations to keep current on the effects of silviculture practices.
2. Habitat mapping in core areas.
3. Population estimates and trends.

### **Cross References**

Bay-breasted Warbler, Cape May Warbler

### **References Cited**

- American Ornithologists' Union (AOU). 1983. Checklist of North American birds. Lawrence, Kans. 877 p.
- Askins, R.A. 1994. Open corridors in a heavily forested landscape: impact on shrubland and forest-interior birds. *Wildl. Soc. Bull.* 22:339–347.
- Askins, R.A., J.F. Lynch, and R. Greenberg. 1990. Population declines in migratory birds in eastern North America. *Curr. Ornith.* 7:1–57.
- Askins, R.A. and M.J. Philbrick. 1987. Effect of changes in regional forest abundance on the decline and recovery of a forest bird community. *Wilson Bull.* 99:7–21.
- Baichich, P.J. and C.J. Harrison. 1997. A guide to the nests, eggs, and nestlings of North American birds. 2nd ed. Academic Press, London, U.K. 347 p.
- Bennett, S., P. Sherrington, P. Johnstone, and B. Harrison. 2000. Habitat use and distribution of neotropical migrant songbirds in northeastern British Columbia. *In Proc. Conf. on the biology and management of species and habitats at risk.* L.M. Darling (editor). Kamloops, B.C., Feb. 15–19, 1999. B.C. Min. Environ., Lands and Parks, Victoria, B.C., and Univ. Coll. Cariboo, Kamloops, B.C., pp. 79–88.
- Bent, A.C. 1953. Life histories of North American wood warblers. Smithsonian Inst. Press, Washington, D.C. Bull. 203. 734 p.
- Brittingham, M.C. and S.A. Temple. 1983. Have cowbirds caused forest songbirds to decline? *Bioscience* 33:31–35.

