American Woodcock
Population Status, 2000

AMERICAN WOODCOCK POPULATION STATUS, 2000

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Abstract: Singing-ground and Wing-collection surveys were conducted to assess the population status of the American woodcock (*Scolopax minor*). Singing-ground Survey data indicated that the number of displaying woodcock in the Eastern Region decreased 11.0% (*P*<0.1) from 1999 levels. In the Central Region, there was a 10.4% increase in the number of woodcock heard displaying (*P*<0.1) compared to 1999 levels. Trends from the Singing-ground Survey during 1990-00 were negative (-3.5 and –3.1% per year for the Eastern and Central regions, respectively; *P*<0.01). There were long-term (1968-00) declines (*P*<0.01) of 2.3% per year in the Eastern Region and 1.6% per year in the Central Region. The 1999 recruitment index for the Eastern Region (1.1 immatures per adult female) was 35% below the long-term regional average; the recruitment index for the Central Region (1.2 immatures per adult female) was 29% below the long-term regional average. The index of daily hunting success in the Eastern Region increased from 1.9 woodcock per successful hunt in 1998 to 2.0 woodcock per successful hunt in 1999, and seasonal hunting success increased 3%, from 7.2 to 7.4 woodcock per successful hunter in 1998 and 1999, respectively. In the Central Region, the daily success index in 1999 was unchanged from the 1998 index (2.1 woodcock per successful hunt) but the seasonal success index decreased 11% from 11.3 to 10.0 woodcock per successful hunter.

The American woodcock is a popular game bird throughout eastern North America that provides an estimated 3.4 million days of recreational hunting annually (U. S. Department of Interior 1988). The management objective of the U. S. Fish and Wildlife Service (FWS) is to increase populations of woodcock to levels consistent with the demands of consumptive and non-consumptive users (U. S. Fish and Wildlife Service 1990).

Reliable annual population estimates, harvest estimates and information on recruitment and distribution are essential for comprehensive woodcock management. Unfortunately, this information is difficult and often impractical to obtain. Woodcock are difficult to find and count because of their cryptic coloration, small size, and preference for areas with dense vegetation. Also, although a sampling frame for woodcock hunters is currently being developed as part of the Harvest Information Program, no comprehensive sampling frame for woodcock hunters is currently available. Because of these difficulties, the Wing-collection Survey and the Singing-ground Survey were developed to provide indices of recruitment, hunting success and changes in abundance.

This report summarizes the results of these surveys and presents an assessment of the population status of woodcock as of June 2000. The report is intended to assist managers in regulating the sport harvest of woodcock and to draw attention to areas where management actions are needed.

METHODS

Woodcock Management Units

Woodcock are managed on the basis of 2 regions or populations, Eastern and Central, as recommended by Owen et al. (1977) (Fig. 1). Coon et al. (1977) reviewed the concept of management units for woodcock and recommended the current configuration over several alternatives. This configuration was biologically justified because analysis of band recovery data indicated that there was little crossover between the regions (Krohn et al. 1974, Martin et al. 1969). Furthermore, the regional boundaries conform to the boundary between the Atlantic and Mississippi flyways. The results of the Wing-collection and Singing-ground surveys are reported by state or province, and region.
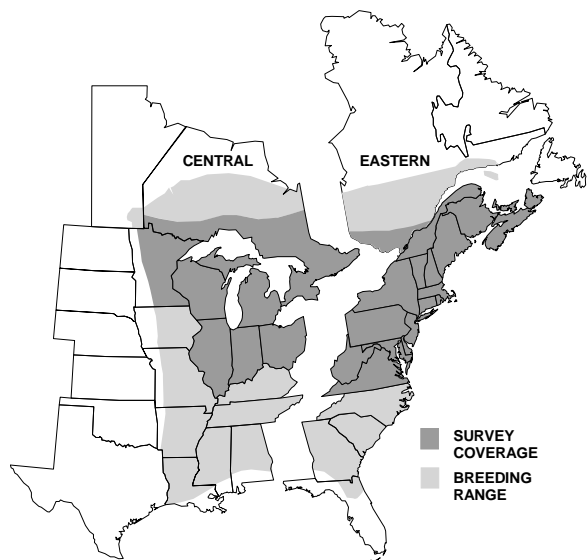
Fig. 1. Woodcock management regions, breeding range, and Singing-ground Survey coverage.

Singing-ground Survey

The Singing-ground Survey was developed to exploit the conspicuous courtship display of the male woodcock. Early studies demonstrated that counts of singing males provide indices to woodcock populations and could be used to monitor annual changes (Mendall and Aldous 1943, Goudy 1960, Duke 1966, and Whitcomb 1974). Before 1968, counts were conducted on non-randomly-located routes. Beginning in 1968, routes were relocated along lightly traveled secondary roads in the center of randomly chosen 10-minute blocks within each state and province in the central and northern portions of the woodcock's breeding range (Fig. 1). Data collected prior to 1968 are not included in this report.

Each route was 3.6 miles (5.4 km) long and consisted of 10 listening points. The routes were surveyed shortly after sunset by an observer who drove to each of the 10 stops and recorded the number of woodcock heard peenting (the vocalization by displaying male woodcock on the ground). Acceptable dates for conducting the survey were assigned by latitude to coincide with peaks in courtship behavior of local woodcock. In most states, the peak of courtship activity (including local woodcock and woodcock still migrating) occurred earlier in the spring and local reproduction may have already been underway when the survey was conducted. However, it was necessary to conduct the survey during the designated survey dates in order to avoid counting migrating woodcock. Because adverse weather conditions may affect courtship behavior or the ability of observers to hear woodcock, surveys were only conducted when wind, precipitation, and temperature conditions were acceptable.

The survey consists of about 1,500 routes. In order to avoid expending unnecessary manpower and funds, approximately one half of these routes are surveyed each year. The remaining routes are carried as "constant zeros." Routes for which no woodcock are heard for 2 consecutive years enter this constant zero status and are not run for the next 5 years. If woodcock are heard on a constant zero route when it is next run, the route reverts to normal status and is run again each year. Data from constant zero routes are included in the analysis only for the years they were actually surveyed. Sauer and Bortner (1991) reviewed the implementation and analysis of the Singing-ground Survey in more detail.

