

*Wilsonia  
canadensis*

# Canada Warbler

FRENCH:

*Paruline du Canada, Fauvette  
du Canada*

SPANISH:

*Chipe de collar, Silvia del  
Canadá, Reinita pechirrayada,  
Chipe collarejo, Reinita  
collareja*

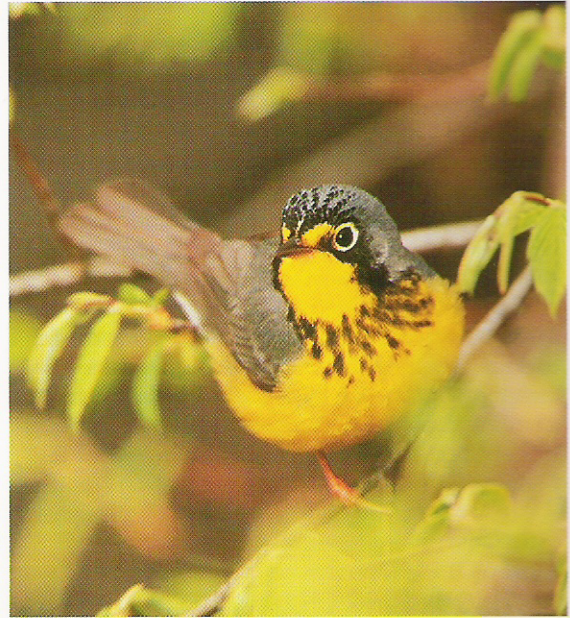
**T**his little-studied wood-warbler breeds in the northeastern U.S., boreal Canada, and through the central ridge of the Allegheny Mountains to Tennessee and Georgia. It undertakes a long annual migration for a wood-warbler, wintering in northern South America. It is often referred to as the "Neck-laced Warbler" because of the pattern of black spots across its bright yellow breast.

During the breeding season, the Canada Warbler inhabits many sorts of forest growth, but is most abundant in cool, moist forests with a mix of coniferous and deciduous trees and a dense understory. It frequents rhododendron thickets in montane areas in the south, steep aspen/poplar forests in the north, and forested wetlands/swamps in the central part of its range. It is often associated with areas having

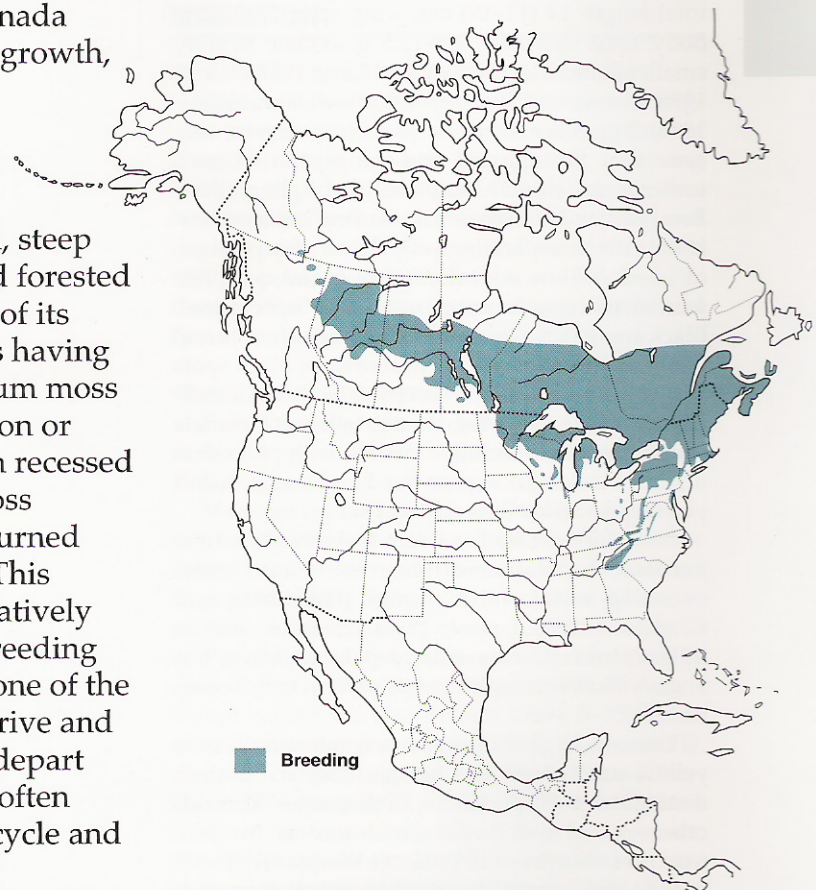
abundant sphagnum moss cover and it nests on or near the ground in recessed pockets within moss hummocks or upturned tree-root masses. This species spends relatively little time on its breeding grounds, usually one of the last warblers to arrive and one of the first to depart

local nesting areas. Canada Warblers often continue to sing late into the nesting cycle and even during fall migration.

This warbler eats a variety of insects and spiders and uses a variety of foraging techniques: foliage gleaning, ground foraging,



CANADA WARBLER



**Figure 1.** Breeding distribution of the Canada Warbler. This species winters in South America. See text for details. Adapted from Dunn and Garrett 1997.

## The Birds of North America

Life Histories for  
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and flycatching. It is an active warbler, its tail often cocked and wings flicking. In some areas, it feeds largely on the wing, which explains its old names: Canadian Flycatcher and Canadian Flycatching Warbler. It is socially monogamous and territorial during the breeding season and often joins mixed-species foraging flocks during winter.

Little is known of this species' breeding biology; no extensive study has focused on the Canada Warbler. Length of incubation and nestling periods and annual reproductive success are among the many traits that have not been well documented in this species. Populations have declined steadily over the past 30 years, possibly in response to forest succession and loss of forested wetlands, making this species a high priority for management and monitoring.

### DISTINGUISHING CHARACTERISTICS

Medium-sized, brightly colored wood-warbler, total length 14 (12–15) cm, wing span 20–22 cm, body mass typically 9.5–12.5 g; female slightly smaller than male (Clement and Gunn 1957, Ostroff 1986, Cramp and Perrins 1994, Howell and Webb 1995). In adult male upperparts (rear crown, rear auriculars through tail and wings) bluish gray, underparts (chin through belly) bright yellow. Forehead and fore crown, lores, and anterior auriculars black, separating yellow and gray portions of head. Yellow supraloral stripe and complete whitish eye ring forming prominent "spectacles." Black area extends beneath eye along side of throat joining with a series of vertical rows of black spots that run across upper breast (necklace). Undertail-coverts white. No wing-bars or tail spots. Female similar to male but duller overall, with paler, less distinct black markings on head and breast. Adult plumages similar throughout year.

Immatures of both sexes are similar to adults but somewhat duller, with even less distinct breast streaking and facial markings (Greenberg and Gradwohl 1980, Rappole 1983). Immature female duller, and may have very pale necklace, but always shows enough of adult pattern to be recognizable.

Unmarked gray upperparts combined with its yellow underparts and unique necklace pattern distinguish this species (in all plumages) from all other species under most circumstances. Juvenile may resemble juvenile Wilson's Warbler (*Wilsonia pusilla*) and is best identified by association with adults (Dunn and Garrett 1997). Adult occasionally confused with Kentucky Warbler (*Oporornis formosus*), which has a similar overall plumage pattern

but Kentucky has olive upperparts, yellow undertail-coverts, and lacks black markings on the underparts. For additional information see Dunn and Garrett (1997).

Song is a sweet, rich, loud, and distinctive series of jumbled warbling notes often preceded by a loud *chip* note (see Sound: vocalizations, below).

### DISTRIBUTION

#### THE AMERICAS

**Breeding range.** Figure 1. Range description based on Dunn and Garrett (1997) and other references as noted. Breeds across the southern boreal region of Canada, and across much of se. Canada, ne. U.S., the Great Lakes region, and south (at higher elevations) along the Appalachian Mtns. to ne. Georgia. Breeds north to n. Alberta (Semenchuk 1992), n.-central Saskatchewan (Smith 1996), central Manitoba, n.-central Ontario (Cadman et al. 1987, Peck and James 1987), s.-central Québec (observed on the Magdalen Is. but status unknown on Anticosti I.; Gauthier and Aubrey 1996), n. New Brunswick, Prince Edward I., and n. Nova Scotia (Erskine 1992). Range extends west to include the Peace River lowlands of British Columbia (west to Fort St. John and Hudson's Hope) and very locally into the w. Taiga Plains of ne. British Columbia (Fort Nelson and Maxhamish Lake; Cooper et al. 1997), and extreme se. Yukon. Breeds south to s.-central Alberta (Rocky Mtn. House district; Semenchuk 1992), s.-central and se. Saskatchewan (Smith 1996), s. Manitoba, ne. Minnesota, ne. Wisconsin, the w. and n. Lower Peninsula of Michigan, s. Ontario, central Pennsylvania, nw. New Jersey, s. Connecticut, s. Rhode Island (Enser 1992), and se. Massachusetts (Veit and Petersen 1993). Range extends south through the Appalachian Mtns. of sw. Pennsylvania (Brauning 1992) to include extreme w. Maryland (Robbins 1996), e.-central West Virginia (Buckelew and Hall 1994), w. Virginia, extreme se. Kentucky (Palmer-Ball 1996), westernmost North Carolina, easternmost Tennessee (Nicholson 1997), and extreme ne. Georgia. Small numbers also breed south locally to s. Wisconsin, n. Illinois, extreme n. Indiana, and s.-central Ohio (Peterjohn and Rice 1991). Found nesting up to 1,680 m elevation. Possibly breeds in nw. South Carolina and probably breeds irregularly in ne. North Dakota (Pembina Hills) and ne. Iowa (Dunn and Garrett 1997). Two summer records (Jul and 9 Aug) from Peru and Ecuador; birds that failed to migrate (Paynter 1995).

**Winter range.** From Venezuela and Colombia south through e. Ecuador to central Peru (Paynter 1995). Mostly in and east of Andes. A few records from Amazon region of Venezuela and Brazil



(Paynter 1995). Rare winter records from foothills of Panamá (Ridgely and Gwynne 1989, Howell and Webb 1995) and casually north to Costa Rica (Dunn and Garrett 1997). Winter records from Mexico (Binford 1989) considered questionable (Howell and Webb 1995), and those from Honduras (Monroe 1968) and Belize (Russell 1964) may pertain to fall stragglers (Dunn and Garrett 1997). Apparently reaches greatest abundance in e. Colombia, and northern Andes of Peru and s. Ecuador (Bent 1953, Paynter 1995).

**Other records.** Irregular migrant in Colorado, New Mexico, Arizona, w. Montana, Oregon, Utah, Wyoming, and sw. British Columbia (Tordoff and Mengel 1956, Carter and Barker 1993, Dunn and Garrett 1997). Two accidental records from n. coast (Beaufort Sea area) in Alaska (Pitelka 1974, Gibson 1982). Casual in Bahamas, Bermuda, Cuba, Jamaica, St. Croix, Guadeloupe, and St. Lucia (Kingery and Graul 1978, Walters and Sorenson 1983, Pashley 1988, Arendt 1992).

