

RESEARCH ON WOOD WARBLERS IN CANADA

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Abstract.—Zoological Record, Wildlife Review, Biological Abstracts, and government publications from 1960 to 1992 were searched to determine the amount and type of research conducted in Canada on 36 species of breeding wood warblers (Emberizidae: Parulinae). Warbler species that exclusively (>90% of breeding ranges) or commonly (50–80% of breeding ranges) breed in Canada were studied more frequently than species that less commonly (20–49% of breeding ranges) or rarely (<20% of breeding ranges) breed there. Despite this trend, the search revealed that data are needed on microhabitat use (tree/shrub species and foraging substrates), nest site selection, foraging ecology (feeding behavior and diet), reproduction and dispersal of most wood warbler species. Ornithologists are urged to collect these critical data so that prudent management decisions can be made in light of extensive harvesting of Canadian forests.

ESTUDIOS SOBRE PARÚLIDOS EN CANADÁ

Síntesis.—Se examinaron publicaciones gubernamentales y las revistas Zoological Record, Wildlife Review, Biological Abstracts entre el 1960 y 1992 para determinar la cantidad y el tipo de investigación llevada a cabo en 36 especies de parúlidos en Canadá. Especies que anidan exclusivamente (>90% de su área de anidaje) o comúnmente (entre 50 y 80% de su área de anidaje) en Canadá se estudiaron más frecuentemente que especies que anidan menos comúnmente (de 20 a 49% de su área de anidaje) o rara vez (< de 20% de su área de anidaje) en Canadá. Sin embargo, la búsqueda reveló que se necesitan datos sobre el uso del microhábitat (especies de árboles/arbustos y sustratos de alimentación), selección de áreas de anidaje, ecología de abordaje (comportamiento alimenticio y dieta), reproducción y dispersión de la mayoría de estas especies. Se urge a los ornitólogos a que coleccionen estos datos críticos para que se puedan tomar decisiones de manejo prudentes en vista del extenso cosecho de maderas en los bosques canadienses.

It is claimed that research on American songbirds is far from adequate (Martin 1992, Verner 1992). This statement is generally made, however, without documentation. We surveyed literature published in the last 32 yr on research conducted on 36 wood warbler (Emberizidae: Parulinae) species in Canada (Godfrey 1986). We selected wood warblers because: (1) some warbler species are showing long-term population declines at least in parts of their breeding ranges (Dunn 1991, Robbins et al. 1989, Terborgh 1992), (2) some warbler species require continuous or large forests (>500 ha) in order to reproduce (Askins et al. 1987, Gibbs and Faaborg 1990, Porneluzi et al. 1993, Villard et al. 1993) and such habitat is decreasing, (3) most warbler species winter in the neotropics where habitat loss is also a threat (Greenberg 1992), and (4) comprehensive data bases on warblers and other forest birds are needed as these species are increasingly, and correctly, incorporated into management decisions (Robbins et al. 1993, Schmiegelow and Hannon 1993).

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We examined research on warblers in Canada; 36 (69%) out of 52 North American warbler species breed in Canada. As a result of intensive harvesting of Canadian forests (McLaren 1990), some warbler species may be rapidly losing breeding habitat. We, therefore, need to assess the state of our current knowledge of these species to determine if we can make prudent management decisions based on information now available.

METHODS

We searched (1960–1992) the Canadian portion of the Aves section of Zoological Record (not published in 1986), Wildlife Review, and Biological Abstracts. Additionally, for the same period, we searched government publications such as those published by the Canadian Wildlife Service. We searched literature published after 1959 because publication of quantitative studies on wood warblers started after MacArthur's (1958) work.

If studies investigated more than one warbler species, for example, "Vocal behavior of Wood Warblers," it was included in the review. Simple surveys, such as checklists of birds, however, were not included except when they reported the first sighting or use of new habitat for a species. A number of studies dealt with North American wood warblers and included data from Canada, but some of these studies did not specifically mention for which species data were obtained in Canada (e.g., Barrowclough and Corbin 1978); these studies were not incorporated into our survey. Our survey also did not include unpublished theses, abstracts of papers presented at conferences, unpublished environmental impact assessment reports, and books (except monographs).