Trend Estimation.—Trends were estimated for each route by solving a set of estimating equations (Link and Sauer 1994). Observer data were used as covariables to adjust for differences in observers' ability to hear woodcock. To estimate state and regional trends, a weighted average from individual routes was calculated for each area of interest as described by Geissler (1984). Regional estimates were weighted by state and provincial land areas. Variances associated with the state, provincial, and regional slope estimates were estimated using a bootstrap procedure (Efron 1982). Trend estimates were expressed as percent change per year and trend significance was assessed using normal-based confidence intervals. Short-term (1999-00), intermediate-term (1990-00) and long-term (1968-00) trends were evaluated.

The reported sample sizes are the number of routes on which trend estimates are based. These numbers may be less than the actual number of routes surveyed for several reasons. The estimating equations approach requires at least 2 non-zero counts by the same observer for a route to be used. With the exception of the 1999-00 analysis, routes that did not meet this requirement during the interval of interest were not included in the sample size. For the 1999-00 analysis, a constant of 0.1 was added to counts of low-abundance routes to allow their use in the analysis. Each route should be surveyed during the peak time of singing activity. For editing purposes, "acceptable" times were between 22 and 58 minutes after sunset (or, between 15 and 51 minutes after sunset on overcast evenings). Due to observer error, some stops on some routes were surveyed before or after the peak times of singing activity. Earlier analysis revealed that routes with 8 or fewer

acceptable stops tended to be biased low. Therefore, only route observations with at least 9 acceptable stops were included in the analysis. Routes for which data were received after 1 June 2000 were not included in this analysis but will be included in future trend estimates.

Annual indices.—Annual indices were calculated for the 2 regions and each state and province by finding the deviation between the observed count on each route and that predicted by the 1968-00 regional or state/provincial trend estimate. These residuals were averaged by year and added to the fitted trend to produce annual indices of abundance for each region, state and province. Yearly variation in woodcock abundance was superimposed on the long-term fitted trends (see Sauer and Geissler 1990). Thus, the indices calculated with this method portray year-to-year variation around the predicted trend line, which can be useful for exploratory data analysis (e.g., observing periods of departure from the long-term trend). However, the indices should be viewed in a descriptive context. They are not used to assess statistical significance and a change in the indices over a subset of years does not necessarily represent a significant change. Observed patterns must be verified using trend estimation methods to examine the period of interest (Sauer and Geissler 1990, Link and Sauer 1994).

Wing-collection Survey

The Wing-collection Survey was incorporated into a national webless migratory game bird wing-collection survey in 1997. Only data on woodcock will be presented in this report. As with the old survey, the primary objective of the Wing-collection Survey is to provide data on the reproductive success of woodcock. The survey also produces information on the chronology and distribution of the harvest and data on hunting success. The survey is administered as a cooperative effort between woodcock hunters, the FWS and state wildlife agencies. Participants in the 1999 survey included hunters who either: (1) participated in the 1998 survey; or (2) indicated on the 1998-99 Annual Questionnaire Survey of U. S. Waterfowl Hunters or Harvest Information Program Survey that they hunted woodcock. Wing-collection Survey participants were provided with prepaid mailing envelopes and asked to submit one wing from each woodcock they bagged. Hunters were asked to record the date of the hunt, and the state and county where the bird was shot. Hunters were not asked to submit envelopes for unsuccessful hunts. The age and sex of the birds were determined by examining plumage characteristics (Martin 1964,

Sepik 1994) during the annual Woodcock Wingbee, a cooperative work session. Wings were accepted through 21 April 2000.

The ratio of immature birds per adult female in the harvest provided an index to recruitment of young into the population. The 1999 recruitment indices were compared to long-term (1963-98) averages. Annual indices were calculated as the average number of immatures per adult female in each state, weighted by the relative contribution of each state to the total number of wings received during 1963-98 (to maintain comparability between years).

Daily and seasonal bags of hunters who participated in the Wing-collection Survey in both 1998 and 1999 were used as indices of hunter success. These indices were weighted to compensate for changes in the proportion of the estimated woodcock harvest attributed to each state and adjusted to a base-year value (1969) for comparison with previous years (Clark 1970, 1972, 1973). Only data on successful hunts from prior years were used so that they would be comparable to data from the new survey. A successful hunt was defined as any envelope returned with complete information in which >1 woodcock wing was received.

RESULTS AND DISCUSSION

Singing-ground Survey

Trend Estimation.— The number of woodcock displaying during the 2000 Singing-ground Survey in the Eastern Region decreased (*P*<0.1) 11.0% from 1999 levels (Table 1, Fig. 2). The number of woodcock displaying in the Central Region increased (*P*<0.1) 10.4% over 1999 levels. Trends for all states and provinces are reported in Table 1, but results based on fewer than 10 routes should be considered unreliable.

Trends for the 1990-00 period were computed for 350 routes in the Eastern Region and 440 routes in the Central Region. Eastern and Central region breeding populations declined (*P*<0.01) 3.5 and 3.1% per year, respectively, during this period (Table 1).