#### OUTSIDE THE AMERICAS

Accidental records from Greenland (Am. Ornithol. Union 1983), and Iceland; male on 29 Sep 1973 (Cramp and Perrins 1994).

#### HISTORICAL CHANGES

Little information. Considered less abundant compared to historical distribution because of land cleared for farming in sw. Ontario (Cadman et al. 1987, Peck and James 1987). However, elimination of original pine forest and subsequent replacement by mixed forest may have allowed distribution to expand in s.-central Ontario (Cadman et al. 1987). May be more widely distributed now compared to earlier this century in New York and Vermont as forest cover has increased since that time (Laughlin and Kibbe 1985, Andrlé and Carroll 1988). May be currently extending range southward in New York (Andrlé and Carroll 1988). Probably disappeared from lower peninsula of Michigan in late 1800s and early 1900s because of forest clearing, but has reoccupied some of this area as isolated forest patches have regenerated (Berger et al. 1991). Loss of suitable habitat owing to development has slightly reduced historical distribution in e. Pennsylvania (Brauning 1992). May have recently colonized British Columbia; first record was in 1974 but unclear whether recent records due to range expansion or increased number of observers (Cooper et al. 1997).

#### FOSSIL HISTORY

No information.

## SYSTEMATICS

#### GEOGRAPHIC VARIATION; SUBSPECIES

Monotypic. No known geographic variation in size, vocalizations, or plumage coloration. Individual variation in plumage and song is rather broad, but no studies have examined patterns in variation.

#### RELATED SPECIES

Only 2 other species in the genus: Hooded Warbler (*Wilsonia citrina*) and Wilson's Warbler (*W. pusilla*). Like other *Wilsonia*, relatively short tarsi, and long wings and tail compared to other wood-warblers (Ostroff 1986). Considered morphologically more similar to Hooded Warbler than to Wilson's Warbler (Ostroff 1986), but relationship within *Wilsonia* not well understood (Dunn and Garrett 1997).

**Hybridization.** Little information, but reportedly has hybridized with Mourning Warbler (*Oporornis philadelphia*; Dunn and Garrett 1997).

## MIGRATION

#### NATURE OF MIGRATION IN THE SPECIES

Complete, Neotropical–Nearctic seasonal migrant; traveling annually between breeding areas in n. and e. North America (Fig. 1) and wintering areas in n. South America. Compared to other warblers, arrives breeding areas late in spring and departs early in fall (see Fig. 4; Baker 1932, Burt 1977, Rappole et al. 1979, Francis and Cooke 1986, Cooper et al. 1997); the last warbler to arrive and first to leave Alberta (Semenchuk 1992).

#### TIMING AND ROUTES OF MIGRATION

**Fall.** Typically departs breeding areas mid-Jul to late Aug in British Columbia (Cooper et al. 1997).

Main passage is rapid and compressed, extending locally over about 3 wk (Hall 1983, Ramos 1988). Peak is late Aug to early Sep in Ontario (Keast 1980, Weir 1989), 30 Aug in Maine (Morris et al. 1994; S. Morris, pers. comm.), 26 Aug–4 Sep in w. Pennsylvania (Leberman and Clench 1971), 29 Aug–11 Sep in New Jersey (Sibley 1993), 18 Aug–3 Sep in central Illinois (Bohlen 1989), 5–15 Sep in coastal Alabama (Woodrey 1995, F. Moore and D. Cimprich, unpubl. data), 11–20 Sep in Texas (Oberholser 1974, Rappole et al. 1979), 8–27 Sep in Oaxaca, Mexico (Binford 1989), 21–30 Sep in Veracruz, Mexico (Rappole et al. 1979). Regular but rare vagrant during Sep (extremes 24 Aug and 16 Oct) in Bermuda (Amos 1991). Rare (25 Sep–16 Oct) in Florida (Fisk 1979), very rare transient during Sep and Oct (extremes early Aug and 20 Nov) in



California (Small 1994), and extremely rare (4 records) during Sep and Oct in Oregon (Gilligan et al. 1994).

First individuals reach Central America by early Sep (Ramos 1988, Stiles and Skutch 1989). Rare migrant in Belize 15 Sep–14 Oct (Russell 1964, Mills 1989), 8 Sep–7 Oct in Guatemala, 21 Sep–7 Oct in Honduras (Monroe 1968), and early Sep–20 Oct in Costa Rica (A. F. Skutch in Bent 1953). Peak is late Sep–early Oct (extremes early Sep and late Nov) in Panamá (Ridgely and Gwynne 1989). Begin to arrive on winter grounds end of Sep in Colombia and early Oct in Peru (Paynter 1995).

**Spring.** As in fall, main passage is rapid and compressed. Most birds leave winter grounds by late Mar in Peru, early Apr in Ecuador, and mid-Apr in Colombia (Bent 1953, Paynter 1995). Peak migration late Apr–early May in Panamá (Greenberg and Gradwohl 1980, Ridgely and Gwynne 1989), mid-Apr in Honduras (Monroe 1968), 22 Apr–12 May in Oaxaca, Mexico (Binford 1989), 1–10 May in Veracruz, Mexico (Rappole et al. 1979), 2–20 May in Texas (Oberholser 1974, Rappole et al. 1979), 25 Apr–7 May in coastal Alabama and Mississippi (F. Moore and D. Cimprich pers. comm.), first 2 wk of May in Kentucky (Palmer-Ball 1996), 29 May in Chicago (Bohlen 1989), last 2 wk of May in Michigan (Schroeder and DeBlaey 1968, Berger et al. 1991, Brewer et al. 1991), late May in Minnesota (Janssen 1987), mid- to late May in New Jersey (Sibley 1993), second week of May in Massachusetts (Veit and Petersen 1993) and Vermont (Laughlin and Kibbe 1985), 28 May in Maine (Morris et al. 1994, S. Morris, pers. comm.), last week of May in Ontario (Devitt 1967, Francis and Cooke 1986, Weir 1989), final days of May to early Jun in British Columbia, Saskatchewan, and Alberta (Houston and Street 1959, Salt and Salt 1976, Semenchuk 1992, Cooper et al. 1997). Extremely rare transient (<1 record/season) 20 May–20 Jun in coastal California (Small 1994).

**Routes.** During migration commonly occurs west to e. North Dakota, e. Nebraska, e. Kansas, w. Oklahoma, central Texas, and e. Mexico (Forbush 1929, Carter and Barker 1993). Rare but regular in California, mainly in fall (early Sep through Oct), also in ne. Montana. Southerly fall route mainly in and west of Appalachian Mtns. (avoiding southeastern states), through south coastal Texas, through highlands in e. Mexico (generally absent from Yucatán peninsula), Guatemala, s. Belize (rarely), n. El Salvador, Honduras, Nicaragua, Costa Rica, Panamá and on to South America (Bent 1953, Clement and Gunn 1957, Rappole et al. 1979, Howell and Webb 1995). Midwest and central Canada breeders proceed straight to Texas coast (Clement and Gunn 1957). Rarity of records on eastern Gulf Coast and

in Florida, West Indies, Bahamas, Bermuda, Puerto Rico, Jamaica, and Cuba (Pashley 1988, Dunn and Garrett 1997) suggests individuals do not cross Caribbean directly (Cramp and Perrins 1994). Rare migrant along California coast (especially during fall in south) and very rare during fall migration in coastal and s.-central Oregon (Gilligan et al. 1994, Small 1994). In s. Mexico, birds apparently cross over to Pacific slope of Central America and proceed along narrow coastal route or move south along montane areas of Central America to wintering grounds in nw. South America (Rappole et al. 1979, Howell and Webb 1995). In spring, populations wintering in western part of winter range may cross the e. Pacific Ocean south of Central America proceeding directly to s. Mexico (Rappole et al. 1979). Once in North America, spring migration route is similar to southerly fall route except possibly more to the east (Clement and Gunn 1957). More abundant during spring than fall migration in coastal Texas (Rappole et al. 1979, Rappole 1983). Longer stopovers in fall compared to spring in Maine (Morris et al. 1994).

#### MIGRATORY BEHAVIOR

Nocturnal migrant (Land 1970), possibly as pairs (but see A. F. Skutch in Bent 1953). Observed from Pacific coast up to 1,980 m during fall migration in Central America (A. F. Skutch in Bent 1953). Stopovers longer during fall (mean = 3.4 d  $\pm$  2.3 SD, [range 1–10 d,  $n$  = 20]) than spring in Maine (Morris et al. 1994, Morris et al. 1996). Greater numbers captured during spring migration (447) than fall (261) migration over 13 yr in w. Pennsylvania (Leberman and Clench 1971).

**Speed, method of orientation, response to weather.** Bent (1953) suggested birds spend 3–4 wk in spring migration.

**Degree of flocking.** Observed in mixed-species flocks lead by Tufted Titmice (*Baeolophus bicolor*) during fall in Michigan, along with American Redstarts (*Setophaga ruticilla*) and Magnolia (*Dendroica magnolia*), Black-throated Green (*D. virens*), Blackburnian (*D. fusca*), Black-and-white (*Mniotilta varia*), Bay-breasted (*D. castanea*), and Chestnut-sided (*D. pensylvanica*) warblers (Pielou 1957). One individual observed in mixed-species flock with Blue-gray Gnatcatchers (*Poliophtila caerulea*), chickadees (*Poecile* spp.), Tufted Titmice, and a Carolina Wren (*Thryothorus ludovicianus*) during fall migration in Texas (Bent 1953). Often associated with Wilson's Warblers during migration (Dunn and Garrett 1997). In Panamá occur exclusively as single birds or pairs within mixed-species flocks of small insectivorous birds with antwrens (*Microrhopias quixensis* and *Myrmotherula* spp.; Greenberg and Gradwohl 1980). Proportion of mixed-species flocks observed



containing 1–2 Canada Warblers: 40 of 67 flocks during spring and 21 of 50 during fall (Greenberg and Gradwohl 1980).

**Differential migration of age/sex classes.** Majority of migrants at an island stopover site in Maine were hatch-year/second-year birds; 99.4% of 161 birds during spring, 95.7% of 47 birds during fall (Morris et al. 1994). Fifty-seven percent of 288 fall migrants in coastal Texas were immatures (Rappole et al. 1979), 79% of 224 migrants in w. Pennsylvania were hatch-year (HY) birds (Leberman and Clench 1971). Mean arrival dates for males slightly earlier than for females at banding stations along migration route (Cooper et al. 1997). In Maine, males arrive 4 d earlier than females in spring, but no difference during fall migration (S. Morris pers. comm.). No detectable difference in fall passage dates between sexes in coastal Alabama (F. Moore and D. Cimprich unpubl.). Males arrive earlier than females on breeding grounds in Québec (Gauthier and Aubry 1996) and Ontario (3.2 d earlier [ $p < 0.01$ ]; Francis and Cooke 1986). Evidence suggesting adult males arrive earlier in spring than second-year (SY) males in Ontario (wing length negatively correlated with arrival date; Francis and Cooke 1986). Mean fall passage for HY birds occurs significantly earlier compared to adult birds in coastal Alabama (F. Moore and D. Cimprich unpubl.). Peak for adults 5 d after peak for immatures in w. Pennsylvania (Leberman and Clench 1971).