We included in our survey, two breeding-bird atlases published during the specified period (Cadman et al. 1987, Semenchuck 1992). These atlases contain anecdotal descriptions of habitat use and nesting habits of the wood warblers, but we included these atlases either under the "distribution" (Semenchuck 1992) or under the "distribution" and "abundance" (Cadman et al. 1987) topic categories. We did not include individual Breeding Bird Censuses except when they reported first sightings or new habitat use for a species. We incorporated annual summaries published on Breeding Bird Censuses (e.g., Erskine 1984), however. Erskine (1978), Collins and Wendt (1989), Dunn (1991), and Erskine et al. (1992) analyzed Breeding Bird Survey data for 1966–1975, 1966–1983, 1966–1989, and 1966–1991, respectively. To avoid redundancy, we included only the most complete Breeding Bird Survey analysis (Erskine et al. 1992).

We classified 36 warbler species (Appendix) into four categories according to their breeding distribution in Canada (Robbins et al. 1983): (1) species that breed in Canada exclusively and have at least 90% of their breeding ranges in Canada (Tennessee Warbler, Magnolia Warbler, Cape May Warbler, Palm Warbler, Bay-breasted Warbler, Blackpoll Warbler, and Connecticut Warbler), (2) species that commonly breed in Canada and have 50–80% of their breeding ranges in Canada (Orange-crowned Warbler, Nashville Warbler, Yellow Warbler, Chestnut-sided Warbler, Black-throated Blue Warbler, Yellow-rumped Warbler, Town-

send's Warbler, Black-throated Green Warbler, Blackburnian Warbler, Black-and-white Warbler, American Redstart, Ovenbird, Northern Waterthrush, Mourning Warbler, MacGillivray's Warbler, Common Yellowthroat, Wilson's Warbler, and Canada Warbler), (3) species that less commonly breed in Canada and have 20–49% of their breeding ranges in Canada (Northern Parula and Pine Warbler), and (4) species that rarely breed in Canada and have less than 20% of their breeding ranges in Canada (Blue-winged Warbler, Golden-winged Warbler, Black-throated Gray Warbler, Prairie Warbler, Cerulean Warbler, Prothonotary Warbler, Louisiana Waterthrush, Hooded Warbler, and Yellow-breasted Chat).

RESULTS AND DISCUSSION

Our search revealed 262 individual manuscripts on wood warblers, 7.3 studies per warbler species. By treating individual warbler species as the research unit, however, and counting studies concerning more than one species, once for each, we reached a total number of 1195 investigations (sum of bold numbers in Appendix). On the basis of this approach, 33.2 studies were published per warbler species. Yellow Warbler was the most frequently investigated species. Prothonotary Warbler and Louisiana Waterthrush were the least studied species. It appears that distribution of a warbler species is correlated with the number of studies conducted. The average number of studies on exclusively, commonly, less commonly, and rarely breeding warbler species were 36.7 ± 12.5 (SD), 42.8 ± 14.3 , 25.0 ± 12.7 and 12.8 ± 3.3 , respectively.

Different research topics were not evenly investigated for Canadian wood warblers (Fig. 1A; $\chi^2 = 1192$, $df = 7$, $P < 0.0001$). This trend was also apparent when each breeding-status category was analyzed separately (Fig. 1B). The figures and appendix suggest that there are ample data on the distribution of wood warblers within Canada. Research effort on this topic is unrelated to breeding status (ANOVA: $F = 1.0$, $df = 3,32$, $P = 0.39$). Population trends and abundances of warblers were unevenly investigated ($F = 20.2$, $df = 3,32$, $P = 0.0002$), with significantly more publications on exclusively and commonly breeding species than rarely breeding species (Scheffe F -tests, $P < 0.05$). There appears to be considerable data on habitat requirements of wood warbler species but again this topic has not been investigated systematically ($F = 23.1$, $df = 3,32$, $P = 0.0001$), with significantly more publications on exclusively and commonly breeding species than rarely breeding species (Scheffe F -tests, $P < 0.05$). Also habitat studies pertain mainly to macrohabitat use (e.g., use of different forest types) and usually lack statistical analyses, such as multivariate techniques (but see Darveau et al. 1992). Data are sparse on microhabitat use (tree/shrub species and foraging substrates) and nest site selection for almost all wood warbler species.

