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The cooperative Breeding Bird Survey in Canada, 1988

Anthony J. Erskine[1], Brian T. Collins[2], and John W. Chardine[3]

Introduction

The Breeding Bird Survey (BBS) was started experimentally in the United States in 1965 and has been operational in Canada, with coordination by the Canadian Wildlife Service (CWS), since 1966. It was set up to detect and measure trends in numbers of birds, particularly small land birds, across North America. It is our most effective widespread monitoring survey for land birds. The data are collected annually by volunteers and professionals who share an interest in and knowledge of breeding birds. Earlier reports covering 1966 through 1980 (Erskine 1977, 1978; Finney et al. 1978, 1980; Freemark et al. 1979; Silieff and Finney 1981) focused on changes in breeding bird populations between successive years, while seeking a satisfactory means of assessing long-term trends in bird numbers. This report covers the 1988 season and summarizes trends over the whole 1966–88 period, as well as 1987–88, using a new statistical approach.

The roles of the authors were as follows: BTC developed the analysis program, designed the input files and protocols, and oversaw the adaptation of the BBS files received from the U.S. Fish and Wildlife Service (USFWS); JWC set up the data selection program and, with BTC, helped to establish procedures for the operation; and AJE carried out the route screening, area weighting, and analyses, interpreted the results, and drafted the text.

Methods

Data collection and assembly

The BBS procedures for data collection and assembly are unchanged from those of former years; for details, see summaries by Erskine (1978) and Robbins et al. (1986).

Data analysis

The analysis used a custom-written FORTRAN program based on the same statistical principles used in BBS analyses by the USFWS since 1979 (Geissler and Noon 1981). The program was used for the 1987–88 comparisons as well as in evaluating long-term trends. It also linked together the computer files arising from the screening of routes, the area weighting, and the species data selection, described below.

[1]CWS, Atlantic Region, P.O. Box 1590, Sackville, N.B. E0A 3C0.
[2]CWS, Ottawa, Ont. K1A 0H3.
[3]CWS, Atlantic Region, Bedford Institute of Oceanography, P.O. Box 1006, Dartmouth, N.S. B2Y 4A2. (Present address: CWS, Atlantic Region, P.O. Box 9158, St. John's, Nfld. A1A 2X9.)

Data screening

Methods for screening data for inclusion in analyses diverged from those of the USFWS model, which uses all surveys not rejected initially, with no further assessment of comparability. The scoring system used by Erskine (1978) was used to compare coverage in successive pairs of years but could not be applied directly to long-term comparisons.

Four criteria were used to screen data (partly after Collins and Wendt 1989):

(1) *Observer*: Only surveys by the same observer were combined in analyses (cf. Collins and Wendt 1989);

(2) *Survey date*: Only surveys within a 14-day span were compared; a group of such surveys was considered a subroute. If one observer surveyed a single route in different years on dates differing by more than 14 days, the surveys were compared in two (rarely three) subroutes, each including at least two surveys comparable in other respects;

(3) *Weather*: Only surveys with "acceptable" weather were compared (Erskine 1978, App. 1; Robbins et al. 1986, App. B); thus, surveys with wind force 4 at both start and finish were rejected, except in the Prairie provinces; surveys with wind force 5 at any time were rejected, except in the Prairies for surveys with wind force 2 or less at start; surveys with sky code 5 (drizzle) or 8 (showers) at both start and finish were rejected; routes with combinations of unfavourable wind and sky codes were rejected if the results were obviously lower than when good conditions prevailed. The weather data recorded do not allow an objective rating, and the data files include some obvious errors, which have not yet been corrected;

(4) *Timing rules*: Only surveys on 28 May through 7 July (inclusive) were compared; only surveys starting within a 30-minute period including the time prescribed (30 minutes before local sunrise) were compared; only surveys completed within 5.5 hours were compared. Such absolute cutoffs exclude some surveys that may well have yielded comparable results, but we impose explicit limits for consistency and credibility.

The regions used to group comparable (sub)routes for analysis are those used by Erskine (1978) (Fig. 1).

Area weighting

Weighting of (sub)routes took into consideration the varying numbers of routes in a degree-block of latitude/longitude, the proportion of land area in each degree-block, and whether or not adjacent degree-blocks could be used in comparisons. Unsampled degree-blocks that were bordered on three or four sides by blocks with comparable routes had their areas partitioned between adjacent blocks, and unrepresented blocks bordered by two or fewer blocks with comparable routes were ignored in the area weighting, to avoid giving undue weight to peripheral coverage.