#### CONTROL AND PHYSIOLOGY

Little information. Most birds captured during spring (84.2% of 177) and fall (71.7% of 46) migration at a Maine stopover site had little or no fat; comparatively higher percentage than 8 other migrant warblers (Morris et al. 1994). Fall migrants gained an average of 0.1 g/d  $\pm$  0.4 SD (Morris et al. 1996).

## HABITAT

#### BREEDING RANGE

Wide range of deciduous and coniferous forests. Most abundant in moist, mixed coniferous-deciduous forests with a well-developed understory. Often near open water. Common at higher elevations (hills and mountains), especially in southern portion of range (Andrle and Carroll 1988, Brauning 1992). At lower elevations, often restricted to cool, wet, low-lying areas: cedar (Cupressaceae) woods, swampy forests, sphagnum (*Sphagnum* spp.) bogs, moist forest clearings and woodland edges, spruce (*Picea* spp.)–tamarack (*Larix laricina*) bogs, aspen (*Populus* spp.) and moist spruce-birch (*Betula* spp.) forests, and alder (*Alnus rugosa*) and willow (*Salix* spp.) stands along stream banks (Clement and Gunn

1957, Peck and James 1987, Andrle and Carroll 1988). Less common in shrub wetlands. Suitable habitat often has a developed layer of moss and an uneven forest floor (Baker 1932, Griscom 1938, Forbush and May 1955, Laughlin and Kibbe 1985). In British Columbia and Saskatchewan, most common on steep slopes within deciduous forest with dense birch understory, or riparian willow and alder shrubbery (Enns and Siddle 1996, Smith 1996). Also in younger, cut-over forests and forest edge. Heterogeneous second-growth (early successional) mixed coniferous-deciduous forests in n. Wisconsin (Sodhi and Paszkowski 1995). Presence correlated with number of deciduous woody stems <10 cm dbh and >4.5 m tall in regenerating clear-cut spruce-fir (*Abies* spp.)/hardwood forests of Maine (Titterton et al. 1979). In Great Lakes/St. Lawrence river valley, one of the most common warblers in the Eastern hemlock (*Tsuga canadensis*)–white pine (*Pinus strobus*)–red pine (*Pinus resinosa*) forests that have a maple (*Acer* spp.)–birch–American beech (*Fagus grandifolia*) component (Clement and Gunn 1957). More abundant in old than young aspen forests in Alberta (Schieck et al. 1995, Schieck 1997). In the Allegheny Mtns. of w. Maryland and nw. West Virginia, relative abundance positively correlated with foliage density 0.3–1.0 m above ground, forest moisture index, tree basal area, and size of forest fragment; negatively correlated with mean canopy height and percentage ground cover based on responses from point count surveys (Robbins et al. 1989). Understory foliage density, forest moisture index, and tree basal area were the most important predictors (Robbins et al. 1989).

In Pennsylvania, at elevations >457 m, in areas with cool summer temperatures and above-average precipitation (Brauning 1992). Up to 900 m elevation in New York and New Hampshire (Eaton 1910, Bent 1953). Rhododendron (*Rhododendron* spp.) thickets and streamside vegetation within mountains in s. U.S. (Clement and Gunn 1957, Palmer-Ball 1996). At higher elevations in southern part of range (>650 m in West Virginia, >1,160 m in Kentucky, >2,200 m in Georgia, up to 1,900 m in N. Carolina; Howell 1910, Bent 1953, Buckelew and Hall 1994, Palmer-Ball 1996).

#### SPRING AND FALL MIGRATION

Found in shrubbery, bushes and vine tangles near edge of parks, villages, and cities, thickets of stream and woodland edges, swamps, and willow trees (Eaton 1914). Brushland, second-growth woodlands, and along edges of timbered lowlands and watercourses during spring migration in s. Minnesota (Roberts 1932). During spring migration in Ohio in shrub layer of upland and lowland forests with preference for spicebushes (*Lindera*



*benzoin*) within swamp forest (M. B. Trautman in Bent 1953). Very habitat-specific during spring migration in N. Carolina compared to 18 other warblers; 76.5% of foraging birds observed in one (floodplain forest) of 7 habitat types (Power 1971). Forests, undergrowth and thickets near water in Texas (Oberholser 1974). Coastal, riparian, and urban areas and dry and wet forests on Caribbean Islands (Arendt 1992). In Mexico, low to mid-story vegetation within humid to semihumid forest, swamp forest, and forest edge, sea level to 2,500 m elevation (Binford 1989, Howell and Webb 1995). Up to 1,500 m in open forest, second-growth, and scrub habitats in Honduras; more common on Pacific slope than Caribbean slope (Monroe 1968). Captured infrequently in young and old second-growth forest, and low (50–75 m) and mid-elevation (1,000 m) primary forest at La Selva, Costa Rica (Blake and Loiselle 1992). Several birds observed in black mangrove forests in w. Panamá (Lefebvre and Poulin 1996).

#### WINTER RANGE

Dense undergrowth of submontane cloud and rain forests, early to mid-secondary woodland growth, clearings, and shrubby forest edge 1,000–2,100 m (Meyer de Schauensee and Phelps 1978, Ridgely and Tudor 1989, Curson et al. 1994). Also coffee plantations, hedgerows, and other semi-open areas (DeGraaf and Rappole 1995). Abundant and widespread in Colombia, avoiding the coast and e. lowlands; most common in mountains and foothills, 1,000–2,500 m (500–3,150 m; Hilty 1980, Paynter 1995). In Ecuador and Peru, abundant on e. slope of Andes and adjacent lowlands, 300–1,750 m, occasionally to 3,000 m (Paynter 1995). May be sexual segregation based on elevation in Ecuador (M. Foster pers. comm.).

## FOOD HABITS

#### FEEDING

**Main foods taken.** Flying insects and spiders (Clement and Gunn 1957, Semenchuk 1992).

**Microhabitat for foraging.** BREEDING. Lower tree branches and shrubs, aerial; occasionally forages on ground (Forbush and May 1955). Uses both coniferous and deciduous trees, but in n. Wisconsin both sexes foraged more frequently in conifers and less frequently in hardwoods compared to availability and sympatric wood-warblers (Sodhi and Paszkowski 1995). Used conifers for 36% of 884 foraging maneuvers in New Hampshire (Sabo and Holmes 1983). Nearly all foraging done below 5 m (Laughlin and Kibbe 1985, Berger et al. 1991, Enns and Siddle 1996); 3.8 m  $\pm$  1.4 SD (range 2.6–5.2) in

New Hampshire (Sabo and Holmes 1983). Always foraged within shade in Wisconsin (Burt 1977). In n. Wisconsin, males foraged lower in vegetation than sympatric Nashville and Chestnut-sided warblers, but higher than Mourning Warblers (Sodhi and Paszkowski 1995). Similar to other wood-warblers, females tended to forage lower in vegetation than males (females 3.18 m  $\pm$  0.27 SD [range 1.0–8.3,  $n = 39$ ] and males 4.06 m  $\pm$  0.25 SD [range 0.3–23.0,  $n = 122$ ]; Sodhi and Paszkowski 1995). Most frequently foraged on red-osier dogwood (*Cornus stolonifera*) and young birch trees within understorey in British Columbia (Enns and Siddle 1996).

**MIGRATION.** Of 180 foraging observations on 19 individuals during fall migration in Ontario, most were gleaning from shrubs, sapling foliage and branches, and inner branches of trees, 1.5–7 m high (Keast 1980). During Oct and early Nov in Panamá, foraging birds usually associated with antwren foraging flocks in moist and dry forests (Hespenheide 1980).

**WINTERING.** Lower and upper layers of vegetation within forests and second growth (Meyer de Schauensee and Phelps 1978).

**Food capture and consumption.** Variety of foraging techniques, including flycatching, sallying, hover gleaning, foliage gleaning, and ground gleaning. Equal to American Redstart in flycatching ability. Based on 1.3 h of observation, males and females in n. Wisconsin used foraging methods involving flight (mostly hover and sally) in approximately 70% and 43% of prey pursuits, more frequently than sympatric wood-warblers (Sodhi and Paszkowski 1995). In New Hampshire used primarily gleaning and hovering (as opposed to flycatching) during 884 foraging maneuvers (Sabo and Holmes 1983). During 100 observations in New York, used aerial hawking, climbing hop with flutter, and methodical search (gleaning) on low branches (Commisso 1988). Sometimes slams wiggling insect against side of branch after capture (Krause 1965). While foraging, travels most frequently by hopping along branches (Sodhi and Paszkowski 1995). Moves faster while foraging (0.40 and 0.33 hops and flights/s for males and females, respectively) than sympatric Mourning and Chestnut-sided warblers (Sodhi and Paszkowski 1995). Flight distances between substrates while foraging; 0.98 m  $\pm$  0.04 SD ( $n = 210$ ) for males and 0.85 m  $\pm$  0.10 SD ( $n = 33$ ) for females (Sodhi and Paszkowski 1995). On winter grounds, very active foliage-gleaner within mixed-species flocks, sometimes making short aerial sallies (Ridgely and Gwynne 1989). Can move so quickly during foraging that observers have described their behavior as "bouts of animated flycatching" (Andrle and Carroll



1988), "a bundle of restless activity" and "violent activity" (Krause 1965).

#### DIET

**Major food items.** Mostly winged insects; mosquitoes (Culicidae), flies (Diptera), moths (Lepidoptera), beetles (Coleoptera), small hairless caterpillars (Lepidoptera), and spiders (Arachnida) (Forbush 1929, Bent 1953). Observed eating oak scales (*Kermes* spp.; McAtee 1906). One female observed catching worms, flies, and mosquitoes during incubation recesses in Michigan (Krause 1965). Observed flycatching mosquitoes on the wing (Roberts 1932). Stomach contents of birds in Maryland contained ants (Formicoidae) and bees (Family Andrenidae, *Andrena* spp., *Halictus* spp.; Judd 1902). Flies, hymenopterous insects, beetles, larvae in 3 specimens examined in Wisconsin (F. H. King in Bent 1953). In coastal Rhode Island, 2 of 5 birds had fruit (all 5 had insects) in fecal samples during autumn migration ( $24.0\% \pm 19.1$  SD fruit in samples; Parrish 1997). Five locusts (Cicadidae) and 29 other insects in one stomach examined in Nebraska (Aughey in Bent 1953). Stomach contents of 2 birds during fall migration in Ontario contained beetles and 1.5-mm-wide snails (Keast 1980). Insects in winter (Ridgely and Tudor 1989), but no detailed data available.