Research on the reproductive behavior of wood warblers was not related to the breeding status in Canada ($F = 0.77$, $df = 3,32$, $P = 0.51$). In contrast, significantly more publications exist on the foraging behavior of commonly breeding species than rarely breeding species (Scheffe F -test,

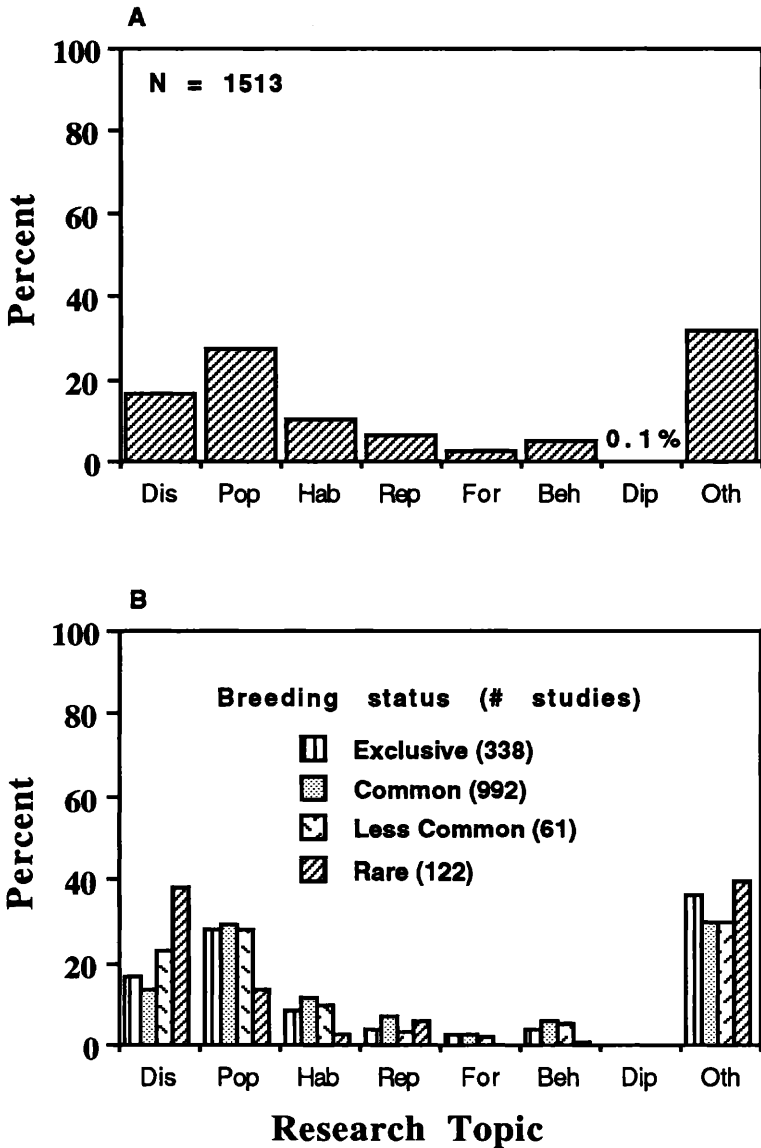


FIGURE 1. A. Distribution of published research conducted in Canada on various aspects of the biology of 36 wood warbler species. B. Distribution of published research on various aspects of the biology of 36 wood warbler species with differing breeding status within Canada (see text). Number in parentheses is the total number of studies on a breeding status category. Note that a study dealing with more than one topic was counted multiple times. Beh = behavior, Dis = distribution, Dip = dispersal, For = foraging behavior, Hab = habitat, Oth = other studies, Pop = population, and Rep = reproduction. Subjects covered by each research topic are contained in Appendix.

$P < 0.05$). In general, studies on foraging behavior and reproduction are not detailed (e.g., a report of contents of a nest; but see Peck and James 1983). Little recent information, for example, is available on reproductive patterns to compare trends across regions within Canada. Such comparisons may be important if forest fragmentation and other environmental changes affect species differently in different regions (Hannon 1993). Last, data are needed on the dispersal of almost all wood warblers.

We believe that the stigma attached to descriptive studies and the challenges offered by species that often have low population densities, or are difficult to observe and monitor, have discouraged ornithologists from intensively studying Canadian wood warblers in the past 32 yr. We urge ornithologists to collect vital data on this group despite these drawbacks. We believe that such research can be facilitated by the efforts of editors, reviewers, managers, and funding agencies. We hope that this literature review will stimulate more, and undoubtedly crucial, research on Canadian wood warblers.

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APPENDIX. Studies of wood warblers in Canada listed in Zoological Records, Wildlife Review, Biological Abstracts, and published in government reports/notes between 1960 and 1992. Note that the total number of studies on a species does not always agree with the value obtained by adding the subject categories because some papers were concerned with more than one subject.