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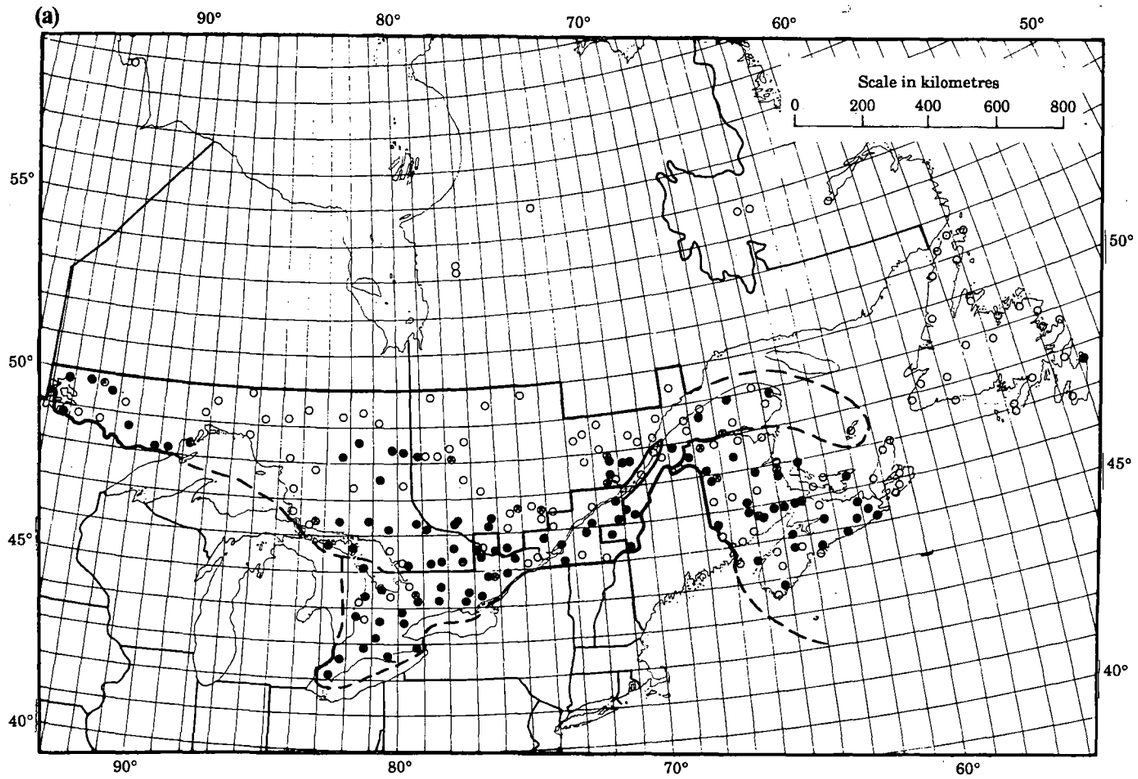
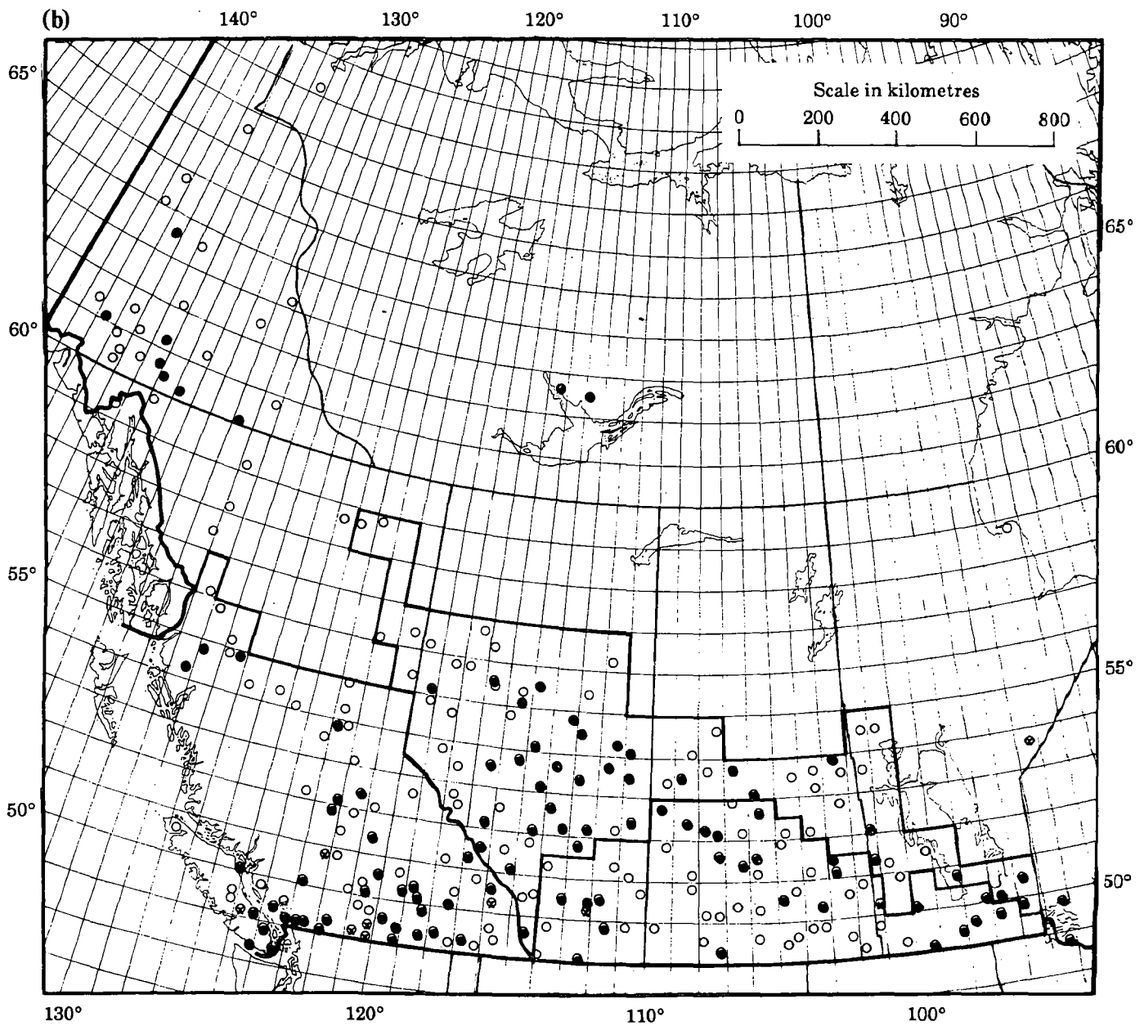
Figure 1
Distribution of Breeding Bird Survey routes surveyed in 1966–88 in (a) the Maritime provinces and southern and central Ontario and Quebec, and (b) the southern and central Prairie provinces, British Columbia, and the territories





- ● BBS route surveyed in 1988.
- ○ BBS route surveyed previously but not in 1988; available for use.
- ⊗ BBS route surveyed previously, no longer available (roads, traffic, etc.)
- — outline of groupings for analysis.

Data selection

Data were selected and fed into the analysis program using a special dBASE III PLUS program.

Refinement of the computer programs will follow from further examination of the databases and analysis outputs. The results presented below represent one stage in progress towards a fully computerized analysis protocol.

Results

Coverage

Figure 1 shows the distribution of all BBS routes surveyed in Canada in 1966–88, the coverage in 1988, and former routes that are no longer usable. Table 1 compares the numbers of routes surveyed in 1988 and recent years, by province and territory. The totals shown are of surveys with data in the files used for analysis. As a few surveys are missing from the files, for various reasons, the totals may not agree with earlier summaries.

Analyses

Analyses were done for about 60 species in each of six major biogeographic regions: the Maritime provinces, central Ontario and central Quebec, southern Ontario and southern Quebec, the southern Prairie provinces, the central Prairie provinces, and southern British Columbia. In general, these included all species with samples large enough for analysis, the minimum being about 50 individuals in a region per year. Sometimes we analyzed data for a species that was relatively scarce in one region to allow wider comparisons with other regions. The total number of different species analyzed across Canada came to about 140.

In this report, we present data for about 40 species in each region. These are the same common birds that were covered in earlier Progress Notes on the BBS (Erskine 1977; Finney et al. 1978, 1980; Freemark et al. 1979; Silieff and Finney 1981), although gulls are omitted this time, as they are not sampled representatively by the BBS.

Changes between 1987 and 1988

The analyses (Tables 2–7) cover southern Canada in six biogeographic regions. Data from Newfoundland and Labrador, the territories, and northern parts of other provinces (except the Maritimes) are too few for separate analysis and too different to merge with data from nearby regions.

Despite the widespread drought in Prairie Canada in summer 1988, there were no significant decreases in numbers of wetland birds from 1987 to 1988. No other environmental factors likely to have widespread effects on bird populations that are detectable by the BBS were obvious. Because of the small samples of routes available for two-year comparisons, few species showed statistically significant changes. There was no obvious concentration of significant short-term changes among species in any major habitat type (e.g., open country, shrubland, forest, wetlands) within any region.