Long-term (1968-00) trends were estimated for 603 routes in the Eastern Region and 604 routes in the Central Region. There were long-term declines (P<0.10) in the breeding population throughout most states and provinces in the Eastern and Central Regions (Table 1, Fig. 3). The long-term trend
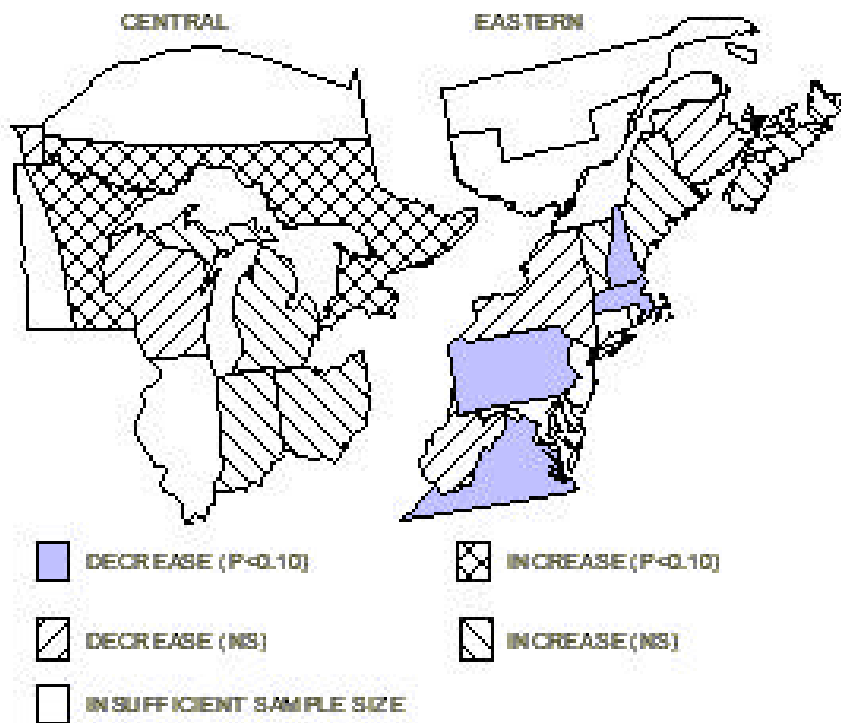
Fig. 2. Short-term trends in the number of American woodcock heard on the Singing-ground Survey, 1999-00.
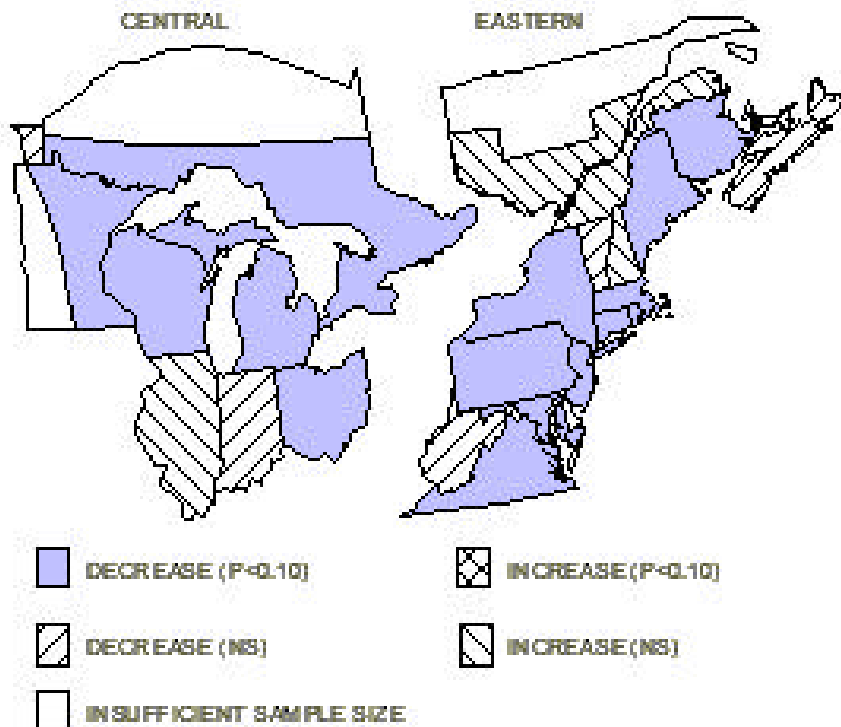

Fig. 3. Long-term trends in the number of American woodcock heard on the Singing-ground Survey, 1968-00.

estimates were -2.3 and -1.6% per year (*P*<0.01) for the Eastern and Central regions, respectively.

Annual Breeding Population Indices.—In the Eastern Region, the 2000 breeding population index of 1.68 singing-males per route was less than the predicted value of 1.71 (Table 2, Fig. 4). The Central Region population index of 2.23 males per route was very near the predicted value of 2.25.

The major causes of these declines are thought to be degradation and loss of suitable habitat on both the breeding and wintering grounds, resulting from forest succession and various human uses (Dwyer et al. 1983, Owen et al. 1977, Straw et al. 1994). If current trends in land use practices persist, continued long-term population declines are likely.
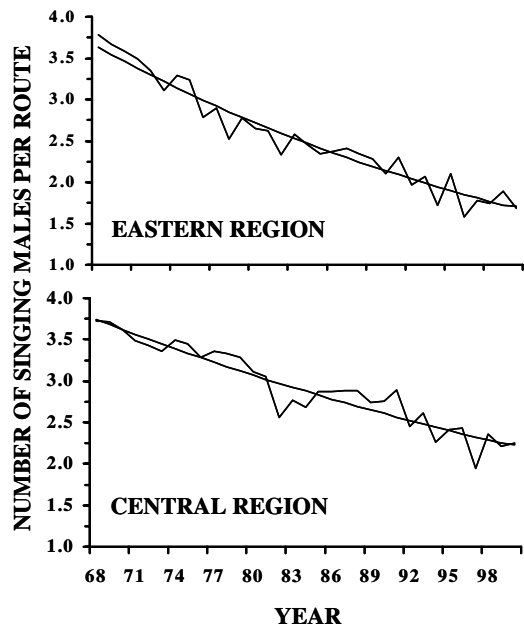

Fig. 4. Long-term trends and annual indices of the number of woodcock heard on the Singing-ground Survey, 1968-00.

Wing-collection Survey

A total of 4,465 potential woodcock hunters in states with woodcock seasons were contacted and asked to participate in the 1999 Wing-collection Survey. Twenty-eight percent (Table 3) cooperated by sending in 9,746 woodcock wings (Table 4).