**Quantitative analysis.** No information.

#### FOOD SELECTION AND STORAGE

No information.

#### NUTRITION AND ENERGETICS

No information.

#### METABOLISM AND TEMPERATURE REGULATION

No information.

#### DRINKING, PELLET-CASTING, AND DEFECTION

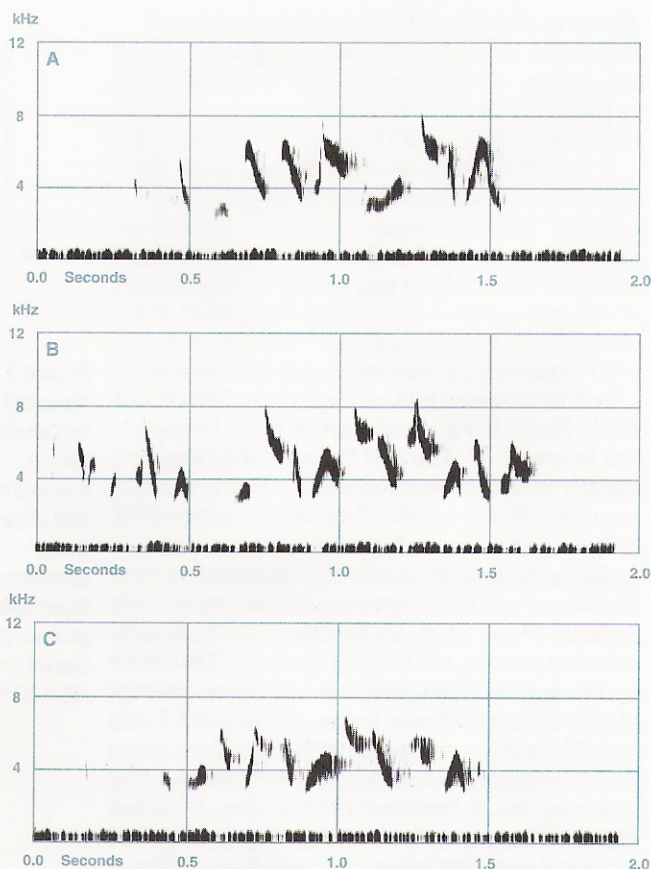
Limited information on drinking or defecation. One female observed with beak lifted, nibbling rain drops dripping off leaf tip (Krause 1965).

## SOUNDS

#### VOCALIZATIONS

**Development.** Little information. Young observed chirping or squawking after being forced-fledged (Milosevich and Olson 1981, A. J. Erskine unpubl.). No data on vocal learning.

**Vocal array.** **SONGS.** Figure 2. Clear, loud, distinctive Primary Song consists of 1 *chip* (rarely 2) followed by an abrupt, explosive series of short notes that invariably ends with a 3-note phrase, the last one loud and rising in pitch (Baker 1932, Lemon



**Figure 2.** Three examples of Primary Song of male Canada Warblers.

Prepared by the staff of the Borror Laboratory of Bioacoustics (BLB), The Ohio State University (BLB nos. 5311, 2909, Lincoln Co., ME, 30 Jun 1961, 7 March 1996, 24 Jun 1957).

et al. 1983, Laughlin and Kibbe 1985). Consecutive notes are rarely on same pitch. Primary Song extremely variable (Baker 1932); described as *chip chupety swee-ditchety* or *chip, suey de swee-ditchety* (Clement and Gunn 1957), *chip, chipperry, chipperry, chipperry, chee-the-chee* (Silloway 1920); always a distinctive pause after the initial *chip*. Modal frequency of song 4.66 kHz (range 2.58–7.93) for 16 birds in New Brunswick (Lemon et al. 1983). Mean duration 1.51 s (range 1.25–2.6,  $n = 16$  birds, 23 songs; Bent 1953, Clement and Gunn 1957, Lemon et al. 1983). Persistent, emphatic singer (Baker 1932). Reportedly has a Flight Song (variable warble containing elements of normal song, but more prolonged) given during rising flight on slowly flapping or quivering wings with direct and silent descent (Bent 1953, Ficken and Ficken 1962).

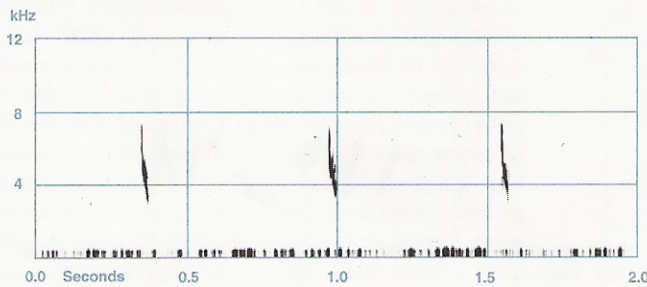
**CALLS.** Both sexes give subdued *chip* (or *tschip, tsik*), and a loud, sharp *check* or *chip* Alarm Call (see Fig. 3), and a high-pitched *zzee* in flight (Eaton 1914, Clement and Gunn 1957, Curson et al. 1994).

**COMPARISON OF SEXES.** Only males sing. Both sexes give calls.

**GEOGRAPHIC VARIATION.** No information.

**Phenology.** Sings throughout summer (Baker 1932, Cadman et al. 1987), but more frequently





**Figure 3.** Alarm Call of the Canada Warbler. Prepared by the staff of the Borror Laboratory of Bioacoustics (BLB no. 2111, Lincoln Co., ME, 1 Jul 1956).

prior to mating; approximately 6 songs/min while advertising for a mate (Kendeigh 1945a, Semenchuk 1992). Flight Song usually given more frequently late in season (Ficken and Ficken 1962). Sings frequently after molting and during spring and fall migration (Roberts 1932, Griscom 1938, Bent 1953, Ridgely and Gwynne 1989).

**Daily pattern of vocalizing.** DESCRIPTION OF THE PATTERN WITH DATA. Sings throughout day in early summer (Baird et al. 1875). One male during incubation period gave Primary Song for 13 bouts for an average of 9 min each, 8 bouts for an average of 4.6 min, and 7 bouts for an average of 5.3 min on 3 different days (Krause 1965). Flight Song given more frequently at dusk (Ficken and Ficken 1962).

**VARIATIONS AT DIFFERENT TIMES OF DAY.** No information. Unknown whether one song type is used more at dawn as in other wood-warblers (Wiley et al. 1994).

**VOCALIZING AT ABNORMAL TIMES OF DAY.** Female sometimes gives several *chips* upon leaving nest. One male did not sing while following incubating female during periods off nest but sang continuously while female was sitting on eggs (Krause 1965).

**Places of vocalizing.** Generally sings from a low perch within territory (Laughlin and Kibbe 1985, Gauthier and Aubry 1996); 1–10 m above ground in New York, usually from exposed perches (Kendeigh 1945b). Relatively little flight during singing bouts compared to other warblers; based on observation of 30 flights of singing males, mean interval between flights during singing bouts was 20.4 s, and mean flight duration 0.6 s (Burt 1977). Occasionally sings while flying (Curson et al. 1994). Parents give Alarm Calls near nest.

**Repertoire and delivery of songs.** Song is variable among individuals and varies greatly within the same bird (Baker 1932, Bent 1953). Repertoire size is large (up to 11 song types) and several may be sung in succession (Dunn and Garrett 1997). Typically 10 notes (5–15)/song (Bent 1953). Least repetition and greatest number of phones/individual song (12.2) among 19 warblers examined (Lemon et al. 1983).

**Social context and presumed functions of vocalizations.** Unknown whether one or more song types are used more in inter- vs. intrasexual interactions as commonly observed in other wood-warblers (Spector 1992, Wiley et al. 1994). Agitated *chips*, frequently observed in response to human presence in territory or near nest (Baker 1932), may function to alert mate of potential danger. *Chips* of both male and female occasionally given during incubation when female is off nest probably function to communicate location to mate. Function of Flight Song (Ficken and Ficken 1962), and reason for exceptionally prolonged time frame during which male sings, unknown.

#### NONVOCAL SOUNDS

*Whirr* of wings and loud snap of mandibles audible when pursuing flying insects during foraging (Clement and Gunn 1957, Krause 1965).

## BEHAVIOR

#### LOCOMOTION

Typically active and alert, gregarious (Clement and Gunn 1957). Often observed in low vegetation with tail cocked and wings flicked (Curson et al. 1994, Howell and Webb 1995). Hops and climbs along branches while moving through thick vegetation. Flight is direct.

#### SELF-MAINTENANCE

After leaving nest, one incubating female sometimes perched for 1–2 min to yawn, rub mandibles on branch, defecate, ruffle and shake feathers, stretch wings and legs, or preen (sometimes vigorously) breast, wrist, or under wing before foraging (Krause 1965). Unlike Hooded Warbler and most other passerines, scratches head directly by bringing foot forward and under wing, rather than over wing (Ficken and Ficken 1962).

No information on sleeping, roosting, sunbathing, or daily time budget.

#### AGONISTIC BEHAVIOR

During winter near Popayán, Colombia, 3 hostile intraspecific interactions (no details provided) and no hostile interspecific interactions observed during 206 foraging observations (Chiple 1980). During the breeding season, Morse (1970) observed 5 hostile intraspecific interactions and 9 hostile interspecific interactions during 86 foraging observations (more hostile interactions than 3 sympatric warblers).

Exhibits Wing Display, in which male faces male opponent with contour feathers sleeked, body held horizontal, and wings lifted horizontally out from body (Burt 1977).



## SPACING

**Territoriality.** Little information. In Ontario, average territory size 0.2 ha in Algonquin Provincial Park (Martin 1960); one territory in Québec 0.4 ha (A. Cyr in Gauthier and Aubry 1996). Two paired males apparently defended areas of 0.8 and 1.2 ha in New York (Kendeigh 1945a). Two pairs feeding newly fledged young just out of nest only 60–90 m apart (Walkinshaw 1956). Three pairs nesting <30 m away from each other along stream in West Virginia and 5 nests found along 46 m of stream in Vermont (Cornell Nest Records Program [CNRP]).

Male appears to arrive in breeding territory before female and establishes and aggressively defends territory by singing (Kendeigh 1945a). No information on winter territoriality, but typically joins mixed-species foraging flocks singly or as pairs; flocks may be territorial.

**Individual distance.** No information.

## SEXUAL BEHAVIOR

**Mating system and sex ratio.** Little information. Considered socially monogamous, but extent of extra-pair fertilizations unknown. Some evidence that birds maintain pair bond year-round; on Barro Colorado I. in Panamá occur as male-female pairs during spring and fall migration (18 of 30 birds observed in fall and 64 of 81 birds observed in spring were in bright-dull pairs, the other 12 were solitary birds; Greenberg and Gradwohl 1980).