Long-term trends

Tables 2–7 summarize the long-term trends in bird populations in the six major regions. Because there were much larger samples of (sub)routes available for analysis, more changes were statistically significant over the long term than between 1987 and 1988. Patterns were not striking; generally, more species of open lands and of edges or

shrublands showed significant changes (mostly decreases and increases, respectively) than forest birds. Thus, European Starlings *Sturnus vulgaris*, Common Grackles *Quiscalus quiscula*, Brown-headed Cowbirds *Molothrus ater*, both meadowlarks *Sturnella* spp., and House Sparrows *Passer domesticus* all showed significant decreases in three regions (and significant increases in no regions). Song Sparrows *Melospiza melodia* and Northern Flickers *Colaptes auratus* decreased significantly in four and three regions, respectively, but Cedar Waxwings *Bombycilla cedrorum*, Tree Swallows *Tachycineta bicolor*, Alder Flycatchers *Empidonax alnorum*, and American Robins *Turdus migratorius* each increased significantly in two or three regions (with no significant decreases). Long-term significant changes in wetland species, nearly all in the Prairies, were mostly downward.

Discussion

Coverage

The BBS in Canada has been running largely on observer and coordinator enthusiasm for the past decade. Coverage decreased gradually after the 1981 peak of 262 routes surveyed. The absence of Canadian reports on BBS results after 1981 and the failure of CWS officials to visit provincial coordinators after 1980 were probably factors in this decline. We cannot ignore the importance of direct, personal feedback to our volunteer participants in maintaining extensive, competent coverage of survey routes. The modest upswing in coverage in the last three years may reflect the enthusiasm of the new USFWS BBS coordinator, Sam Droege, who has greatly improved the annual feedback from his agency to BBS participants.

Coverage did not decline evenly across Canada. The extra surveys in Newfoundland in 1980–83 were made to provide standardized sampling for a new avifaunal book and were not expected to become ongoing coverage. BBS coverage in Ontario, Quebec, and the Maritimes declined in turn with competition from their breeding bird atlas programs (started in 1981, 1984, and 1986, respectively). We may see an upswing in BBS coverage in Ontario, because the Ontario atlas was published in 1987. The Quebec and Maritimes atlas projects are likely to deflect some BBS effort through 1990. The Alberta and Saskatchewan atlas projects have not affected BBS coverage.

Reduction of coverage has been most evident in the more remote areas. BBS coverage in the eastern boreal region (Ontario and Quebec) was much sparser in the 1980s than the 1970s, despite initiation of some new routes. This and the sparse recent coverage in the Maritimes have eroded our ability to monitor trends in bird populations centred in the boreal forest.

Under the former analysis regime, coverage of a route in many successive years by the same observer was essential; it still remains the ideal pattern. The new analysis program for long-term trends enables us to also use any route that has been surveyed comparably in two or more years by the same observer, even if the years were not consecutive. Comparisons of adjacent years are still restricted to routes covered by the same observer.

The routes with long-term coverage by one observer carry most weight in the analysis and often determine the overall trend for a species in a region. Through 1988, 18 persons had each surveyed a Canadian BBS route in 20+ years, another 37 persons had surveyed a route in 15+ years, and 69 more had surveyed routes in 10+ years. Several individuals had surveyed more than one route for 15+ years, and often other routes for shorter periods as well. Only three and 23 BBS routes outside the Maritimes were covered in 1966 and 1967, respectively; four of the five people who participated in the BBS every year from 1966 through 1988 started in the Maritimes. Table 8 lists the observers who each covered one or more BBS routes in 15+ years. We salute their dedication; their efforts have been of the greatest value in making the BBS an effective tool for monitoring changes in the relative abundance of common birds.

Changes between 1987 and 1988

With recent emphasis focused on long-term trends and with declining numbers of observers in the 1980s, the samples for 1987–88 comparisons were near or below the minimum useful size in most regions. To make meaningful paired-year comparisons in a region, we need 20 or more routes with similar coverage in each pair of years. "Similar coverage" means same observer; dates within the same 10-day period during June; winds ≤ force 3, no rain; and survey started on time and finished without delay, with no route changes.

Few changes from 1987 to 1988 were statistically significant ($P \leq 0.05$) in any region, and we are not aware of any factors with which the changes were correlated. Despite the drought on the Prairies in summer 1988, more wetland birds there showed increases than decreases from 1987 to 1988, and the few decreases were not statistically different from "no change."

The largest conifer cone crop in decades in the Maritimes in 1988 was not mature enough to attract birds during June. The massive invasion of White-winged Crossbills *Loxia leucoptera* after 7 July, the last day for surveys in this study, was not detected by the BBS. The huge numbers of crossbills in the Maritimes from July 1988 through March 1989 probably came from a large part of eastern North America.

Long-term trends

Methodology. Long-term trends in bird numbers attract attention, whether as decreases in species that may be in trouble or as increases in species that may cause trouble. Detection and measurement of such trends are the prime objectives of the BBS. We are still examining ways of analyzing the long-term data more meaningfully.

The method used earlier, that of accumulating the percentages of change between pairs of successive years, proved unsatisfactory when samples of routes analyzed for successive pairs of years differed markedly. That method also restricted analyses to routes with coverage comparable between the pair of years under study, so that many valuable surveys could not be used. Geissler and Noon (1981) recommended a route-regression approach to BBS data analysis; this approach was used subsequently in the United States and Canada.

The route-regression approach uses over 80% of the available data, compared with about 60% with the earlier method. However, some of the long-term trends look improbable. Although many species show large changes between successive years, such changes are usually reversed later, with relative stability over the long term. Our recent analyses suggest that 30–50% of the species examined in each region have more than doubled, or decreased to less than half, their numbers at the start of the analysis period (now 21–23 years). Some large changes are likely, but not so many or such large changes. These results may be artifacts of the statistical treatment, and we are examining the effects of varying the procedures.

Alternatively, the sampling may be biased because few routes were surveyed over long periods. As routes with long-term coverage carry greatest weight, any local influence on such a route may carry through to the regional picture. For example, a forest fire affected the vegetation, and thus the birds present, along half of one route with long-term coverage. Because there have been only 20–25 routes available in that region recently, we suspect that changes in that one route distorted the overall trend. We are still working on techniques to determine whether that was the case. Increasing the sample of routes covered regularly will help to minimize such effects.

Presentation of results. Because of the uncertainty with respect to the sizes of the population changes, we show only the scale and direction of long-term changes, and their statistical significance, in Tables 2–7. When a species shows substantial changes in adjoining areas, all the trends gain support by consensus. Some of the changes shared in adjoining regions are summarized in Table 9, which includes a few species/region combinations not shown in Tables 2–7.