Recruitment.—The 1999 recruitment index in the Eastern Region (1.1 immatures per adult female) was the lowest on record, and was 35% below both the

1998 index and the long term (1963-98) regional average (Table 4, Fig 5). In the Central Region the 1999 recruitment index (1.2 immatures per adult female) also was the lowest on record. The 1999 index was 25% lower than the 1998 index, and 29% below the long-term regional average of 1.7 immatures per adult female.
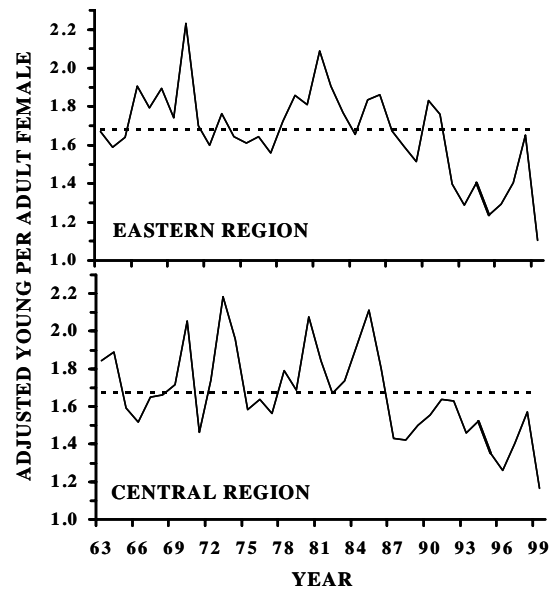
Fig. 5. Adjusted annual indices of recruitment, 1963-99. The dashed line is the 1963-98 average.

Hunting Success.— There were no changes in Federal frameworks for woodcock hunting during the 1999-00 season (Appendix 1). The index of daily hunting success in the Eastern Region was 2.0 woodcock per successful hunt, slightly higher than during the 1998 season (1.9 woodcock per successful hunt) (Table 5). The index of seasonal hunting success increased 3%, from 7.2 to 7.4 woodcock per successful hunter. In the Central Region, the daily success index (2.1 woodcock per successful hunt) was unchanged from the 1998 index; the seasonal success index decreased 11%, from 11.3 woodcock per successful hunter in 1998 to 10.0 woodcock per hunter in 1999. Base-year adjusted indices of daily and seasonal hunting success were below long-term averages in both regions (Figs. 6 and 7).

Seasonal hunting success indices indicate that the annual woodcock harvest has been declining among participants in the survey for over a decade. This is consistent with the results of the Annual Questionnaire Survey of U.S. Waterfowl Hunters

(Martin 1979, and unpubl. rep., U. S. Fish and Wildl. Serv., Office of Migratory Bird Management, Laurel, Maryland) which indicates that the woodcock harvest and the number of woodcock hunters have generally declined since the early 1980s (Fig. 8).
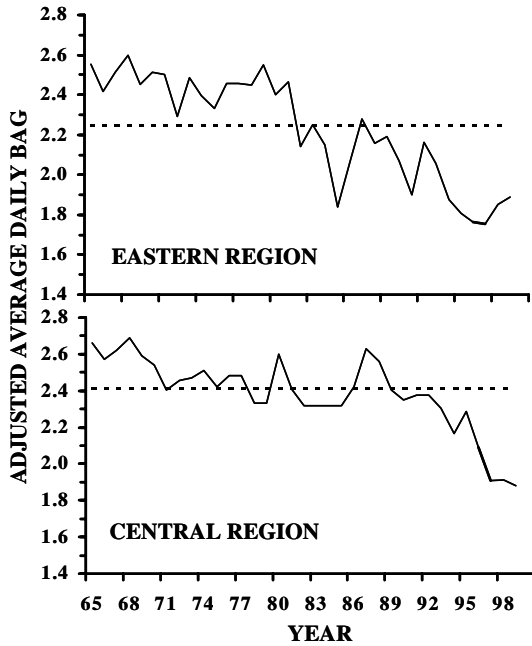
Fig. 6. Base-year adjusted indices of daily hunting success, 1965-99. The base year is 1969; the dashed line is the 1965-98 average.
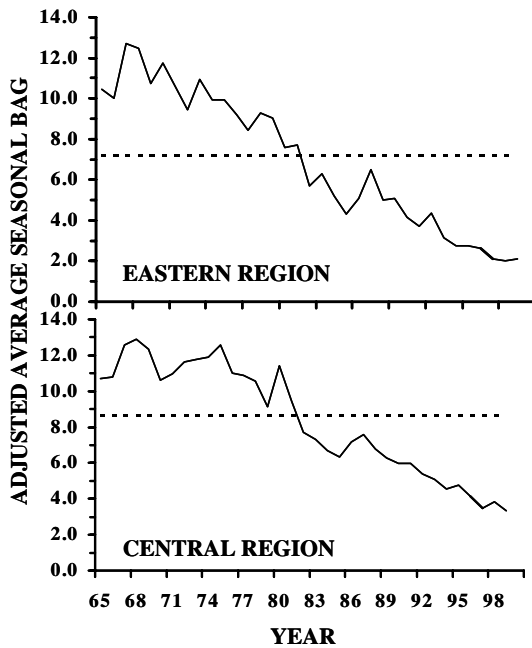
Fig. 7. Base-year adjusted indices of seasonal hunting success, 1965-99. The base year is 1969; the dashed line is the 1965-98 average.