**Extra-pair copulations.** No information.

## SOCIAL AND INTERSPECIFIC BEHAVIOR

**Degree of sociality.** Mostly solitary or with mate during breeding season. Observed in flocks and interacting with other species, and potentially a mate, during migration. Often as small groups within mixed-species feeding flocks in winter; attends army ant swarms in winter (Bent 1953, Ridgely and Gwynne 1989, Curson et al. 1994).

**Nonpredatory interspecific interactions.** Two separate aggressive encounters (no details given) observed between male Gray Catbird (*Dumetella carolinensis*) and migrant Canada Warbler at catbird nests (Slack 1976). In Québec, a male Chestnut-sided Warbler chased away a male Canada Warbler that had come near its nest (Mousley 1924). Observed mixing with other species of wood-warblers in early summer prior to territory formation (Baker 1932). No apparent conflict with Yellow Warblers (*Dendroica petechia*) nesting only 9 m away from nest in New Brunswick (Maritimes NRS).

## PREDATION

**Kinds of predators.** No information.

**Manner of predation.** No information.

**Response to predators.** When disturbed at nest, female often gives distraction display on ground, feigning injury with breast feathers ruffled, tail fanned, and wings half-cocked or fluttering above the back (Milosevich and Olson 1981, Semenchuk 1992). Male may do likewise (Pierson 1978).

Becomes agitated when a human observer enters territory (more so than many warblers), chipping loudly and flying from shrub to shrub (Baker 1932, Harrison 1984, Andrlé and Carroll 1988, Brauning 1992). Pishing or squeaking on territory often elicits agitated behavior; wing flipping, bill cleaning, and sharp *chip* calls (Laughlin and Kibbe 1985).

## BREEDING

## PHENOLOGY

**Pair formation.** No information.

**Nest-building.** Little information. Generally mid-May through early Jun in Vermont, Pennsylvania, Ontario (Baird et al. 1875, Laughlin and Kibbe 1985, CNRP).

**Only brood per season.** LAYING OF FIRST TO LAST EGG IN CLUTCH. Primarily first week of Jun (1–20 Jun) in New York (Eaton 1914, Baker 1932), and 22 May–24 Jun in Pennsylvania, Ohio, N. Carolina, British Columbia, Maine (Griscom 1938, Kendeigh 1945a, Peterjohn and Rice 1991, Cooper et al. 1997, CNRP). Incubation presumably lasts 12 d, but few data.

**NESTLINGS.** See Figure 4. Typically third week in Jun to second week in Jul (range 5 Jun through first week in Aug; CNRP [ $n = 35$  nests], Berger et al. 1991, Brewer et al. 1991, Peterjohn and Rice 1991, Erskine 1992, Gauthier and Aubry 1996, Cooper et al. 1997). Nestling period presumably lasts 10 d, but little information.

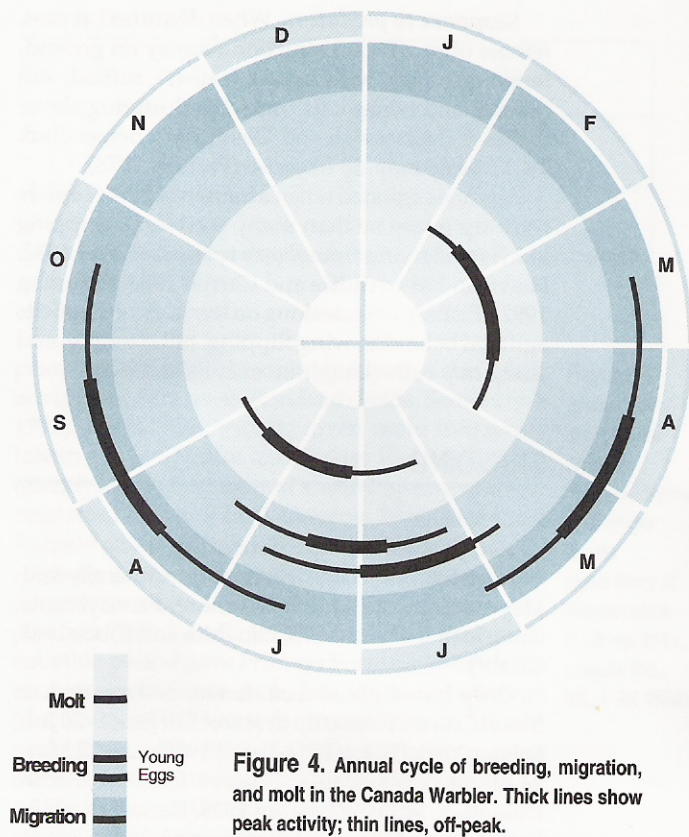
## NEST SITE

**Selection process.** No information.

**Microhabitat.** Well-concealed, often in thickets or areas with dense ferns (Peck and James 1987, Andrlé and Carroll 1988). In wet, mossy areas within forest among ferns, stumps, and fallen logs. Often in rhododendron thickets in southern part of range. Dense nest site cover appears to be important habitat requirement (Kendeigh 1945a).

**Site characteristics.** Typically on or near ground, often on slopes, knolls, in earthen banks, or rocky areas (Peck and James 1987). Typically built within recessed hole of upturned tree root mass, rotting tree stump or sphagnum moss hummock. Less often within clump of grass, at base of tree stump, tucked under overhanging bank, beside fallen log, in rock cavity, at base of sedge tussock, under leaf on forest floor, at base of moss-covered logs/rocks, or in brush pile (Bull 1974, Fall 1977, Casebere





1978, Milosevich and Olson 1981, Peck and James 1987, CJC). One unusual nest was 0.9 m off ground in crotch of maple sapling (Peck and James 1987).

#### NEST

**Construction process.** Female builds nest. Carries grass, bark, and leaves to nest with bill.

No information on time of day nest built, or how long it takes.

**Structure and composition matter.** Bulky, loosely constructed. Cup with exterior made of some combination of grasses, bark strips, dead leaves, plant fibers, plant down, weed stalks, moss, pine needles, and twigs with deciduous leaves woven into outer wall (Baird et al. 1875, Eaton 1914, Baker 1932, Clement and Gunn 1957, Krause 1965, Peck and James 1987, Andrle and Carroll 1988). Lining often contains horse, deer, or other animal hair, and rootlets, deciduous leaves, and fine grasses (Eaton 1914, Baker 1932, Peck and James 1987).

**Dimensions.** Outside diameter 9–14 cm, outside height 5.5–10.2 cm. Inside diameter 5.0–7.6 cm, inside depth 2.5–5.0 cm (Bent 1953, Milosevich and Olson 1981, Peck and James 1987).

**Microclimate.** No quantitative information. Common component of preferred nesting sites

appears to be relatively cool temperatures and high humidity (Eaton 1914, Allen 1919, Andrle and Carroll 1988).

**Maintenance or reuse of nests, alternate nests.** Little information. One nest built on top of nest from previous year (Western Foundation of Vertebrate Zoology [WFVZ] egg collection).

**Nonbreeding nests.** No information, but probably none.

#### EGGS

**Shape.** Ovate or slightly short ovate (Forbush 1929, Bent 1953).

**Size.** From WFVZ: Length: 17.33 mm (range 15.99–19.50,  $n = 22$  clutches, 86 eggs); breadth: 13.20 mm (range 12.00–14.05,  $n = 22$  clutches, 86 eggs). All means are based on clutch averages, ranges on individual eggs excluding obvious runt and giant eggs. Also see Eaton 1914, Forbush 1929, and Bent 1953.

**Mass.** Fresh egg mass 1.56 g (Bennett 1986); 1.65 g estimated using the equation  $\text{mass} = 0.548 \times \text{length} \times \text{breadth}^2$  (Hoyt 1979). Eggs approximately 15% of adult female mass.

**Color.** Ground color brilliant, buffy, or creamy white, slightly glossy, well speckled with dots and small blotches of various shades and tints (brown, reddish brown, purple, chestnut, gray, purplish gray, lavender, and violet) in a wreath around the larger end (Baird et al. 1875, Forbush 1929, Baker 1932, Bent 1953, Clement and Gunn 1957, Krause 1965).

**Surface texture.** No information.

**Eggshell thickness.** No information. From WFVZ: Empty shell weight from sample drawn throughout North American range: 0.086 g (range 0.072–0.113,  $n = 22$  clutches, 86 eggs).

**Clutch size.** Mean 4.13 eggs (range 2–6,  $n = 23$  nests) in Ontario; most (17 of 23) contained 4 or 5 eggs (Peck and James 1987). Mean 4.36 eggs (range 3–5,  $n = 11$  nests) in Michigan (Berger et al. 1991). Mean 4.45 eggs  $\pm$  0.70 SD (range 3–5,  $n = 75$  nests) based on nonparasitized nests in 5 nest record schemes (NRS) and egg collections (CNRP, Maritimes NRS, Québec NRS, Royal Ontario Museum NRS, WFVZ egg collection); most (66 of 75) contained 4 or 5 eggs. Four- and 5-egg clutches laid with equal frequency in Vermont (Laughlin and Kibbe 1985). One nest with 6 nestlings found in Ontario (Peck and James 1987).

**Egg laying.** No information.

#### INCUBATION

**Onset of broodiness and incubation in relation to laying.** No information, but presumably incubation starts with laying of final egg.

**Incubation patch.** No information.



**Incubation period.** Twelve days, although based on few nests (CJC); more study needed.

**Parental behavior.** From Krause (1965). Only the female incubates. One female spent 85% of time on nest. Based on 39.7 h of observation on 1 nest in Michigan, average on-bout 32 min (range 1–84), average off-bout 7 min (range 1–17); median off-bout was 4 min.

Considered close sitters, difficult to flush. One sitting female remained motionless on the nest for 10–20 min periods and appeared to doze off, broken by minor activity; yawning, swallowing, stretching neck or wings, rising up in nest, turning eggs, shifting position (Krause 1965). Sometimes utters low *chip* as leaving nest. Return after off-bout slower and less direct than departure; includes perching and scanning if intruders present in area.

Male frequently joins female during foraging off nest, typically remaining silent several feet away from female; male appears to be following female rather than vice versa. One Michigan male sometimes perched near nest for 1–10 min periods during on-bouts (at least 3% of incubation during 39.7 h of observation). One male approached nest 9 times during 39.7 h of observation, in all cases he gave *chip*, and female left nest immediately prior to his arrival. Male often displays anticipatory feeding behavior prior to hatching (Semenchuk 1992). One male called female off nest and “brought food” to unhatched eggs 9 times during 39.7 h of observation over 7 d, and as early as 8 d prior to hatching; male gave food to incubating female only once and female initially refused food.

**Hardiness of eggs against temperature stress; effect of egg neglect.** No information.

#### HATCHING

No information.