Presentation of long-term trends as single, straight regression lines for each species conceals much information. Some species increased or decreased continuously over the analysis period, but more often such trends extend over shorter periods. We hope to examine all trends year by year, to define the periods over which each species changed, and to consider parallel changes in different species. The long-term trends shown here should be recognized as preliminary and possibly not representative of what is happening in nature.

Areas of concern. (1) Neotropical migrants. Some recent concern has focused on birds that winter in Latin America, where widespread deforestation for agriculture is threatening a unique and productive ecosystem (e.g., Holmes and Sherry 1988). Earlier unpublished BBS analyses by the USFWS also suggested that numbers of neotropical migrants might be decreasing.

The results of our analyses gave no indication that birds that breed in Canada and winter in Latin America are declining in number. Of 48 species that winter largely or entirely south of the United States and for which samples allowed long-term trend analyses, twice as many showed increases as decreases, and most statistically significant changes were upward. In an area as large and diverse as Canada, it is unlikely that all significant changes are driven by the same causes. The trend patterns differed among the six regions. Most significant increases were in the east, especially in the Maritimes, whereas most significant decreases were in British Columbia or Alberta. As more western than eastern birds winter north of Panama, these decreases are consistent with the idea that deforestation has been more serious in Mexico and Central America (smaller forest areas, closer to export markets in the United States) than in South America. However, only one neotropical migrant showing a significant decline in Canada was a forest bird. Increases in bird numbers in eastern Canada might involve recovery from use of DDT (which was less widespread in western Canada) on forests and crops in Canada (see Erskine 1978, Fig. 6), and thus be unrelated to changes in Latin American forests. Many neotropical migrants winter in disturbed and early successional habitats, so deforestation in Latin America may not harm, and may even enhance, their wintering opportunities, even if it is disastrous for South American endemic bird species. The evidence on the neotropical migrants is inconclusive.

(2) Open-country birds. The widespread and substantial decreases in Common Grackles, European Starlings, and Brown-headed Cowbirds might be related to the efforts by agencies in the United States to reduce blackbird numbers in their winter roosts. The most abundant icterid in the United States in winter, the Red-winged Blackbird *Agelaius phoeniceus*, has not decreased to the same extent (Table 9). However, Red-winged Blackbirds roost mostly in marshes, whereas control operations were in woodlot roosts, where the other species predominated. Through 1975, the Red-winged Blackbird showed sustained increases in all Canadian regions east of the Rockies, and its growth in several areas paralleled increases in area planted to corn (Erskine 1978, Figs. 11 and 12). The long-term trends through 1988 in numbers of Red-winged Blackbirds were slightly downward in four of the five regions where upward trends prevailed through 1975. Red-wings may have shared with other blackbirds the declines in 1975–88, cancelling out earlier increases. Other birds not subject to control operations, but using grasslands and edge for breeding, foraging, and wintering habitats as do blackbirds, also exhibited widespread declines (Table 9). Thus, there may be more fundamental adverse influences acting on this bird community.

Most changes shared between regions (Table 9) involved migrants that winter in the United States. Many of the shared changes extend across Canada from the Atlantic to the Rockies and even beyond. Only a factor such as the "greenhouse effect" (global warming) would cause parallel changes over such vast breeding areas. Since it is premature to attribute the widespread changes to global warming, it is tempting to conclude that the changes must be driven by factors acting in more restricted wintering areas. The majority of shared changes involving common species that winter in the United States are decreases, supporting the intuitive impression among Canadian bird students (e.g., Cohrs 1989) that many birds are declining in number. We must ensure that our monitoring efforts show what is happening. Without good evidence, management agencies are unlikely to devote scarce resources to attempts to mitigate undesired changes in bird numbers.

(3) Water and marsh birds. Earlier comparisons (Erskine 1978) involving wetland birds in the Prairie provinces were inconclusive, as the BBS trends (June) did not agree with the trends from the USFWS aerial waterfowl surveys (May) in the same years. The present analyses also

fail to show the widespread declines in prairie waterfowl resulting from habitat losses associated with the intensification of agriculture. This is not very surprising. No survey method samples all habitats and situations equally well, and a survey based on roads, as is the BBS, samples wetland habitats less well than drier areas. It also samples those species that breed in a dispersed pattern better than those whose breeding is clumped because of habitat or social habits.

Other data and ways of assessing trends in bird numbers

Although the BBS alone cannot monitor all bird species, it is one of the most extensive surveys available that collects useful data at minimal cost. The proliferation of other, more demanding, surveys, often relying on the same volunteer workforce, needs coordination to ensure that the effort is used to best advantage. Potential losses in the BBS must be considered as well as the benefits from more restricted surveys.

Bird students whose experience spans a long period in a region recognize that some species have increased and others have decreased since they began watching birds. Such impressions often cover quite extensive areas. Some people keep detailed field notes that document population changes; others rely on memories and impressions. The assembly of such anecdotal information might confirm trends arising from the BBS analyses. Some compilation of this material is done through "Season Reports" in *American Birds* and other bird journals, which document extralimital records better than long-term trends in numbers of common birds. Systematic attempts, by assembling and summarizing field checklists (e.g., A. Cyr and J. Larivee, unpubl. data for Quebec; cf. Temple and Temple 1986 for Wisconsin), show some trends paralleling those found from BBS data analysis, but changes in the opposite direction are also frequent. Comparisons using only BBS results from the restricted areas covered by the checklists would give better agreement. Some changes shown by BBS analyses agree well with impressions of long-time observers: e.g., the increases of Killdeers *Charadrius vociferus* in the Maritimes and of Mourning Doves *Zenaida macroura* in southern Ontario and southern Quebec (Table 4), declines of meadowlarks (both species) across Canada (e.g., Tables 4, 5, 6), and so on. Many other changes cannot be assessed by the BBS, because our surveys detect too few of those species. Independent checking will help ensure that the results of the statistical analyses represent what is happening in the real world.

We also need ways to consider the many changes, recognizing different sample sizes and varying levels of significance, in species of different distribution patterns and habits, so as to recognize patterns shared across ecosystem or habitat groupings of species. The BBS was set up to make use of computers, and the data generated can only be used effectively with modern data management programs.

Conclusions

This report follows the model of earlier Progress Notes on the BBS, the last one issued in 1981 (Silieff and Finney 1981). With new computer programs for data selection and analysis, we have increased the emphasis on long-term trends in recognition of the longer data series (21–23 years) now available.

Canadian BBS coverage in 1988 encompassed 210 survey routes, up slightly from 1984–86 but about 20% below the peak coverage in 1981. Coverages in British Columbia and Ontario were the best since 1982 and 1983, respectively, and the first routes ever were run in the Northwest Territories.