These results should be interpreted cautiously because of the limitations of both of these surveys. A comprehensive critique of these limitations is beyond the scope of this report; interested readers should see Owen et al. (1977), Martin (1979), and Straw et al. (1994). Briefly, indices based on the Wing-collection Survey are potentially biased because of the non-random sampling procedure by which survey participants were selected. Because the Annual Questionnaire Survey of U. S. Waterfowl Hunters does not provide information on the woodcock harvest by non-waterfowl hunters, it does not provide an estimate of total harvest or the total number of hunters. Nevertheless, results from this survey should at least approximate trends in harvest and hunter participation. The Harvest Information Program currently being implemented by the FWS and state wildlife agencies is, in part, designed to address the problems with these, and other migratory bird surveys. Within the next several years, the Harvest Information Program will provide estimates of the total woodcock harvest, more comprehensive information on hunter effort and success, and larger samples of wings where needed.
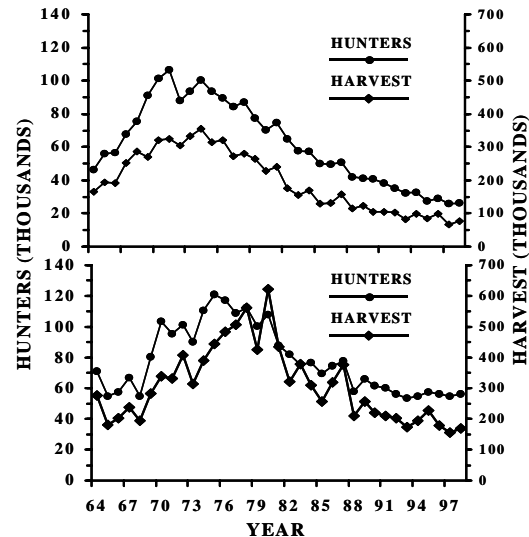
Fig. 8. U. S. harvest of American woodcock by duck stamp purchasers, and hunter numbers, 1964-98 (Martin 1979, and unpubl. rep., FWS, Office of Migratory Bird Management, Laurel, Maryland).

ACKNOWLEDGEMENTS

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Table 1. Trends (% change per year[a]) in the number of American woodcock heard in the Singing-ground Survey as determined by the estimating equations technique (Link and Sauer 1994).

State, Province or Region	No. of Routes[b]	1999-00				1990-00				1968-00			
		n[c]	% change	90% CI		n[c]	% change	90% CI		n[c]	% change	90% CI	
CT	3					3	7.7 ***	3.7	11.7	9	-8.0 **	-15.1	-2.8
DE	2	2	632.4	-694.6	1959.3	2	8.4	-3.4	20.3	2	8.0	-6.4	21.5
ME	44	28	7.2	-9.8	24.3	54	-1.3	-3.0	0.4	63	-2.2 ***	-3.1	-1.2
MD	7					7	-0.8	-53.6	52.0	21	-12.1 ***	-18.9	-6.3
MA	11	5	-34.1 **	-62.7	-5.6	14	4.3	-1.6	10.2	20	-4.3 **	-8.2	-1.0
NB	48	24	-0.2	-23.2	22.7	52	-1.4	-4.0	1.2	62	-1.4 **	-2.5	-0.2
NH	13	10	-30.3 **	-50.1	-10.5	12	3.6	-0.7	7.9	18	0.7	-2.2	3.5
NJ	8					4	-18.2 ***	-28.9	-7.5	17	-11.3 ***	-15.1	-8.0
NY	64	32	-21.3	-43.4	0.8	71	-6.9 ***	-10.1	-3.6	104	-2.5 ***	-3.7	-1.5
NS	30	20	12.4	-14.3	39.0	36	4.2	-0.2	8.7	55	-0.6	-1.8	0.6
PA	31	10	-37.2 ***	-59.6	-14.8	27	-4.7 *	-9.1	-0.4	56	-5.1 ***	-7.4	-2.8
PEI	6	4	40.0	-38.0	117.9	8	-0.5	-7.2	6.3	12	-0.8	-2.6	0.9
QUE	19					12	-4.9 **	-8.6	-1.1	54	0.3	-1.1	2.0
RI										2	-17.0 ***	-24.0	-8.2
VT	15	10	24.0	-15.9	64.0	18	2.0	-3.5	7.4	21	-1.6	-3.7	0.3
VA	14	4	-28.5 **	-47.8	-9.3	12	-5.0	-14.9	4.8	45	-10.3 ***	-14.1	-6.7
WV	14	8	-15.1	-73.6	43.4	18	-4.5	-10.1	1.1	42	-2.1	-4.5	0.1
Eastern	329	160	-11.0 *	-20.5	-1.5	350	-3.5 ***	-5.0	-2.1	603	-2.3 ***	-2.8	-1.9
IL	10					9	13.3 *	1.2	25.4	23	24.9	-21.5	71.2
IN	15	3	88.2	-514.3	690.7	9	-6.7	-14.0	0.7	38	-5.9	-12.1	0.4
MB[e]	22	7	-2.8	-49.1	43.6	18	-3.5	-7.9	0.9	18	-4.0	-8.4	0.4
MI	93	37	10.5	-11.8	32.8	119	-3.2 ***	-4.6	-1.8	140	-1.4 ***	-2.1	-0.8
MN	71	44	19.6 **	3.3	35.9	77	-2.9 ***	-4.5	-1.2	97	-1.0 *	-1.9	-0.1
OH	31	11	5.3	-40.9	51.5	30	-8.7 *	-16.7	-0.7	54	-5.7 **	-9.8	-1.6
ON	43	13	38.4 *	4.5	72.2	104	-3.1 ***	-4.9	-1.4	135	-1.5 ***	-2.2	-0.7
WI	75	37	-5.4	-23.7	12.9	74	-2.7 ***	-4.3	-1.0	99	-1.8 ***	-2.6	-1.0
Central	360	153	10.4 *	0.9	20.0	440	-3.1 ***	-3.9	-2.3	604	-1.6 ***	-2.0	-1.2
Continent	689	313	3.5	-3.6	10.7	790	-3.3 ***	-3.9	-2.6	1207	-1.8 ***	-2.1	-1.5

[a] Mean of weighted route trends within each state, province or region. To estimate the total percent change over several years, use: $(100((\% \text{ change}/100)+1)^y)-100$ where y is the number of years. Note: extrapolating the estimated trend statistic (% change per year) over time (e.g., 30 years) may exaggerate the total change over the period.

[b] Total number of routes surveyed in 2000 for which data were received by 31 May.

[c] Number of comparable routes with at least 2 non-zero counts.

[d] Indicates slope is significantly different from zero: * $P<0.10$, ** $P<0.05$. *** $P<0.01$; significance levels are approximate for states where $n<10$.

[e] Manitoba began participating in the Singing-ground Survey in 1990.

Table 2. Breeding population indices for American woodcock from the Singing-ground Survey, 1968-00. These indices are based on the 1968-00 trend and should be used for exploratory data analysis only; observed patterns should be verified using trend estimation methods (Sauer and Geissler 1990).