- Burgess, R.L. and D.M. Sharpe. 1981. Forest island dynamics in man-dominated landscapes. Springer-Verlag, New York, N.Y.
- Campbell, R.W., N.K. Dawe, I. McTaggart-Cowan, J.M. Cooper, G.W. Kaiser, A.C. Stewart, and M.C.E. McNall. 2001. The birds of British Columbia. Vol. IV: Passerines. Wood Warblers through Old World Sparrows. Royal B.C. Mus., Victoria, B.C., and Can. Wildl. Serv., Delta, B.C.
- Cannings, R.J. 1998. The birds of British Columbia: a taxonomic catalogue. B.C. Min. Environ., Lands and Parks, Wildl. Br. and Resour. Inventory Br., Victoria, B.C. WB-86. 252 p.
- Chytyk, P., J.M. Cooper, and S. Bennett. 2001. 2000 Northern Goshawk inventory of the Burnt River and lower Sukunka landscape units. Report prepared by Manning, Cooper and Associates for Canfor, Chetwynd Division, Chetwynd, B.C. Unpubl.
- Collins, S.L. 1983. Geographic variation in habitat structure of the Black-throated Green Warbler (*Dendroica virens*). *Auk* 100:382–389.
- Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2002. Canadian Species at Risk. [www.speciestrisk.gc.ca](http://www.speciestrisk.gc.ca)
- Cooper, J.M., K.A. Enns, and M.G. Shepard. 1997. Status of the Black-throated Green Warbler in British Columbia. B.C. Min. Environ., Lands and Parks, Wildl. Br., Victoria, B.C. WR-80.
- Enns, K.A. and C. Siddle. 1992. The distribution, abundance and habitat requirements of selected passerine birds of the Taiga and Boreal Plains. Report prepared for B.C. Min. Environ., Lands and Parks, Victoria, B.C. Unpubl. 68 p.
- Finch, D.M. 1991. Population, ecology, habitat requirements, and conservation of neotropical migratory birds. U.S. Dep. Agric. For. Serv., Fort Collins, Colo. Gen. Tech. Rep., RM-205. 26 p.
- Finch, D.M. and P.W. Stangel. 1993. Status and management of neotropical migratory birds. U.S. Dep. Agric. For. Serv., Fort Collins, Colo. Gen. Tech. Rep. RM-229. 422 p.
- Francis, C.M. and F. Cooke. 1986. Differential timing of spring migration in wood warblers (Parulinae). *Auk* 103:548–556.
- Fraser, D.F., W.L. Harper, S.G. Cannings, and J.M. Cooper. 1999. Rare birds of British Columbia. B.C. Min. Environ., Lands and Parks, Wildl. Br. and Resour. Inventory Br., Victoria, B.C. 244 p.
- Freedman, B., C. Beauchamp, I.A. McLaren, and S.I. Tingley. 1981. Forestry management practices and populations of breeding birds in Nova Scotia. *Can. Field-Nat.* 95:307–311.
- Friedmann, H. 1963. Host relations of the parasitic cowbirds. U.S. Natl. Mus. Bull. 233, Washington, D.C. 276 p.
- Godfrey, W.E. 1986. The birds of Canada. Natl. Mus. Can., Ottawa, Ont. 595 p.
- Hagan, J.M. III and D.W. Johnston. 1992. Ecology and conservation of neotropical migrant landbirds. Smithsonian Inst. Press, Washington, D.C. 609 p.
- Hill, N.P. and J.M. Hagan III. 1991. Population trends of some northeastern North American landbirds: a half-century of data. *Wilson Bull.* 103:165–182.
- Holmes, R.T. 1986. Foraging patterns of forest birds: male-female differences. *Wilson Bull.* 98:196–213.
- Holmes, R.T. and T.W. Sherry. 1988. Assessing population trends of New Hampshire forest birds: local vs. regional patterns. *Auk* 105:756–768.
- Keast, A. and E.S. Morton. 1980. Migrant birds in the neotropics: ecology, behavior, distribution and conservation. Smithsonian Inst. Press, Washington, D.C.
- Kendeigh, S.C. 1947. Bird population studies in the coniferous forest biome during a spruce budworm outbreak. *Biol. Bull.* 1:1–100.
- Lance, A.N. and M. Phinney. 1994. Bird diversity and abundance following aspen clearcutting in the boreal white and black spruce biogeoclimatic zone. Report for 1993, Unpubl. FRDA Rep. prepared for B.C. Min. For., Victoria, B.C. 40 p.
- MacArthur, R.H. 1958. Population ecology of some warblers of northeastern coniferous forests. *Ecology* 39:599–619.
- MacClintock, L., R.F. Whitcomb, and B.L. Whitcomb. 1977. Evidence for the value of corridors and minimization of isolation in preservation of biotic biodiversity. *Am. Birds* 31:6–13.
- Maurer, B.A. and S.G. Heywood. 1993. Geographic range fragmentation and abundance of neotropical migratory birds. *Conserv. Biol.* 7:501–509.
- Morse, D.H. 1968. A quantitative study of foraging of male and female spruce woods warblers. *Ecology* 49:779–784.
- \_\_\_\_\_. 1971. The foraging of warblers isolated on small islands. *Ecology* 52:216–228.
- \_\_\_\_\_. 1976. Variables affecting the density and territory site of breeding spruce-woods warblers. *Ecology* 57:290–301.