Samples of routes available for 1987–88 comparisons were small. None of the obvious short-term anomalies expected to affect bird numbers in 1988 were detectable in the results, although significant changes in some species continued the long-term trends for those species.

No evidence was found of general declines among birds that winter in Latin America, where deforestation may limit wintering habitat for some North American species. More of these birds increased than decreased in number, especially in eastern Canada. Several other common birds showed long-term decreases, most of these being species that winter in the United States. Declines in blackbirds may result from control measures in the United States, but this cannot explain parallel decreases in other species that winter in the same areas and habitats. The BBS in Canada does not confirm the long-term declines in prairie waterfowl shown by USFWS aerial surveys.

Computer analyses of BBS data make possible rapid examination of these and other trends in bird populations that are of public concern. We expect further streamlining of the process, now in train, to allow focus on particular geographic areas and time periods in the future.

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Table 1
Number of routes surveyed in the Breeding Bird Survey in Canada, 1981–88, and the total number of routes ever surveyed, by province or territory

Province/Territory	No. of routes surveyed								Total no. of routes
	1981	1982	1983	1984	1985	1986	1987	1988	
Newfoundland	14	21	23	0	0	3	1	1	28
Prince Edward Island	3	4	4	4	4	4	2	2	4
Nova Scotia	16	15	11	12	12	11	13	12	24[a]
New Brunswick	19	15	14	16	15	13	17	14	29
Quebec	39	37	32	30	29	24	23	25	74[a]
Ontario	56	59	53	49	43	48	46	51	79[a]
Manitoba	18	16	15	15	13	17	16	12	20
Saskatchewan	20	21	21	14	16	14	22	16	51
Alberta	39	27	26	24	30	24	32	31	60[a]
British Columbia	38	37	32	32	31	29	28	36	86
Yukon Territory	0	2	0	0	0	9	10	8	23
Northwest Territories (District of Mackenzie)	0	0	0	0	0	0	0	2	2
Total	262	254	231	196	193	196	210	210	480[a]

[a]The total number of distinct routes is uncertain. The route number, in the early years, was not always changed when part of a survey route had to be altered.

Table 2
Changes in bird populations between 1987 and 1988 (maximum 17 comparable routes) and in 1966–88, from the Breeding Bird Survey in the Maritime provinces[a]

Species	1987–88 changes		1987–88 mean no. per route	Long-term trend		
	%	Sig		Rt	Ch	Sig
Common Snipe	−18.8		2.18	137	+	
Belted Kingfisher	−52.7		0.58	113	+	
Yellow-bellied Sapsucker	+56.0		3.34	124	−	*
Northern Flicker	+35.1		2.21	150	NC	
Alder Flycatcher	−3.2		14.09	149	+	nr
Least Flycatcher	−0.5		3.04	138	+	
Tree Swallow	−16.8		10.34	151	+	*
Bank Swallow	−21.1		4.05	125	+ +	nr
Barn Swallow	+1.7		20.85	151	NC	
Blue Jay	−2.8		3.44	148	+	*
American Crow	+20.8	nr	37.70	151	+ +	**
Common Raven	+27.9	nr	10.13	149	+ +	**
Black-capped Chickadee	+82.7	**	4.47	144	+ +	**
Winter Wren	−27.6		1.45	119	−	
Ruby-crowned Kinglet	+25.6	nr	5.82	140	−	*
Veery	+22.5	*	8.55	122	+ +	nr
Swainson's Thrush	−8.5		8.91	149	NC	
Hermit Thrush	+17.7		6.02	143	+ +	*
American Robin	+0.8		54.94	151	NC	
European Starling	+5.7		23.10	148	−	*
Red-eyed Vireo	+2.8		11.63	151	+ +	**
Nashville Warbler	−30.6	nr	2.89	136	NC	
Yellow Warbler	−10.0		8.59	148	+ +	**
Chestnut-sided Warbler	−13.6		3.73	127	NC	
Magnolia Warbler	+9.9		10.85	144	+	*
Yellow-rumped Warbler	−7.7		5.44	141	+ +	**
Black-throated Green Warbler	−2.5		2.96	139	−	
American Redstart	+2.8		15.08	149	+	*
Ovenbird	−6.4		10.44	146	+	nr
Common Yellowthroat	−9.0		20.71	151	NC	
Chipping Sparrow	−20.9	*	6.79	147	NC	
Savannah Sparrow	+28.4		4.25	143	− −	*
Song Sparrow	−1.2		17.20	151	−	**
White-throated Sparrow	−7.3		24.55	151	− −	**
Dark-eyed Junco	−7.9		5.30	150	NC	
Bobolink	−21.8	**	7.73	138	+	
Red-winged Blackbird	−19.2	**	7.41	151	NC	
Common Grackle	+16.1		11.79	149	−	**
Brown-headed Cowbird	−48.3	**	3.79	147	− −	nr
Purple Finch	−39.9	nr	2.65	149	−	
American Goldfinch	−31.7		4.28	149	NC	
Evening Grosbeak	−38.4		1.21	126	+ +	
House Sparrow	−28.8	*	3.82	139	− −	**

[a]Key to column headings, long-term trends, and significance:
% Annual percent change
Rt No. of (sub)routes included in analysis
Sig Statistical significance, with
** = $P < 0.01$ (highly significant)
* = $0.01 < P < 0.05$ (significant)
nr = $0.05 < P < 0.15$ (nearly significant)
(Blank) = $P > 0.15$ (not significant)
Ch Mean annual percent change, with
+ + = change > +3%
+ = +3% > change > +1%
NC = +1% > change > −1%
− = −1% > change > −3%
− − = −3% > change.

Table 3
Changes in bird populations between 1987 and 1988 (maximum 15 comparable routes) and in 1967–88, from the Breeding Bird Survey in central Ontario and central Quebec[a]