State, Province or Region	Year															
	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
Eastern Region																
CT[a]	--[b]	5.75	5.76	4.50	5.55	4.12	4.06	4.32	2.37	2.78	1.68	1.70	1.49	2.01	2.56	1.97
DE[a]	0.34	0.28	0.34	0.25	0.34	0.57	0.51	1.14	0.37	0.50	0.50	0.43	--	--	--	1.68
ME	5.04	5.21	5.47	4.96	4.67	4.97	4.93	5.26	4.66	4.19	3.85	4.20	3.70	4.04	2.79	3.58
MD	16.17	13.70	11.95	10.50	8.40	9.40	5.27	5.35	3.60	3.13	3.22	2.39	2.85	2.46	2.33	1.43
MA	--	3.93	4.60	5.37	3.93	5.25	4.23	2.44	3.21	2.43	2.82	3.09	2.22	2.23	1.90	1.40
NB	--	5.54	5.80	5.59	5.80	5.12	5.65	6.38	4.67	5.77	4.12	4.55	4.03	4.05	4.20	4.43
NH	--	3.10	3.58	2.90	3.63	2.82	3.86	3.27	4.03	3.36	3.32	3.40	4.12	4.30	2.52	2.95
NJ	8.50	7.23	8.89	11.08	6.49	9.09	8.89	6.55	3.62	3.99	2.36	4.07	2.53	1.94	1.87	2.15
NY	4.73	5.22	4.01	4.54	4.25	4.30	4.53	3.80	3.81	3.93	3.08	3.48	4.02	3.67	2.97	3.44
NS	4.12	2.93	2.51	3.07	2.94	2.82	3.49	3.00	2.60	2.59	2.95	2.42	2.27	2.09	1.86	2.32
PA	3.65	3.34	3.67	3.19	2.82	3.04	2.19	2.45	2.37	2.35	1.87	2.12	1.94	1.91	1.54	1.75
PEI[a]	--	3.34	2.57	4.78	2.84	2.28	3.06	4.67	3.98	3.51	2.81	3.47	2.58	1.96	2.11	3.34
QUE[a]	--	--	--	3.60	3.32	2.58	3.18	3.23	2.26	2.53	3.13	3.21	3.56	2.81	2.77	3.47
RI[a]	--	2.41	2.43	4.52	3.35	3.35	2.50	1.93	1.93	--	0.64	1.12	1.12	0.64	2.63	1.88
VT	--	2.86	4.84	3.61	4.06	3.58	3.45	3.93	3.55	4.22	3.19	3.04	2.68	2.38	1.76	2.57
VA	--	4.34	4.50	3.59	3.13	2.26	3.31	2.83	2.36	2.28	1.72	1.90	1.61	1.60	1.51	1.19
WV	1.49	1.68	1.20	1.17	1.42	1.15	1.11	1.28	1.12	1.14	0.78	1.15	0.95	1.31	1.16	1.22
Region	3.79	3.67	3.58	3.50	3.35	3.11	3.29	3.24	2.79	2.90	2.52	2.78	2.65	2.62	2.33	2.58
Central Region																
IL	--	--	0.05	0.06	0.07	0.08	0.07	0.14	0.11	0.13	0.13	0.16	0.17	0.25	0.19	0.29
IN	1.94	1.68	1.59	1.24	1.50	1.55	1.15	1.12	1.12	1.12	0.99	1.25	0.92	0.96	0.70	0.74
MB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MI	5.77	5.65	5.39	5.20	4.94	5.09	5.92	5.96	5.50	5.04	5.34	5.27	5.20	4.35	4.60	4.01
MN	--	4.57	3.90	4.18	3.55	4.04	4.69	4.09	4.11	4.07	4.08	4.03	4.48	4.10	3.70	3.36
OH	--	--	3.07	3.12	2.62	2.17	2.80	2.12	2.31	2.64	2.11	1.64	1.63	1.87	1.36	1.73
ON	6.03	6.61	6.28	5.98	6.64	5.93	6.37	5.61	5.40	5.88	6.37	6.13	6.29	5.84	4.43	4.59
WI	4.18	4.13	4.46	3.94	3.75	3.83	3.92	3.79	3.63	3.94	4.10	3.99	3.44	2.94	2.87	2.89
Region	3.72	3.71	3.62	3.48	3.43	3.36	3.49	3.45	3.28	3.36	3.33	3.28	3.11	3.05	2.56	2.77
Continent	3.70	3.65	3.55	3.45	3.35	3.20	3.36	3.31	3.01	3.10	2.88	3.01	2.86	2.82	2.44	2.68

[a] Annual indices are unreliable due to small sample size.

[b] Insufficient data.

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Table 2. Continued.