#### YOUNG BIRDS

No information. No study of growth and development.

#### PARENTAL CARE

**Brooding.** No information.

**Feeding. ROLES OF PARENTS.** Both parents feed nestlings. Male carried food to one nest in Illinois twice as often as female did when nestlings were approximately 6 d old (Milosevich and Olson 1981). Male took dominant role in feeding young at one Michigan nest (Krause 1965), but at another, female fed more than male (Walkinshaw 1956). May result from differences between sexes in response to observers; male appeared bolder than female in feeding young at one nest (male fed 14 times and female twice during 2 h of observation; Middleton 1957). Female observed gleaning

insects from leaves very near nest (Milosevich and Olson 1981).

**METHOD OF FEEDING.** Direct; carries food in bill and places it in opened mouths of young.

**FOOD OF YOUNG: KINDS AND SIZE OF ITEMS.** Little information. Crane-flies (*Tipulidae*) brought to young in New York (Allen 1919). Male brought larger insects than female at 1 Michigan nest; female fed little wooly aphids that were very abundant (Walkinshaw 1956). Observed feeding nestlings yellow grubs, lepidopteran larvae, brown measuring worms, moths, and mosquitoes (Bent 1953).

**RATE OF FEEDING.** Little information. During 230 min of observation at 1 nest, male fed 3- to 4-d-old nestlings 30 times, female fed 49 times (Walkinshaw 1956). Another pair fed at 3–6 min intervals (extremes, 1–20 min; C. J. Stanwood in Bent 1953). No information on amount of food brought to nest or apportionment among nestlings.

**Nest sanitation.** Both parents remove fecal sacs (Bent 1953).

#### COOPERATIVE BREEDING

Not observed.

#### BROOD PARASITISM

**Identity of the parasitic species.** Brown-headed Cowbird (*Molothrus ater*).

**Frequency of occurrence, seasonal or geographic variation.** Considered to be fairly regularly parasitized by cowbirds in suitable localities (Friedmann et al. 1977, Semenchuk 1992), although little information. Needs more detailed study. Parasitized nests reported in Saskatchewan, Ontario, New Brunswick, New York, Indiana, Michigan, and Minnesota (Friedmann 1963). Five of 25 nests (20%) parasitized by cowbirds in Ontario; 3 of these nests contained 3 cowbird eggs each (Peck and James 1987). In Michigan, 3 of 14 nests (21.4%) parasitized (Berger et al. 1991), and 6 of 11 nests parasitized (54.5%; Black 1955a, 1955b, Middleton 1957). Proportion of observed nests with cowbird eggs underestimates frequency of parasitism if hosts abandon parasitized nests or reject cowbird eggs, or if parasitized nests suffer higher probability of depredation than non-parasitized nests.

**Timing of laying in relation to host's laying.** No information.

**Response to parasitic mother, eggs, or nestlings.** No information, but at least some individuals accept and successfully hatch and fledge cowbirds.

**Effects of parasitism on host.** Little information. Of 3 nests with cowbird nestling in Michigan, 2 had one unhatched host egg and the other only had one host nestling (Black 1955a, Middleton 1957), suggesting removal of host eggs and/or reduced survival of host young. The only remaining unhatched



host egg in one of these nests was partially encased in the broken shell of the cowbird egg, and the cowbird was ready to fledge (Middleton 1957). One nest in Ontario was abandoned after cowbirds laid 3 eggs and broke or removed the 3 host eggs (Devitt 1967). Of 11 parasitized nests in nest record schemes (CNRP, Maritimes NRS, Québec NRS, Royal Ontario Museum NRS), 2 (Nova Scotia, Minnesota) fledged a cowbird but no host young, 1 was depredated, 1 failed due to human activity; outcomes of others not determined. Fewer host eggs in parasitized nests (mean 2.5 eggs  $\pm$  0.85 SD [range 1–4 eggs,  $n=10$ ]) compared to nonparasitized nests.

#### FLEDGLING STAGE

**Departure from the nest.** No information on age at departure, but probably 10 d; Kendeigh (1945a) assumed 8–10 d. At departure, young unable to fly but are vocal. Five young jumped the nest when approached by a human; only 2 d earlier these young were unable to open their eyes (Milosevich and Olson 1981).

**Growth: mass, proportions, structures.** No information.

**Association with parents or other young.** Parents continue feeding young after they leave the nest (Semenchuk 1992). Male observed feeding fledgling a few days out of nest (Campbell 1938). Parents still on territory feeding fledged young 1 wk after fledging in Minnesota (Fall 1977).

**Ability to get around, feed, and care for self.** No information.

#### IMMATURE STAGE

Little information. Skull ossification complete 15 Oct through Dec (Pyle 1997).

## DEMOGRAPHY AND POPULATIONS

#### MEASURES OF BREEDING ACTIVITY

**Age at first breeding; intervals between breeding.** No information, but probably breeds annually starting at 1 yr of age.

**Clutch.** Usually 4 or 5 eggs per clutch (see Breeding: eggs). No information on number of clutches per breeding season.

**Annual and lifetime reproductive success.** Limited information. Fledging brood size 3.8 young  $\pm$  1.03 SD (range 2–6,  $n=26$ ; rangewide, 4 nest record schemes). Daily nest survival 0.9555 for 37 nests (10 failures) from 5 nest record schemes/egg collections that reported  $>1$  nest visit. Too little information to address variation in reproductive success among years or locations, or to identify factors affecting

reproductive success. No information on number of young per successful clutch and pair.

**Number of broods normally reared per season.** No information, but probably only one (Forbush 1929). Brauning (1992) suggested that pairs may occasionally raise 2 broods/yr, based on wide range of dates (31 May–26 Jul) that birds were observed feeding young in Pennsylvania. Peterjohn and Rice (1991), however, suggested that re-nesting attempts are responsible for fledged young seen with adults though the end of Jul, and that the record for fledged young on 31 May in Pennsylvania is questionable.

**Proportion of total females that rear at least one brood to nest-leaving or independence.** No information.

#### LIFE SPAN AND SURVIVORSHIP

Maximum reported life span 7 yr, 11 mo (Klimkiewicz et al. 1983, R. Pantle pers. comm.). No reliable estimates of survivorship available. Of 46,973 banded birds reported to the National Banding Lab, only 20 subsequently recovered (Klimkiewicz et al. 1983).

#### DISEASE AND BODY PARASITES

No information.

#### CAUSES OF MORTALITY

No information.

#### RANGE

**Initial dispersal from natal site.** Little information, but 2 birds first captured as juveniles were caught in subsequent years in same location (Anderson and Maxfield 1967).

**Fidelity to breeding site and winter home range.** Unknown, but one nest in Pennsylvania built on top of old nest from previous year (WFVZ collection). Marked adults observed returning to same breeding location for up to 4 subsequent yr (Anderson and Maxfield 1967). Fidelity to wintering grounds unknown.

**Dispersal from breeding site.** Frequency and distance of dispersals from breeding sites unknown. One breeding female in central New York returned 2 yr later to same general location to breed again, then was subsequently recovered 5 yr later (25 May 1971) near Cleveland, Ohio, 800 km west of original breeding site after flying into window (R. Pantle pers. comm.).

**Home range.** Size of singing area for 1 male in New York State was 0.24 ha, but he ranged over a 0.8 ha area (1.2 ha for another male) after nesting began (Kendeigh 1945a). It is these larger areas that are apparently defended as territories against intruders (Kendeigh 1945a). See Behavior: spacing, above.



## POPULATION STATUS

**Numbers.** Not abundant within most of its breeding distribution (Griscom 1938, Cadman et al. 1987). Within suitable habitat, breeding density typically 1–5 pairs/10 ha (range 0.25–13) but varies by location and forest type; average of 0.25 pairs/10 ha in mature maple-beech-birch-hemlock forest in New York (Baird 1990) and in mature white pine-red oak (*Quercus* spp.) forest in coastal Maine (Witham and Hunter 1992); 0.3 males/10 ha within maple stands in Nova Scotia and Ontario (Erskine 1977); 0.4 pairs/10 ha in aspen-fir-birch-spruce forests of Saskatchewan (Kirk et al. 1997); 1.2–1.7 territorial males/10 ha within stands of aspen, birch and fir in New Brunswick and Ontario (Erskine 1977); 1.7 and 2.5 pairs/10 ha based on spot mapping within mid- and late-seral stages of previously clear-cut spruce-fir forests with dense deciduous understory, but absent from late-seral stage stands with open forest floor in Maine (Titterton et al. 1979); 2.2 pairs/10 ha in eastern mixed-deciduous forest of New York (Litwin and Smith 1992); 1.9–3.5 birds/10 ha in coniferous, deciduous, and mixed forest habitats adjacent to clear-cuts in n.-central Maine (Elliott 1987). More than 3 singing males/10 ha in maple-oak-beech forest in West Virginia (Maurer et al. 1981); 1.7–8.6 pairs/10 ha in poplar-aspen forests with dense understory and 3.8–4.1 pairs/10 ha in balsam fir/white birch forest of w. Manitoba (Kirk et al. 1997); 2.1–10 pairs/10 ha in s. Québec (Gauthier and Aubry 1996). Four to five singing males/10 ha in hemlock-cedar forests in Algonquin Provincial Park in Ontario (Martin 1960); 5.6 territorial males/10 ha within good habitat in n. Alberta (Cooper et al. 1997); 6.0 birds/10 ha in subalpine valleys of New Hampshire (Sabo and Holmes 1983), 6.2 singing males/10 ha on Black Mtn. in Kentucky (Palmer-Ball 1996). Up to 13 pairs/10 ha in mixed-wood cut-over forest in ne. Ontario (Welsh and Fillman 1980). Where present in Great Smoky Mtns. of Tennessee and N. Carolina, 1.2–5.4 breeding pairs/10 ha in moist stream valley deciduous forests with dense *Rhododendron* thick-ets, 6.7–13 breeding pairs/10 ha in eastern hemlock-deciduous forests with extensive birch and *Rhododendron* understory, and 1.0–1.3 breeding pairs/10 ha in beech-oak forests (Wilcove 1988). Breeding population estimated at 58,000 ± 15,000 pairs in Maritimes Provinces (Erskine 1992).

The majority of birds captured during spring (99.4% of 161) and fall (86.5% of 245) migration in Maine were young of the year (Morris et al. 1994, Morris et al. 1996).

**Trends.** Based on Breeding Bird Survey (BBS) data 1966–1996, populations have declined 2.1%/yr ( $p = 0.03$ ,  $n = 453$  routes) throughout breeding range; magnitude of decline is similar 1966–1979

and 1980–1996 (BBS unpubl.). Declines particularly severe in ne. U.S. (5%/yr; BBS unpubl., also see Witham and Hunter 1992, James et al. 1996). Population declines reported for New England earlier in century (Griscom 1949). In Ontario, populations declined 3.7%/yr from 1961 to 1988 ( $p < 0.01$ ) based on migration counts; declines greatest in recent years (Hussell et al. 1992). In contrast, captures during migration at banding stations in Massachusetts and Pennsylvania showed no obvious trends between 1970 and 1988 (Hagan et al. 1992).