Species	1987–88 changes		1987–88 mean no. per route	Long-term trend		
	%	Sig		Rt	Ch	Sig
Killdeer	−17.3		1.90	132	−	
Common Snipe	−24.9		1.38	129	−	
Yellow-bellied Sapsucker	+79.1		3.16	128	NC	
Northern Flicker	−39.1	nr	2.96	155	−	
Alder Flycatcher	−1.5		5.93	154	+	nr
Least Flycatcher	+4.9		8.38	153	−	
Tree Swallow	+53.8		7.68	156	− −	nr
Bank Swallow	−15.1		4.28	98	− −	nr
Barn Swallow	+7.3		8.52	144	−	nr
Blue Jay	−21.2		2.87	135	−	nr
American Crow	−4.8		17.18	155	NC	
Common Raven	+5.6		5.00	144	+ +	
Winter Wren	−1.6		3.37	148	−	
Ruby-crowned Kinglet	−12.4		2.77	143	− −	**
Veery	+5.0		11.27	143	NC	
Swainson's Thrush	−1.8		4.59	143	NC	
Hermit Thrush	−4.1		4.26	148	+	
American Robin	−4.2		32.43	157	NC	nr
Cedar Waxwing	−20.6		8.13	147	+	*
European Starling	+12.9		23.01	140	−	
Red-eyed Vireo	+9.1		32.62	155	+	**
Nashville Warbler	−20.8	nr	6.22	151	−	
Yellow Warbler	−22.0		2.90	141	NC	
Chestnut-sided Warbler	−2.1		8.61	154	NC	
Magnolia Warbler	+2.2		3.90	147	− −	nr
Yellow-rumped Warbler	+25.6		6.20	155	NC	
American Redstart	+17.2		7.57	152	−	nr
Ovenbird	+11.0		16.56	155	NC	
Mourning Warbler	+30.6	**	4.98	152	NC	
Common Yellowthroat	−9.8		10.30	156	−	nr
Rose-breasted Grosbeak	−14.1		3.05	122	−	
Chipping Sparrow	+2.2		19.88	155	NC	
Savannah Sparrow	−12.5		4.10	127	NC	
Song Sparrow	−20.0		10.61	150	− −	**
White-throated Sparrow	−7.7		31.13	157	−	**
Dark-eyed Junco	−15.1		2.87	120	− −	*
Bobolink	−4.6		3.91	104	NC	
Red-winged Blackbird	−0.4		8.22	151	−	nr
Common Grackle	−4.2		6.05	154	− −	**
Brown-headed Cowbird	−44.1	*	2.60	136	− −	**
American Goldfinch	−24.5	nr	3.02	135	− −	*
Evening Grosbeak	−71.8	*	1.92	127	− −	nr
House Sparrow	−52.9		1.54	97	− −	**

[a]Key to column headings, long-term trends, and significance is as in footnote to Table 2.

Table 4
Changes in bird populations between 1987 and 1988 (maximum 19 comparable routes) and in 1967–88, from the Breeding Bird Survey in southern Ontario and southern Quebec[a]

Species	1987–88 changes		1987–88 mean no. per route	Long-term trend		
	%	Sig		Rt	Ch	Sig
Killdeer	+1.3		14.62	116	NC	
Common Snipe	−33.8	nr	3.72	82	+	
Rock Dove	+4.6		15.41	114	++	*
Mourning Dove	−6.0		12.98	115	++	**
Northern Flicker	+2.0		2.91	116	−−	**
Eastern Wood-Pewee	+26.1		2.22	113	NC	
Great Crested Flycatcher	−0.0		2.65	109	+	
Eastern Kingbird	−9.4		6.33	115	+	nr
Horned Lark	−0.0		3.06	102	NC	
Purple Martin	+55.0		2.61	75	−	
Tree Swallow	−7.2		13.34	116	++	*
Bank Swallow	−39.0		7.99	101	−	
Barn Swallow	−3.3		27.89	116	NC	
Blue Jay	+51.7	**	3.90	114	++	**
American Crow	+3.9		43.45	116	NC	
House Wren	−12.8		2.89	113	+	nr
Veery	−6.2		3.82	100	−	
American Robin	+0.0		55.26	116	+	*
Gray Catbird	+13.2		1.68	114	−	
Brown Thrasher	+30.2		1.50	107	−	nr
Cedar Waxwing	−16.0		7.04	112	++	**
European Starling	+0.4		105.33	116	−	**
Warbling Vireo	+39.9	*	3.38	109	++	**
Red-eyed Vireo	−3.5		6.25	111	NC	
Yellow Warbler	+38.6	*	9.04	114	++	*
Common Yellowthroat	−4.1		8.46	113	+	nr
Rose-breasted Grosbeak	+71.2	**	3.46	113	+	
Chipping Sparrow	−10.6		12.58	115	+	**
Vesper Sparrow	−2.4		2.12	108	−−	**
Savannah Sparrow	−10.0	nr	27.88	115	−	*
Song Sparrow	−7.5		38.94	116	NC	
White-throated Sparrow	−4.9		4.15	81	NC	
Bobolink	+7.9		25.68	116	−	
Red-winged Blackbird	+6.1		119.10	116	NC	
Eastern Meadowlark	+5.2		11.62	116	−−	**
Common Grackle	−12.8		46.02	116	−	**
Brown-headed Cowbird	−2.5		11.18	116	−	**
Northern Oriole	+17.1		2.88	113	−	nr
American Goldfinch	−7.0		14.40	116	NC	nr
House Sparrow	+3.5		32.25	116	NC	

[a]Key to column headings, long-term trends, and significance is as in footnote to Table 2.

Table 5
Changes in bird populations between 1987 and 1988 (maximum 18 comparable routes) and in 1967–88, from the Breeding Bird Survey in the southern Prairie provinces[a]

Species	1987–88 changes		1987–88 mean no. per route	Long-term trend		
	%	Sig		Rt	Ch	Sig
Mallard	−65.8		8.29	103	−	
Northern Pintail	+224.1		3.27	99	−−	**
Blue-winged Teal	+91.4	*	4.89	92	+	
Northern Shoveler	+112.1		1.47	92	++	
American Wigeon	+58.8		2.72	80	++	nr
Lesser Scaup	+30.6		7.69	71	+	
Sora	−43.9		1.36	88	−−	nr
American Coot	+439.3		5.18	75	+	
Killdeer	+17.6		7.63	103	−	nr
Black Tern	−42.2	nr	3.15	72	−−	*
Rock Dove	+62.2		3.72	97	++	
Mourning Dove	−14.4		8.01	98	NC	
Northern Flicker	−41.1	nr	1.41	68	−−	**
Least Flycatcher	−27.9	nr	2.81	75	NC	
Eastern Kingbird	−8.6		6.56	103	+	
Horned Lark	+9.4		54.53	103	NC	
Tree Swallow	−28.0		2.30	78	+	
Cliff Swallow	+16.0		9.25	66	+	
Barn Swallow	+12.9		13.87	103	+	
Black-billed Magpie	−20.7	nr	6.42	102	−	
American Crow	−15.1	nr	28.68	103	−	nr
House Wren	−15.8	*	14.38	94	+	**
American Robin	+12.5		8.82	96	++	**
European Starling	−31.6	*	18.53	101	++	nr
Warbling Vireo	−7.8		2.72	63	+	
Yellow Warbler	+0.5		2.92	92	NC	
Common Yellowthroat	−22.2		2.50	74	+	
Clay-colored Sparrow	−18.8	nr	19.75	103	NC	
Vesper Sparrow	−13.5	*	27.63	102	+	
Savannah Sparrow	−4.8		14.56	103	+	nr
Song Sparrow	−20.0		5.54	74	−	*
Chestnut-collared Longspur	+14.2		10.77	59	+	
Bobolink	−16.5		2.10	61	++	nr
Red-winged Blackbird	+14.9	nr	67.37	103	−	nr
Yellow-headed Blackbird	−21.5		7.05	93	++	nr
Western Meadowlark	−8.2	*	47.63	103	−	**
Brewer's Blackbird	−26.1	nr	12.26	103	+	
Common Grackle	−8.4		2.28	74	+	
Brown-headed Cowbird	−3.4		28.26	102	+	*
American Goldfinch	−25.2		5.75	88	+	
House Sparrow	−3.6		48.06	103	NC	

[a]Key to column headings, long-term trends, and significance is as in footnote to Table 2.