State, Province or Region	Year																
	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Eastern Region																	
CT[a]	1.36	1.18	1.71	0.81	2.01	0.85	0.76	0.81	0.55	0.45	0.57	0.76	0.70	0.61	0.59	1.65	0.83
DE[a]	0.93	1.01	--[b]	--	--	--	2.60	1.17	0.87	--	--	--	2.59	2.59	5.12	1.50	3.24
ME	3.56	3.61	3.75	4.09	3.85	3.98	2.72	3.40	2.88	3.09	2.71	2.93	2.19	2.52	2.32	2.96	2.92
MD	1.02	1.01	0.86	0.58	0.64	0.72	0.53	0.46	0.16	0.29	0.32	0.17	0.21	0.21	0.13	0.13	0.23
MA	2.46	1.92	1.96	2.05	2.03	1.58	1.44	1.72	1.42	1.19	1.34	0.99	1.25	1.33	1.23	1.95	1.33
NB	3.55	3.69	3.23	3.82	4.06	5.27	4.16	3.95	3.79	5.06	5.01	4.19	3.47	4.37	3.59	4.77	3.96
NH	2.62	2.78	4.71	3.35	3.36	3.45	2.97	4.03	2.34	2.88	2.52	4.68	3.78	4.10	3.74	4.01	3.23
NJ	2.42	1.74	1.66	1.88	1.44	1.32	0.89	0.79	0.63	0.62	0.29	0.67	0.59	0.16	0.51	0.45	0.38
NY	2.76	3.51	2.98	2.74	3.18	2.47	2.96	3.22	2.73	2.24	2.24	2.38	2.18	2.19	2.24	2.21	1.98
NS	2.23	2.22	2.61	2.33	2.52	2.72	1.88	2.22	2.48	2.65	2.07	2.51	2.50	1.96	2.19	2.39	2.93
PA	1.84	1.42	1.64	1.54	1.53	1.13	1.42	1.60	1.15	1.33	0.64	1.23	0.99	0.96	0.95	0.79	0.53
PEI[a]	3.79	2.80	3.68	2.58	4.11	3.95	3.23	2.42	2.40	2.31	2.37	2.75	3.13	2.72	2.87	2.53	2.84
QUE[a]	2.87	3.56	3.44	3.63	3.18	3.99	3.17	3.80	3.39	4.05	3.14	3.82	1.40	2.70	2.90	3.67	2.81
RI[a]	1.58	0.53	0.53	--	0.79	0.79	--	0.12	--	--	--	--	--	0.04	--	--	--
VT	2.54	2.00	2.52	2.68	3.18	2.92	2.77	2.72	1.75	1.82	1.84	2.09	1.57	2.02	2.29	2.14	3.00
VA	1.72	0.87	0.89	0.92	0.66	0.62	0.58	0.57	0.47	0.51	0.42	0.34	0.30	0.36	0.27	0.26	0.24
WV	1.00	0.95	0.91	1.05	0.83	0.87	0.92	0.85	0.84	0.76	0.64	1.14	0.73	0.80	0.67	0.71	0.76
Region	2.45	2.34	2.38	2.41	2.34	2.28	2.10	2.30	1.97	2.07	1.72	2.10	1.58	1.78	1.74	1.89	1.68
Central Region																	
IL	0.30	0.52	0.42	0.60	0.56	0.65	0.53	0.81	0.93	1.14	1.10	1.04	2.57	1.15	--	1.51	4.74
IN	0.73	0.60	0.81	0.59	0.58	0.56	0.64	0.67	0.59	0.55	0.50	0.53	0.42	0.34	0.69	0.45	0.38
MB	--	--	--	--	--	--	--	--	2.34	4.16	2.24	2.44	2.31	1.28	1.63	1.81	1.88
MI	4.42	4.63	4.72	4.36	4.73	4.55	4.45	5.25	3.75	3.76	3.44	3.73	3.53	3.44	4.09	3.31	3.37
MN	2.99	3.57	3.75	3.58	4.00	3.53	4.00	3.75	3.15	3.37	2.97	3.31	2.99	2.53	3.17	3.17	3.45
OH	1.60	1.39	1.09	1.19	1.44	0.99	1.37	1.04	0.93	0.97	0.81	0.81	0.85	0.66	0.70	0.59	0.65
ON	4.83	4.93	4.91	5.12	5.05	5.39	5.07	5.03	4.85	4.39	3.83	4.82	3.54	4.10	4.16	4.12	4.60
WI	3.16	2.92	3.42	3.40	3.41	3.15	3.08	3.09	2.46	2.44	2.30	2.29	2.41	2.30	2.21	2.55	2.53
Region	2.68	2.87	2.87	2.88	2.88	2.74	2.76	2.89	2.45	2.61	2.26	2.41	2.43	1.95	2.36	2.21	2.23
Continent	2.57	2.60	2.63	2.65	2.61	2.52	2.43	2.61	2.23	2.36	2.00	2.28	2.00	1.89	2.06	2.08	1.98

[a] Annual indices are unreliable due to small sample size.

[b] Insufficient data

Table 3. Distribution of hunters contacted and hunters who submitted woodcock wings in the 1999-00 Wing-collection Survey.

State of residence	No. of hunters Contacted	No. of hunters who submitted wings	Percent who submitted wings
AL	24	0	0
AR	16	0	0
CT	133	21	16
DE	17	1	6
FL	81	0	0
GA	67	3	4
IL	101	9	9
IN	70	11	16
IA	48	4	8
KS	13	0	0
KY	27	4	15
LA	143	19	13
ME	210	98	47
MD	63	7	11
MA	246	47	19
MI	530	281	53
MN	364	114	31
MS	11	0	0
MO	97	10	10
NE	24	0	0
NH	112	60	54
NJ	102	18	18
NY	317	96	30
NC	73	9	12
ND	6	0	0
OH	125	25	20
OK	26	1	4
PA	340	77	23
RI	24	3	13
SC	53	6	11
TN	60	3	5
TX	54	0	0
VT	116	66	57
VA	93	17	18
WV	22	5	23
WI	657	239	36
Total	4,465	1254	28

Table 4. Numbers of woodcock wings received from hunters, and indices of recruitment. Recruitment indices for individual states were calculated as the ratio of immatures per adult female. The regional indices for 1999 were calculated as the average of the state values, adjusted for comparability with the 1963-98 average. Recruitment indices were not calculated for states where the sample of wings was <125.