Common (282 pairs) in early 1930s, but rare (7 pairs) in early 1980s at a study area in New York, probably owing to loss of young forest seres coupled with a poorly developed understory (Baird 1990). Became locally extinct in Sapsucker Woods, Ithaca, NY, between 1950 and 1980 (8.7 pairs/40 ha to completely absent; Litwin and Smith 1992).

Local and rangewide population declines probably a result of change in forest structure over past century combined with loss of forested wetlands. Forest regeneration of previously farmed lands in Northeast probably provided optimal habitat (forest with dense understory) in early and mid-1900s, but continued forest maturation probably eliminated understory and, hence, suitability to Canada Warbler. In addition, much of the forested wetlands in the Northeast (good Canada Warbler habitat) were drained, filled, and developed between 1950 and 1980 (Tiner 1984).

At one aspen/poplar forest site in Manitoba, population density apparently increased 400% from 1972 to 1992 due to blowdowns creating more dense understory shrubs and more open canopy (Kirk et al. 1997).

Abundance may be overestimated relative to other species when using 100-m—or unlimited-diameter point counts (Schieck 1997) due to comparatively clear, loud song.

## POPULATION REGULATION

Populations respond to processes that alter forest understory: regeneration, forest succession, storm-induced tree blowdowns, fire, logging, grazing. Processes that increase forest understory vegetation usually increase abundance, while processes that decrease forest understory decrease abundance. In New England, uncommon in oak forests with many deer (DeGraaf et al. 1991), owing to elimination of understory vegetation. In Ontario, numbers declined after burn in mixed-conifer forest (Spires and Bendell 1982). In New York, more abundant in old, regenerating burns than in nonburned forest (Eaton 1914, Baker 1932). Hence, populations appear to decrease initially after fire due to loss of understory vegetation, but eventually benefit from fire following regeneration of dense understory



vegetation in burned areas. In many areas, populations respond to forest succession; more common in young and mid-successional forest with well-established understory vegetation than in late successional forest lacking understory. See Conservation and management: effects of human activity, below.

## CONSERVATION AND MANAGEMENT

### EFFECTS OF HUMAN ACTIVITY

**Shooting and trapping.** No information; probably not a concern within breeding range.

**Pesticides and other contaminants/toxics.** No information.

**Ingestion of plastics, lead, etc.** No information.

**Collisions with stationary/moving structure or objects.** Six mortalities from collisions with television towers reported in Michigan in early Sep (Cuthbert 1963) and 2 reported in late Sep in e. Kansas after a day of low clouds (Ball et al. 1995). Thirty-four mortalities reported during 5 of 7 yr studied at one television tower in Ontario (Devitt 1967). Forty-seven of 66 birds in Illinois State Museum bird collection are from mortalities from collisions with television towers, including 27 individuals on one day: 3 Sep 1981 (Bohlen 1989). Collisions with chimney killed 325 birds in Ontario 1972–1982 (131 killed in one night: 5 Sep 1981; Weir 1989). Mortalities from flying into house windows, tall buildings, and lighthouses during migration in museum collections.

**Degradation of habitat.** *WINTERING:* Considered vulnerable to human disturbance of mature forest on wintering ground, but will use sites with moderate disturbance (Petit et al. 1995). Common in n. Andes region where human population pressure is great and habitat loss is proceeding rapidly (Robinson 1997).

*BREEDING:* Some evidence that habitat degradation/loss has negatively affected populations. More abundant in nonthinned compared to thinned mature stands of northeastern oak in central Massachusetts (DeGraaf et al. 1991). Rate of habitat change considered moderate to rapid in British Columbia owing to logging of aspen forests for pulpwood and brush control; increased nest parasitism and nest predation resulting from habitat fragmentation considered short-term population threat, but much habitat will probably remain unharvested due to steepness of slopes (Cooper et al. 1997). Management practices aimed at reducing the broad-leaved component in forests of Maritimes Provinces would likely have a negative effect if continued over wide areas (Erskine 1992). Considered sensitive to forest fragmentation (Enser 1992,

Freemark and Collins 1992); only 4 of 75 forest species surveyed showed a stronger positive relationship between abundance and forest area (Robbins et al. 1989). Probability of occurrence in the Allegheny Mtns. of w. Maryland and nw. West Virginia was greatest in contiguous forests >3,000 ha, and probability of occurrence was reduced 50% in forests of 400 ha, and 0% in forests <187 ha (Robbins et al. 1989).

In contrast, occupies young, disturbed forest in n. Wisconsin (Sodhi and Paszkowski 1995). Abundance highest in areas heavily logged 5–15 yr prior (compared to less-heavily logged and unlogged areas), based on point count surveys of northern hardwood (maple-birch-beech) forests in New York (Webb et al. 1977). Present in 10- and 20-yr-old clear-cuts and selectively-cut areas but not in recent clear-cuts or uncut, mature forest areas in maple-oak-beech forests in West Virginia (Maurer et al. 1981). Minor to moderate disturbance may increase habitat suitability in some mature, closed canopy forests; common in hurricane-wrecked maple swamps in New England (Clement and Gunn 1957), and in forested areas with evidence of tree fall disturbance in British Columbia (Enns and Siddle 1996). Abundance increased in years following storm-induced blowdowns of canopy trees which created canopy openings (and probably understory vegetation in gaps) but returned to original numbers as the openings closed in a virgin red spruce (*Picea rubens*)–northern hardwood (birch-beech-maple) forest in West Virginia (Hall 1984).

Appears sensitive to reduction of understory vegetation by forest ungulates. In central Massachusetts, DeGraaf et al. (1991) observed 80 individuals in mature stands of northeastern oak with few deer (1–3 deer/km<sup>2</sup>), but only one individual in mature stands with many deer (13–23 deer/km<sup>2</sup>). Increased density as a result of increased food availability associated with spruce budworm (*Choristoneura fumiferana*) outbreak (Crawford and Jennings 1989).

In general, 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.

**Disturbance at nest and roost sites.** One incubating female flushed from nest when human approached within 1 m but another allowed observer within 0.6 m for some time before flushing (Griscom 1938).

**Human/research impacts.** Little information, but considered not particularly sensitive to minimal disturbance (Cooper et al. 1997). Young fledged from nest in park with bicycle and hiking paths within 14 m (Milosevich and Olson 1981).



## MANAGEMENT

**Conservation status.** Species of Special Concern in both Indiana and Ohio. Listed as Vulnerable (Blue List) in British Columbia due to lack of data on ecology, distribution, population sizes, and uncertainties regarding effect of anthropogenic habitat changes (Cooper et al. 1997). Considered a high priority for conservation owing to population declines and rapid winter habitat loss in n. Andes region (Smith et al. 1993, Robinson 1997). Considered a species in need of management and/or monitoring attention in se. U.S. (Hunter et al. 1993). Of 132 species of neotropical migrants in ne. U.S., tied for 7th for species priorities for conservation needs (Smith et al. 1993).

**Measures proposed and taken.** Several areas with potential Canada Warbler habitat have been proposed as protected areas in British Columbia (Cooper et al. 1997). State wetland regulations protect wooded swamp nesting habitats in most states. Populations are probably not monitored effectively by common monitoring programs because of dense, wet, inaccessible breeding habitats. This also makes detailed studies difficult and is one reason relatively little is known about this warbler.

**Effectiveness of measures: the species' response.** No direct information, but recent reductions in forested wetland losses have apparently not halted population declines.

## APPEARANCE

### MOLTS AND PLUMAGES

**Hatchlings.** Sepia-brown natal down (Dwight 1900).

**Juvenal plumage.** Prejuvenal (postnatal) molt occurs Jun–Jul (Pyle 1997). Sexes alike. Side of head and neck, and chin to chest pale buff brown, wood brown, or olive brown; eye-ring pale buff or off-white. Upperparts drab brown or grayish brown. Throat between isabella color and saccardo umber. Remainder of underparts dull yellow, washed with pale wood brown or olive brown on throat, breast, and flanks. Tail similar to adult but feathers with pointed tips and less broadly truncate. Undertail-coverts whitish. Wings and tail similar to Basic I plumage of female; dull olive-brown feathers faintly edged with dull olive green, but wing-coverts paler (much more brownish), median- and greater-coverts broadly tipped with dull vinaceous buff, forming two obscure to conspicuous buffy wing-bars; flight feathers, tertials, and upper primary-coverts similar to adult, but ground color more brown once worn, less blackish, blue-gray of fringes tinged olive brown, especially on secondaries, tertials, and primary-coverts (Roberts 1932,

Oberholser 1974, Cramp and Perrins 1994, Curson et al. 1994). Practically indistinguishable from juvenile Wilson's Warbler except by duller wing edgings (Forbush 1929, Dwight 1900).

**Basic I plumage.** Prebasic I (postjuvenal) molt partial (can be completed before fledging; Pyle 1997). Includes head, body, and lesser, median, and greater upperwing-coverts; no tertials, greater alula, primaries, secondaries, primary-coverts, or rectrices. Molt typically occurs in early Jul (Jun–Aug; Fig. 4; Dwight 1900, Curson et al. 1994, Pyle 1997).

Basic I plumage similar to Definitive Basic plumage but slightly browner and more worn. Tail-feathers more pointed, primary-coverts, tertials, and secondaries slightly browner and more olive-fringed contrasting with bluish gray of new greater-coverts. Sexes distinct.

**MALE.** Compared to Definitive Basic female, necklace spots average blacker, tail-feathers more pointed, wings less uniformly colored (remiges, alula, primary-coverts and rectrices tend to have duller and grayer edges), upperparts averaging more grayish, and often with concealed black spots on forehead or anterior part of crown. Compared to Definitive Basic male, forehead and anterior part of crown more washed with yellow or tinged with buffy brown, black on forehead and crown less extensive and concealed by brown or gray tips of feathers, and upperparts more washed with olive green; yellow of underparts duller and more greenish; necklace spots duller, less sharply defined, and dark grayish olive instead of black (Dwight 1900, Eaton 1914, Cramp and Perrins 1994), Oberholser 1974.

**FEMALE.** Very similar to Definitive Basic female, but upperparts more brownish or olivaceous, particularly on crown and back; forehead often yellowish olive, necklace spots smaller, less numerous, and sometimes extremely pale, appearing as a grayish wash at a distance (Curson et al. 1994). Compared to Definitive Basic male, upperparts duller, more olivaceous, crown more brownish and always without hidden blackish spots; necklace spots duller, smaller, less numerous, and less sharply defined (Oberholser 1974).