Table 6
Changes in bird populations between 1987 and 1988 (maximum 23 comparable routes) and in 1967–88, from the Breeding Bird Survey in the central Prairie provinces[a]

Species	1987–88 changes		1987–88 mean no. per route	Long-term trend		
	%	Sig		Rt	Ch	Sig
Mallard	+13.7		9.33	111	–	
Northern Pintail	−63.5		0.91	69	– –	nr
Blue-winged Teal	+41.7		5.03	85	– –	
Northern Shoveler	−29.8		2.64	61	– –	
Lesser Scaup	−12.7		6.01	70	– –	
American Coot	+12.3		2.96	68	–	
Killdeer	−18.2		4.72	122	– –	**
Common Snipe	−22.2		4.86	117	NC	
Black Tern	+15.0		1.65	80	– –	**
Rock Dove	+68.6		4.09	85	+ +	
Mourning Dove	−10.2		2.48	89	+	
Northern Flicker	−24.0		2.05	119	– –	*
Western Wood-Pewee	−71.8	nr	3.33	83	+ +	
Alder Flycatcher	−4.0		6.16	105	– –	
Least Flycatcher	+16.8		13.33	121	+	*
Tree Swallow	−7.2		4.57	113	+ +	*
Barn Swallow	+2.9		7.96	121	NC	
Black-billed Magpie	−4.4		9.51	112	–	nr
American Crow	−8.9		22.89	121	–	nr
House Wren	−14.5	nr	12.52	112	NC	
American Robin	+4.0		28.46	128	+	nr
European Starling	+5.3		15.06	112	– –	*
Warbling Vireo	−19.3		2.55	104	NC	
Red-eyed Vireo	+0.4		11.63	118	+ +	*
Yellow Warbler	+2.9		11.04	118	NC	
Common Yellowthroat	−2.8		3.98	112	–	
Chipping Sparrow	−17.4	nr	5.62	118	– –	nr
Clay-colored Sparrow	−0.6		19.71	123	–	**
Vesper Sparrow	−26.2	nr	3.71	109	–	
Savannah Sparrow	+16.4	nr	22.27	118	NC	
Song Sparrow	−8.0		19.06	114	– –	**
White-throated Sparrow	+19.2	*	6.45	97	NC	
Dark-eyed Junco	+4.3		1.46	74	– –	
Red-winged Blackbird	+12.1		47.05	123	NC	
Western Meadowlark	−13.4		3.40	90	–	*
Brewer's Blackbird	−23.4		17.98	110	NC	
Brown-headed Cowbird	−35.3	**	6.81	120	– –	nr
Northern Oriole	−0.8		4.08	104	NC	
Pine Siskin	+32.5		4.14	89	– –	
American Goldfinch	+11.1		6.42	102	+ +	nr
House Sparrow	+9.7		10.31	107	– –	**

[a]Key to column headings, long-term trends, and significance is as in footnote to Table 2.

Table 7
Changes in bird populations between 1987 and 1988 (maximum 13 comparable routes) and in 1968–88, from the Breeding Bird Survey in southern British Columbia[a]

Species	1987–88 changes		1987–88 mean no. per route	Long-term trend		
	%	Sig		Rt	Ch	Sig
Killdeer	−5.5		2.85	89	NC	
Rufous Hummingbird	+3.6		1.13	94	–	
Yellow-bellied Sapsucker[b]	−24.4		3.59	85	– –	
Northern Flicker	−36.6	nr	4.90	103	– –	*
Western Wood-Pewee	−16.0		5.51	91	– –	nr
Willow Flycatcher	+37.4		3.50	72	NC	
Tree Swallow	−34.8	**	4.97	100	+	
Violet-green Swallow	−39.8	nr	7.14	93	– –	
Northern Rough-winged Swallow	−10.2		3.99	81	– –	
Cliff Swallow	+12.7		3.46	81	NC	
Barn Swallow	−25.5		7.76	102	–	
American Crow	−29.4	nr	16.48	81	NC	
Common Raven	−40.5	*	4.08	101	+	
Black-capped Chickadee	+40.7	nr	7.24	88	–	
Chestnut-backed Chickadee	+1.9		3.47	42	– –	
Winter Wren	−2.7		3.38	74	+ +	
Golden-crowned Kinglet	−29.3		1.75	91	– –	
Ruby-crowned Kinglet	−4.3		5.00	83	+ +	
Swainson's Thrush	−17.8	nr	17.39	105	–	*
American Robin	−4.7		58.03	107	NC	
Varied Thrush	−13.5		3.50	81	– –	
Cedar Waxwing	+1.3		5.44	94	NC	
European Starling	−20.7		12.21	99	–	
Warbling Vireo	+23.4	*	7.39	102	+ +	
Red-eyed Vireo	+19.6		3.40	94	NC	
Orange-crowned Warbler	−10.0		2.89	92	+ +	
Yellow Warbler	−28.2		2.00	104	– –	**
Yellow-rumped Warbler	−5.3		7.78	101	NC	
MacGillivray's Warbler	−4.0		3.03	92	–	
Wilson's Warbler	+2.0		2.38	86	–	
Western Tanager	−25.5	*	4.08	101	– –	nr
Rufous-sided Towhee	+6.0		4.67	61	+	
Chipping Sparrow	+25.9	nr	10.08	97	– –	**
Savannah Sparrow	−55.9		7.81	76	NC	
Song Sparrow	+25.9		5.41	104	NC	
Dark-eyed Junco	−13.8		8.23	104	– –	*
Red-winged Blackbird	+9.8		5.76	87	NC	
Western Meadowlark	−22.5		17.15	59	–	
Brewer's Blackbird	−11.2		13.58	90	+	
Brown-headed Cowbird	+11.9		5.46	96	– –	nr
Pine Siskin	+26.8		22.54	106	+	
American Goldfinch	+2.7		3.35	63	–	nr
House Sparrow	−26.7		6.86	49	–	

[a]Key to column headings, long-term trends, and significance is as in footnote to Table 2.
[b]Including Red-naped and Red-breasted sapsuckers.