After each species name is a listing of the number of studies published on the following subjects: Distribution/sighting/range, Population trends/density/abundance, Habitat selection/use, Reproduction, Foraging behavior/diet, Other behavior (antipredator behavior, vocal behavior, and territoriality), Breeding/natal dispersal, Other (identification, taxonomy, morphometrics, hybridization, genetics, capture techniques, census techniques, banding, longevity, migration [e.g., phenology], plumage and molting, parasitism [excluding brood parasitism which was included under "Reproduction"], pellet ejection, and human impacts [toxicology, window kills, effects of forestry, and effects of oil drilling]). This is followed by the total number of studies (in bold). Blue-winged Warbler (*Vermivora pinus*), 9, 1, 0, 1, 0, 0, 0, 9, **18**; Golden-winged Warbler (*V. chrysoptera*), 5, 2, 1, 1, 0, 1, 0, 9, **16**; Tennessee Warbler (*V. peregrina*), 6, 15, 3, 1, 1, 3, 0, 25, **46**; Orange-crowned Warbler (*V. celata*), 6, 10, 4, 2, 1, 0, 0, 8, **24**; Nashville Warbler (*V. ruficapilla*), 11, 20, 8, 1, 2, 2, 0, 14, **47**; Northern Parula (*Parula americana*), 8, 13, 4, 1, 0, 3, 0, 12, **34**; Yellow Warbler (*Dendroica petechia*), 6, 18, 7, 32, 4, 8, 1, 24, **83**; Chestnut-sided Warbler (*D. pensylvanica*), 8, 20, 9, 3, 2, 3, 0, 17, **47**; Magnolia Warbler (*D. magnolia*), 8, 20, 8, 1, 1, 4, 0, 23, **52**; Cape May Warbler (*D. tigrina*), 6, 13, 3, 1, 3, 3, 0, 14, **33**; Black-throated Blue Warbler (*D. caerulescens*), 7, 15, 5, 1, 1, 0, 0, 13, **32**; Yellow-rumped Warbler (*D. coronata*), 9, 21, 9, 3, 4, 2, 0, 28, **59**; Black-throated Gray Warbler (*D. nigrescens*), 6, 3, 1, 1, 0, 0, 0, 7, **15**; Townsend's Warbler (*D. townsendi*), 12, 9, 6, 1, 1, 1, 0, 7, **29**; Black-throated Green Warbler (*D. virens*), 9, 20, 7, 2, 1, 4, 0, 16, **46**; Blackburnian Warbler (*D. fusca*), 6, 16, 5, 1, 2, 3, 0, 15, **38**; Pine Warbler (*D. pinus*), 6, 4, 2, 1, 1, 0, 0, 6, **16**; Prairie Warbler (*D. discolor*), 4, 3, 0, 1, 0, 0, 0, 6, **11**; Palm Warbler (*D. palmarum*), 6, 12, 3, 2, 2, 1, 0, 9, **28**; Bay-breasted Warbler (*D. castanea*), 11, 18, 6, 3, 1, 3, 0, 19, **48**; Blackpoll Warbler (*D. striata*), 6, 11, 3, 2, 0, 0, 1, 17, **33**; Cerulean Warbler (*D. cerulea*), 8, 3, 0, 1, 0, 0, 0, 5, **15**; Black-and-white Warbler (*Mniotilta varia*), 9, 16, 5, 1, 1, 3, 0, 17, **41**; American Redstart (*Setophaga ruticilla*), 5, 20, 9, 7, 1, 7, 0, 24, **55**; Prothonotary Warbler (*Protonotaria citrea*), 7, 1, 1, 0, 0, 0, 0, 2, **9**; Ovenbird (*Seiurus aurocapillus*), 7, 18, 5, 8, 3, 7, 0, 21, **55**; Northern Waterthrush (*S. noveboracensis*), 6, 14, 6, 1, 1, 3, 0, 13, **35**; Louisiana Waterthrush (*S. motacilla*), 4, 1, 0, 1, 0, 0, 0, 5, **9**; Connecticut Warbler (*Oporornis agilis*), 7, 4, 3, 1, 0, 0, 0, 8, **17**; Mourning Warbler (*O. philadelphia*), 8, 16, 6, 1, 0, 4, 0, 19, **41**; MacGillivray's Warbler (*O. tolmiei*), 4, 9, 3, 1, 0, 2, 0, 10, **23**; Common Yellowthroat (*Geothlypis trichas*), 10, 20, 8, 2, 1, 3, 0, 19, **45**; Hooded Warbler (*Wilsonia citrina*), 4, 2, 0, 1, 0, 0, 0, 5, **10**; Wilson's Warbler (*W. pusilla*), 5, 14, 6, 2, 1, 3, 0, 16, **36**; Canada Warbler (*W. canadensis*), 5, 17, 7, 1, 1, 3, 0, 14, **35**; and Yellow-breasted Chat (*Icteria virens*), 7, 1, 0, 2, 0, 0, 0, 7, **13**.