**Alternate I plumage.** Prealternate I (first pre-nuptial) molt limited-partial, same as Definitive Prealternate molt, occurs Feb–Apr (Jan–May) on wintering grounds (Fig. 4; Pyle 1997).

**MALE.** Similar to Definitive Alternate male, but black feather-centers on forecrown sometimes more restricted, black area on upper cheek and lower side of neck averages narrower, and black necklace narrower (6–11 mm), often less sharply defined at rear where black spots often grade into smaller dark or pale olive spots. New crown feathers



contrast with worn feathers in occipital area (Dwight 1900). Upperparts sometimes with a faint olive wash, becoming grayer with wear (Dwight 1900). Tail and larger feathers of wing retained from Basic I plumage; blue-gray tinge on tertials and primary-coverts lost due to wear. Remiges, alula, primary-coverts and rectrices worn and brown-looking, the worn wing feathers often contrasting with the newer, brighter coverts; rectrices average more pointed than in adult (Cramp and Perrins 1994, Curson et al. 1994).

*FEMALE.* Very similar to Definitive Alternate female, but upperparts tinged green, fewer or no black on feathers of forecrown, face pattern less distinct, and black on chest mainly restricted to some spots on side; tail, remiges, tertials, and primary-coverts retained from Basic I plumage, more heavily worn than in Definitive Alternate female, rectrices more pointed, tertials and primary-coverts without blue-gray (Cramp and Perrins 1994, Curson et al. 1994).

*Definitive Basic plumage.* Definitive Prebasic (postnuptial) molt complete. Occurs prior to fall migration, usually Jul (Jun–Aug; Fig. 4, Pyle 1997). Sexes distinct.

*MALE.* Quite different from Basic I plumage of male; the black necklace being of heavy spots and the black area on the lores and crown larger; black feathers with broad grayish edgings on crown, and wing edgings often grayer and bluish instead of greenish. Compared to Definitive Alternate male, duller; back washed with dull olive green, feathers of forehead and crown edged and tipped with gray (less black), a few olive fringes to the mantle feathers; necklace spots more or less veiled by pale yellow edgings of feathers (Dwight 1900, Forbush 1929, Curson et al. 1994, Cramp and Perrins 1994, Oberholser 1974).

*FEMALE.* Very similar to Basic I female, but crown is yellow-tinged rather than brown, bluer gray tint on back (Bent 1953). Compared to Definitive Alternate female, upperparts average duller (dark blue-gray) and more olivaceous (less grayish); forehead and anterior part of crown more yellowish; necklace spots less distinct (Oberholser 1974, Cramp and Perrins 1994; but see Rappole 1983).

*Definitive Alternate plumage.* Definitive Prealternate (prenuptial) molt limited-partial, occurs Feb–Apr (Jan–May) on wintering grounds (Fig. 4; Pyle 1997). Unlike Wilson's Warbler, acquired mainly by wear from winter plumage, but molt includes all head, body, and lesser and median upperwing-coverts; in others, head, neck, and underparts, or head, neck, and chin to chest. No tertials or rectrices, and usually no greater-coverts. Sexes distinct; female always duller in coloration than male (Bent 1953).

*MALE.* Forehead black often with short, narrow median stripe of dull lemon yellow. Crown also black (or dark slate-gray), feathers so broadly edged with neutral or dark gray as to impart black-spotted appearance, fringes wider towards rear; cap thus uniform black in front, heavily spotted black on mid-crown, and marked with smaller spots at rear. Remainder of upperparts neutral gray, mouse gray, or dark bluish gray, sometimes, particularly on back and scapulars, washed with deep olive gray. Sides of head and neck black, gray, or bluish gray, similar to back. Upperparts of head from behind eye and upperparts of neck (nape) uniform dark bluish gray. Short, bright sulphur-yellow, dull lemon-yellow to gamboge yellow supraloral stripe from nostril to just above front corner of eye, contrasting sharply with black forehead, with dark gray front of lore, and with black rear of lore. Broad and conspicuous dull white to lemon-yellow eye-ring, sometimes deeper yellow above eye. Feathering just in front of and below eye-ring (posterior part of lores) dull black to black, extending as black stripe over upper cheek (submalar) and lower side of neck to side of chest. Sides and flanks slightly washed with warbler green or greenish olive, undertail-coverts white (faintly yellow when fresh). Remainder of underparts from chin to vent dull lemon-yellow to gamboge yellow or bright sulphur-yellow. Underparts boldly marked with longitudinal rows of dull black to chateura black rounded or triangular spots (1–2 mm thick) on chest, 10–18 mm wide, becoming solidly black on side of chest, forming conspicuous "necklace." Some small dusky marks on side of throat, lower throat, or side of breast. Tail and wings appear browner than upperparts. No wing-bars. Tail grayish black or chateura drab, feathers without white markings or patches, and narrowly edged on outer webs with gray or dark blue-gray of upper surface (faint or absent on outermost feather). Remiges, tertials, primary-coverts, and alula grayish-black. Fringes along outer webs of wing feathers similar to back; those of primaries medium blue-gray, those along secondaries and shorter feathers of alula similar but slightly darker and wider, less sharply defined, those along primary-coverts dark blue-gray, narrow, outer webs of tertials dark blue-gray. Primaries margined on inner webs, except at tips, with light brown, and secondaries with inner edges dull vinaceous buff. Lesser, median, and greater upperwing-coverts dark blue-gray, centers of lesser- and median-coverts and inner webs of greater-coverts grayish-black. Underwing-coverts and axillaries white, yellowish white, or pale gray, darker gray towards bases; axillaries and lesser coverts tipped yellow (Eaton 1914, Roberts 1932, Oberholser 1974, Cramp and Perrins 1994, Curson et al. 1994).



**FEMALE.** Crown and forehead gray tinged with yellowish-brown or green (sometimes with some black flecks), side of neck usually lacks defined spots along border between gray nape and yellow throat (in contrast to male), cheek usually gray or gray tinged with yellow (rarely yellow or gray-black). Entire upperparts dark bluish gray, feather-centers on forehead and forecrown with narrow black arrow-marks rather variable in width, sometimes almost coalescing to form narrow stripe along side of forehead; feather-fringes from crown to mantle faintly green when plumage fresh. Yellow stripe above lore and broad eye-ring distinct, as in male, but eye-ring often more yellowish. Feathering just in front of and below eye-ring dark gray or sooty, less extensive and less black than male; side of head behind eye and side of neck bluish gray, often with faint darker gray or sooty stripe along lower edge (but no black submalar stripe as in male). Underparts similar to male, but side of chest with single row of smaller black spots or none at all, and necklace usually with distinct olive, grayish or grayish-black streaks (but not black), gradually more washed out towards belly. Wing and tail similar to male, but fringes of flight-feathers sometimes tinged green (Cramp and Perrins 1994). Similar to Definitive Alternate plumage of male but upperparts duller, somewhat more olivaceous (less purely gray); forehead and crown with little or no black, and more or less washed with dull yellow or olive-yellow; black submalar stripe absent, this as well as black on posterior part of lores replaced by olive-gray; yellow of underparts duller, necklace spots duller, lighter, less clearly defined, and deep olive or citrine drab, instead of black (Oberholser 1974).

Substantial variation within plumage classes in forehead, crown, cheek, side of neck, and necklace color for both sexes (Rappole 1983). In particular, wide age-independent variation in necklace color and pattern in both males and females (Rappole 1983; Fig. 8.3 in Morse 1989).

#### BARE PARTS

**Bill and gape.** Short, straight, relatively wide bill with decurved tip of culmen forming small hook; bill approximately half the length of head. In juvenile, pinkish-buff becoming dusky or dull pale brown (Dwight 1900). In adult, upper mandible plumbeous gray, brown, grayish or brownish black, or black; cutting edges and tip of lower mandible bluish gray or horn gray; remainder of lower mandible lighter: dull pink-white, grayish flesh-colored, brownish flesh-colored, pale vinaceous drab, or yellow (Forbush 1929, Cramp and Perrins 1994). Rictal bristles long and well developed; 3 strong bristles projecting forward from each side of base of upper mandible. Tongue white.

**Iris.** In juvenile, dark brown. In adult, hazel to clove-brown or deep brown.

**Legs and feet.** In juvenile, pinkish buff becoming dusky or dull pale brown (Dwight 1900). In adult, pinkish flesh-colored, yellowish flesh-colored, buffish pink, tan-yellow, clay, yellowish clay, pale yellow, flesh-colored, pale tawny olive, light ochraceous-drab, or pale grayish yellow (Oberholser 1974, Cramp and Perrins 1994). Leg color lighter (Munsell color value of 8) than 26 other wood-warblers (Burt 1977).

## MEASUREMENTS

### LINEAR

See Table 1. Many skeletal and other morphological measurements are given in Ostroff (1986). Males significantly larger than females based on body mass, tarsus length, tail length, and wing-chord (Table 1; Cramp and Perrins 1994, F. Moore and D. Cimprich unpubl.). Wings of males average 5–6% longer than females; males generally >64 mm and females <62 mm but considerable overlap exists (Rappole 1983).

**Bill length, exposed culmen.** Mean 8.87 mm  $\pm$  1.09 SD (range 7–11,  $n = 16$ ; North Carolina State Museum). Males, mean 10.7 mm (range 10.2–11.2); females, mean 10.7 mm (range 9.7–11.2; Texas, Oberholser 1974).

**Bill depth.** Mean 2.94 mm  $\pm$  0.85 SD (range 2–4,  $n = 16$ ; North Carolina State Museum).

**Tail length.** Females, mean 52.2 mm  $\pm$  3.0 SD (range 45–61,  $n = 36$ ; Maine, S. Morris, pers. comm.); mean 52.8 mm (range 51.1–53.3; Texas, Oberholser 1974). Males, mean 53.5 mm  $\pm$  2.5 SD (range 44.5–59,  $n = 47$ ; Maine, S. Morris, pers. comm.); mean 56.1 mm (range 54.8–57.2; Texas, Oberholser 1974).

**Middle toe without claw.** Males, mean 11.2 mm (range 10.7–11.7); females, mean 10.7 mm (range 9.1–11.7; Texas, Oberholser 1974).

**Total length.** 12.0–14.6 cm (Baird et al. 1875, Terres 1980, Godfrey 1986, museum skins; N. Carolina State Museum of Natural Science [NCSMNS], Royal Ontario Museum [ROM], University of Nebraska State Museum [UNSM], Science Museum of Minnesota, Manitoba Museum of Man and Nature).

**Testes.** Typically 5.5  $\times$  4 mm during breeding season (museum skins; NCSMNS, ROM, Carnegie Museum of Natural History).

**Wing span.** Mean 185.5 mm  $\pm$  15.8 SD (range 154–197,  $n = 8$ ; Oberholser 1974, museum skins; NCSMNS, ROM, UNSM, Cornell Museum).

### MASS

See Table 1. Fall migrants in Illinois and Alabama average heavier than fall migrants in Maine and



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