Table 8
Observers with 15 or more years' coverage of one or more Breeding Bird Survey routes in Canada, 1966–88, with numbers of years each was active

Province	Name of observer	No. of years/ Span of years
N.S.	Doane, Benjamin[b]	15/15[a]
	Elliott, James	18/18
	Fullerton, Sylvia	20/20
	Helleiner, Christopher	19/20, 18/18[a]
	Hinds, Barbara	21/21
N.B.	Belyea, Marion	18/18
	Christie, David	23/23, 17/23, 14/15, 10/18[a]
	Pearce, Peter	17/17[a]
	Smith, Allan	17/19
	Walker, Harry	15/15
	Wilson, James	23/23[a]
Que.	Hamel, François	17/17[a]
	Lepage, Ronald	21/22, 18/19
	McIntosh, Mabel	22/23, 19/19
	Montgomery, George[b]	18/19
	Ouellet, Reginald	17/17[a]
Ont.	Bateman, Robert[b]	17/18
	Bell, Arthur	22/22
	Bell, Christopher	15/15
	Blomme, Christopher	15/15
	Bucknell, Donald[b]	15/15
	Chesterfield, Norman[b]	18/20
	Gildner, Donald[b]	15/15
	Girling, William[b]	16/17
	Goodwin, Clive[b]	17/18
	Inch, Helen	21/21, 15/15
	Lemon, John	21/21
	Mackenzie, Hubert[b]	15/15
	McFayden, Clifford	20/20, 19/19
	Moulder, Cliff[b]	15/15
	Peruniak, Shirley	20/21
	Ray, Fanny	17/21[a]
	Wallace, Jean	17/17, 11/11
Man.	Copland, Herbert	21/21, 16/16[a]
	Kyle, Douglas	22/22
	Robinson, Barbara	20/20
Sask.	Anaka, William	20/20[a]
	Belcher, Margaret	21/21
	Hayward, Donald	16/17
	Houston, Stuart	17/17
	Mareschal, Maurice	19/19, 15/16
	Roy, Frank	15/19
Alta.	Demulder, Peter	18/18[a]
	Greenlee, Graeme	19/19, 14/14[a]
	Hall, Willis	19/19, 11/12[a]
	Halladay, Ian	21/21
	Horton, Harry[b]	15/15
	Kinneard, John	17/17
	Lohr, Lloyd	19/19
	McKay, Garry	15/15
	Park, Jack	21/21[a]
B.C.	King, Frances[b]	15/15
	Roberts, Anna	16/16
	VanKerkoerle, Peter	15/16
	Walker, Robert	16/16

[a]Same observer also surveyed one or more other routes for periods of less than 10 years.
[b]Observer now retired from BBS.

Table 9
Species with analyses from four or more regions, to illustrate parallel long-term trends, from the Canadian Breeding Bird Survey[a]

Species	Long-term trend in region (significance)					
	Mar.	COQ	SOQ	Pra.	CPP	SBC
Great Blue Heron	++	NC	++(*)			−
Mallard			++	−	−	−
Killdeer	++	−	NC	−(nr)	−−(**)	NC
Common Snipe	+	−	+	−	NC	NC
Rock Dove			++(*)	++	++	NC
Belted Kingfisher	+	−(nr)	−			−−
Northern Flicker	NC	−	−−(**)	−−(**)	−−(*)	−−(*)
Alder Flycatcher	+(nr)	+(nr)	++		−−	
Least Flycatcher	+	−	NC	NC	+(*)	−−
Eastern Kingbird		NC	+(nr)	+	−−(*)	NC
Tree Swallow	+(*)	−−(nr)	++(*)	+	++(*)	+
Bank Swallow	++(nr)	−−(nr)	−(*)			NC
Cliff Swallow	++(nr)	+	−	+	++(*)	NC
Barn Swallow	NC	−(nr)	NC	+	NC	−
American Crow	++(**)	NC	NC	−(nr)	−(nr)	NC
Common Raven	++(**)	++			−	+
Black-capped Chickadee	++(**)	−	++(**)		NC	−
Ruby-crowned Kinglet	−(*)	−−(**)			++	++
Veery	++(nr)	NC	−			−
Swainson's Thrush	NC	NC			++	−(*)
American Robin	NC	NC(nr)	+(*)	++(**)	+(nr)	NC
Gray Catbird	++(*)		−	++	NC	
Cedar Waxwing	++(*)	+(*)	++(**)			NC
European Starling	−(*)	−	−(**)	++(nr)	−−(*)	−
Warbling Vireo			++(**)	+	NC	++(nr)
Red-eyed Vireo	++(**)	+(**)	NC	NC	++(*)	NC
Yellow Warbler	++(**)	NC	++(*)	NC	NC	−−(**)
Ovenbird	+(nr)	NC	++(nr)		−−	
Common Yellowthroat	NC	−(nr)	+(nr)	+	−	+
Rose-breasted Grosbeak	++(*)	−	+		−−	
Chipping Sparrow	NC	NC	+(**)		−−(nr)	−−(**)
Vesper Sparrow			−−(**)	+	−	NC
Savannah Sparrow	−−(*)	NC	−(*)	+(nr)	NC	NC
Song Sparrow	−(**)	−−(**)	NC	−(*)	−−(**)	NC
White-throated Sparrow	−−(**)	−(**)	NC		NC	
Dark-eyed Junco	NC	−−(*)			−−	−−(*)
Bobolink	+	NC	−	++(nr)		
Red-winged Blackbird	NC	−(nr)	NC	−(nr)	NC	NC
[Eastern] Western Meadowlark			[−−(**)]	−(**)	−(*)	−
Common Grackle	−(**)	−−(**)	−(**)	+	−−	
Brown-headed Cowbird	−−(nr)	−−(**)	−(**)	+(*)	−−(nr)	−−(nr)
Pine Siskin	−−	−			−−	+
American Goldfinch	NC	−−(*)	NC(nr)	+	++(nr)	−(nr)
House Sparrow	−−(**)	−−(**)	NC	NC	−−(**)	−

[a]Key to column headings, trends, and significance:
Regions: Mar. — Maritimes; COQ — central Ontario and Quebec; SOQ — southern Ontario and Quebec; Pra. — southern Prairie provinces; CPP — central Prairie provinces; SBC — southern British Columbia.
Trends: ++, +, NC, −, −− as in Tables 2–7.
Significance: **, *, nr as in Tables 2–7; all others were nonsignificant.
Trends *shared by "adjoining" regions* are underlined; for this comparison, adjoining regions are Mar. with COQ, SOQ; COQ with SOQ, CPP; SOQ with Pra.; CPP with SBC.