State or Region of harvest	Wings received						Recruitment index	
	Total		Adult females		Immatures			
	1963-98	1999	1963-98	1999	1963-98	1999	1963-98	1999
Eastern Region								
CT	12,917	64	2,867	8	7,915	47	2.8	
DE	410	1	54	0	287	1	5.3	
FL	660	0	150	0	410	0	2.7	
GA	2,902	11	892	4	1,262	4	1.4	
ME	70,406	830	20,682	276	35,300	365	1.7	1.3
MD	3,739	36	930	10	2,100	14	2.3	
MA	18,390	319	5,515	107	9,203	114	1.7	1.1
NH	25,557	558	8,271	195	11,822	231	1.4	1.2
NJ	23,927	158	5,538	56	14,110	67	2.5	1.2
NY	49,146	905	16,155	364	23,020	305	1.4	0.8
NC	2,825	44	819	21	1,415	16	1.7	
PA	26,454	350	8,280	137	12,372	127	1.5	0.9
RI	2,215	8	414	1	1,500	4	3.6	
SC	2,103	70	629	24	1,030	26	1.6	
VT	18,797	519	5,978	179	8,862	219	1.5	1.2
VA	3,495	179	803	55	2,084	79	2.6	1.4
WV	5,030	40	1,529	13	2,556	19	1.7	
Region	268,973	4,092	79,506	1,450	135,248	1,638	1.7	1.1
Central Region								
AL	910	0	243	0	425	0	1.7	
AR	510	0	163	0	207	0	1.3	
IL	1,223	23	273	6	701	9	2.6	
IN	6,471	77	1,592	35	3,662	22	2.3	
IA	862	16	294	2	380	8	1.3	
KS	44	0	9	0	22	0	a	
KY	925	23	220	5	482	9	2.2	
LA	28,008	236	6,259	59	18,218	135	2.9	2.3
MI	93,112	2,464	29,871	934	47,058	986	1.6	1.1
MN	26,145	861	8,788	312	11,939	312	1.4	1.0
MS	1,716	0	486	0	875	0	1.8	
MO	2,577	27	626	13	1,302	10	2.1	
NE	10	0	4	0	5	0	a	
OH	12,953	263	3,907	100	6,188	99	1.6	1.0
OK	161	5	37	1	84	1	2.3	
TN	955	5	233	2	492	2	2.1	
TX	945	0	239	0	488	0	2.0	
WI	58,289	1,654	18,839	599	28,675	645	1.5	1.1
Region	235,816	5,654	72,083	2,068	121,203	2,238	1.7	1.2

Table 5. State and regional indices of daily and seasonal woodcock hunting success in 1998 and 1999. State and regional indices were calculated for states represented by $\geq$10 hunters who participated in the Wing-collection Survey both years. Regional indices were weighted as described by Clark (1970).

State of harvest	No. of successful hunters	No. of successful hunts		Woodcock bagged		Woodcock per successful hunt		Woodcock per season	
		1998	1999	1998	1999	1998	1999	1998	1999
Eastern Region									
CT	1	1	1	3	1				
GA	2	4	6	4	10				
ME	11	42	40	82	83	2.0	2.1	7.5	7.5
MD	4	5	10	9	19				
MA	4	12	11	24	20				
NH	7	46	35	94	78				
NJ	3	8	9	14	22				
NY	14	62	71	122	134	2.0	1.9	8.7	9.6
NC	5	19	22	35	32				
PA	45	119	112	224	213	1.9	1.9	5.0	4.7
RI	1	2	3	3	4				
SC	2	15	17	33	40				
VT	6	24	27	42	51				
VA	8	37	59	87	143				
WV	1	11	8	20	20				
Region	114	407	431	796	870	1.9	2.0	7.2	7.4
Central Region									
IL	2	7	6	15	10				
IN	8	36	27	64	57				
KY	3	7	6	14	7				
LA	15	92	89	231	214	2.5	2.4	15.4	14.3
MI	218	1,298	1,048	2,732	2,101	2.1	2.0	12.5	9.6
MN	75	359	329	768	661	2.1	2.0	10.2	8.8
MO	6	23	11	43	20				
OH	13	63	80	124	202	2.0	2.5	9.5	15.5
TN	3	21	5	56	5				
WI	130	568	555	1,174	1,119	2.1	2.0	9.0	8.6
Region	473	2,474	2,156	5,221	4,396	2.1	2.1	11.3	10.0

Appendix 1. History of framework dates, season lengths, and daily bag limits for woodcock in the Eastern and Central Regions, 1918-99.

	Eastern Region				Central Region		
Year (s)	Outside dates	Season length	Daily bag limit	Year (s)	Outside dates	Season length	Daily bag limit
1918-26	Oct. 1 - Dec. 31	60	6	1918-26	Oct. 1 - Dec. 31	60	6
1927	Oct. 1 - Dec. 31	60	4	1927	Oct. 1 - Dec. 31	60	4
1928-39	Oct. 1 - Dec. 31	30	4	1928-39	Oct. 1 - Dec. 31	30	4
1940-47	Oct. 1 - Jan. 6	15	4	1940-47	Oct. 1 - Jan. 6	15	4
1948-52	Oct. 1 - Jan. 20	30	4	1948-52	Oct. 1 - Jan. 20	30	4
1953	Oct. 1 - Jan. 20	40	4	1953	Oct. 1 - Jan. 20	40	4
1954	Oct. 1 - Jan. 10	40	4	1954	Oct. 1 - Jan. 10	40	4
1955-57	Oct. 1 - Jan. 20	40	4	1955-57	Oct. 1 - Jan. 20	40	4
1958-60	Oct. 1 - Jan. 15	40	4	1958-60	Oct. 1 - Jan. 15	40	4
1961-62	Sep. 1 - Jan. 15	40	4	1961-62	Sep. 1 - Jan. 15	40	4
1963-64	Sep. 1 - Jan. 15	50	5	1963-64	Sep. 1 - Jan. 15	50	5
1965-66	Sep. 1 - Jan. 30	50	5	1965-66	Sep. 1 - Jan. 30	50	5
1967-69	Sep. 1 - Jan. 31	65	5	1967-69	Sep. 1 - Jan. 31	65	5
1970-71	Sep. 1 - Feb. 15	65	5	1970-71	Sep. 1 - Feb. 15	65	5
1972-81	Sep. 1 - Feb. 28	65	5	1972-90	Sep. 1 - Feb. 28	65	5
1982	Oct. 5 - Feb. 28	65	5	1991-96	Sep. 1 - Jan. 31	65	5
1983-84	Oct. 1 - Feb. 28	65	5	1997	[*]Sep. 20 - Jan. 31	45	3
1985-96	Oct. 1 - Jan. 31	45	3	1998	[*]Sep. 19 - Jan. 31	45	3
1997-99	Oct. 6 - Jan. 31	30	3	1999	[*]Sep. 25 - Jan. 31	45	3

[*] Saturday nearest Sep. 22.

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