- \_\_\_\_\_. 1977. The occupation of small islands by passerine birds. *Condor* 79:399–412.
- \_\_\_\_\_. 1989. American warblers. Harvard Univ. Press, Cambridge, Mass. 406 p.
- \_\_\_\_\_. 1993. Black-throated Green Warbler. No. 55. *In* A. Poole and F. Gill (editors). *The birds of North America*. Acad. Natl. Sci., Philadelphia, Penn., and Am. Ornith. Union, Washington, D.C. 19 p.
- Morton, E.S. and R. Greenberg. 1989. The outlook for migratory songbirds: “future shock” for birders. *Am. Birds* 43:178–183.
- Munro, J.A. and I. McTaggart-Cowan. 1947. A review of the bird fauna of British Columbia. B.C. Prov. Mus., Victoria, B.C. Spec. Publ. 2. 285 p.
- NatureServe Explorer. 2002. An online encyclopaedia of life. Version 1.6. NatureServe. Arlington, VA. Available at <http://www.natureserve.org/explorer/>
- Pearce, P.A., D.E. Peakall, and A.J. Erskine. 1979. Impact on forest birds of the 1976 spruce budworm spray operation in New Brunswick. *Can. Wildl. Serv. Prog. Note* 97. 3 p.
- Peck, G.K. and R.D. James. 1987. Breeding birds of Ontario: nidiology and distribution. Royal Ont. Mus., Toronto, Ont. 321 p.
- Penner, D.F. 1976. Peace River Sites C and E environmental impact studies: wildlife resources. Report prepared by Thurber Consultants Ltd. for BC Hydro, Vancouver, B.C. Unpubl. 307 p.
- Peterson, E.B., A. Kabzems, R.D. Kabzems, and N.M. Peterson. 1989. Boreal mixedwood forest management challenges: a synopsis of opinions from 1988 interviews. *For. Can., North. For. Res. Cent., Edmonton, Alta. ENFOR Project P-353*. 39 p.
- Pitt, M.D. 1984. Range condition and trend assessment in British Columbia. B.C. Min. For., Res. Program, Victoria, B.C. Internal rep. Res. Rep. RR84004-HQ. 117 p.
- Pyle, P. 1997. *An identification Guide to North American Birds: Part 1*. Slate Creek Press, Bolinas, Calif. 732 p.
- Rappole, J.H. 1995. *The ecology of migrant birds: a neotropical perspective*. Smithsonian Inst. Press, Washington, D.C.
- Robinson, S.K. and R.T. Holmes. 1982. Foraging behaviour of forest birds: the relationships among search tactics, diet, and habitat structure. *Ecology* 63:1918–1931.
- Rohwer, S. 1994. Two new hybrid *Dendroica* warblers and new methodology for inferring parental species. *Auk* 111:441–449.
- Sabo, S.R. and R.T. Holmes. 1983. Foraging niches and the structure of forest bird communities in contrasting montane habitats. *Condor* 85:121–138.
- Salt, W.R. 1966. Some unusual bird records from the Peace River district. *Can. Field-Nat.* 80:114–115.
- \_\_\_\_\_. 1973. Alberta vireos and wood warblers. *Prov. Mus. Arch. Alberta, Edmonton, Alta. Publ. No. 3*. 141 p.
- Saunders, D.A., R.J. Hobbs, and C.R. Margules. 1991. Biological consequences of ecosystem fragmentation: a review. *Conserv. Biol.* 5:18–32.
- Siddle, C. 1981. Two recent breeding records. *B.C. Natur. (Winter)*:12.
- \_\_\_\_\_. 1992. The declining populations of warblers in northeastern British Columbia. *In* Community action for endangered species: a public symposium on B.C.’s threatened and endangered species and their habitat. S. Rautio (editor). Vancouver, B.C., Sept. 28–29, 1991. *Fed. B.C. Naturalists and Northwest Wildl. Preserv. Soc., Vancouver, B.C.*, pp. 143–151.
- Terborgh, J.W. 1989. *Where have all the birds gone?* Princeton Univ. Press, Princeton, N.J. 207 p.
- Titterton, R.W., H.S. Crawford, and B.N. Burgason. 1979. Songbird responses to commercial clearcutting in Maine spruce-fir forests. *J. Wildl. Manage.* 43:602–609.
- Webb, W.L., D.F. Behrend, and B. Saisorn. 1977. Effects of logging on songbird populations in a northern hardwood forest. *Wildl. Monogr.* 55:1–35.
- Westworth, D.A. and E.S. Telfer. 1993. Summer and winter bird populations associated with five age-classes of aspen forest in Alberta. *Can. J. For. Res.* 23:1830–1836.
- Wilcove, D.S. 1985. Nest predation in forest tracts and the decline of migratory songbirds. *J. Ecol.* 66:1211–1214.
- Yahner, R.H. and D.P. Scott. 1988. Effects of forest fragmentation on depredation of artificial nests. *J. Wildl. Manage.* 52:158–161.

## Personal Communications

- Phinney, M. 2002. Louisiana-Pacific Canada Ltd., Dawson Creek, B.C.