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Surveys of breeding waterfowl in southern Ontario, 1971–87

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Introduction

The Canadian Wildlife Service (CWS) began surveys of breeding waterfowl in southern Ontario in 1951. Early surveys (e.g., Stirrett 1952) were largely exploratory and did not determine what was happening to duck populations or segments of duck populations. Those surveys, for the most part, covered wetland units rather than blocks of countryside. However, surveys that cover blocks of countryside are especially important in areas such as Ontario, because of varied habitat types and conditions across the province and because much of the population of many duck species is produced in beaver ponds, a transient but extremely important production habitat.

As reported in Dennis (1974), CWS began operational surveys in Ontario south of latitude 46°15′ N in 1971. These were designed to yield a valid breeding-pair index for certain species, and thus provide a benchmark against which to measure trends in population.

The purpose of this paper is to discuss these surveys and the trends in the populations of several species of waterfowl between 1971 and 1987.

Methods

Although survey methods were completely described in Dennis (1974), a brief review is in order. Southern Ontario was divided into two strata based on Mallard (*Anas platyrynchos*) kill locations obtained from the CWS Species Composition Survey for the 1967, 1968, and 1969 hunting seasons. The stratum with high-density wing receipts (H) was considered to represent good-quality habitat, whereas the other, with lower-density receipts (L), should generally represent a lower quantity and perhaps quality of waterfowl production habitat per unit of area. Plots were established on the two strata using a randomly placed grid such that L was sampled at about one-sixth the intensity of H — 74 and 416 plots respectively. Plots were each 0.8 km × 0.8 km, and many were slightly relocated to be adjacent to a road. Figure 1 illustrates the distribution of the plots in the two strata. When surveying plots, a team of observers drove to the boundary of the plot and conducted a detailed check of potential waterfowl habitat, identified on an Ontario Ministry of Natural Resources vertical aerial photograph of the area, walking to and through any potential waterfowl habitat. The observers used a canoe to check water areas they could not reach on foot. Time to survey a plot normally averaged one hour. The surveys were timed to coincide, as far as possible, with the early nesting season of Mallards and Black Ducks (*Anas rubripes*), as described in Dennis (1974). Waterfowl were recorded as pairs, lone males, lone females or flocks (groups of two or more birds of the same sex and species or three or more birds of the same or different species). Table 1 shows the number of plots surveyed each year during 1971, 1972, 1974, 1976, 1981, 1982, 1985, and 1987. Variations in numbers from year to year are largely a factor of accessibility, except for 1974, when two teams of observers conducted repeat observations on fewer plots. After the 1971 survey it became obvious that there were too many in the H stratum for the available observers; therefore, every third plot was not surveyed in subsequent years. In 1971, 1972, 1976, 1981, 1985, and 1987, 266 identical plots were surveyed in the H stratum, and 64 identical L plots were surveyed in 1971, 1982, 1985, and 1987.

Table 1
Number of plots completed in each year

Year	1971	1972	1974	1976	1981	1982	1985	1987
Plots completed	463	280	131	280	280	69	349	349

The mathematical analysis has been described in detail in various publications (Geissler and Noon 1981, Geissler 1984, Collins and Wendt, unpubl.). Let y_{ij} denote the j^{th} observation taken on plot i, and x_{ij} denote the year this observation was taken. The y_{ij} is transformed to:

$$Z_{ij} = \log 10\ (y_{ij} + 0.23)$$

This transformation was used because, first, the counts were only an index to the population, hence absolute changes in the index could not be interpreted as relative changes and, second, trends probably affect some rather than all of the population (Geissler and Noon 1981). These considerations suggest that a multiplicative model would be a suitable base for interpreting the data. A log transform converts a multiplicative model to a linear model, which is easier to manipulate since closed-form expressions for the solution are available. A constant number (0.23) was added to each value since there were many observed values of zero that could not be log transformed. The value 0.23 was chosen because the bias introduced by this value was less than 5% under a variety of simulated trends (Collins and Wendt, unpubl.)

A simple linear regression of z_{ij} against time was done separately for each plot to provide an estimate of trend over time (b_i) for each plot. The overall trend for southern Ontario was calculated as a weighted average of the individual plot trends:

$$b = \frac{\sum_{i=1}^{n} w_i\, b_i}{\sum_{i=1}^{n} w_i}$$

where w_i denotes the weight given to plot i, and n the number of plots in the stratum. The weighting factor is a product

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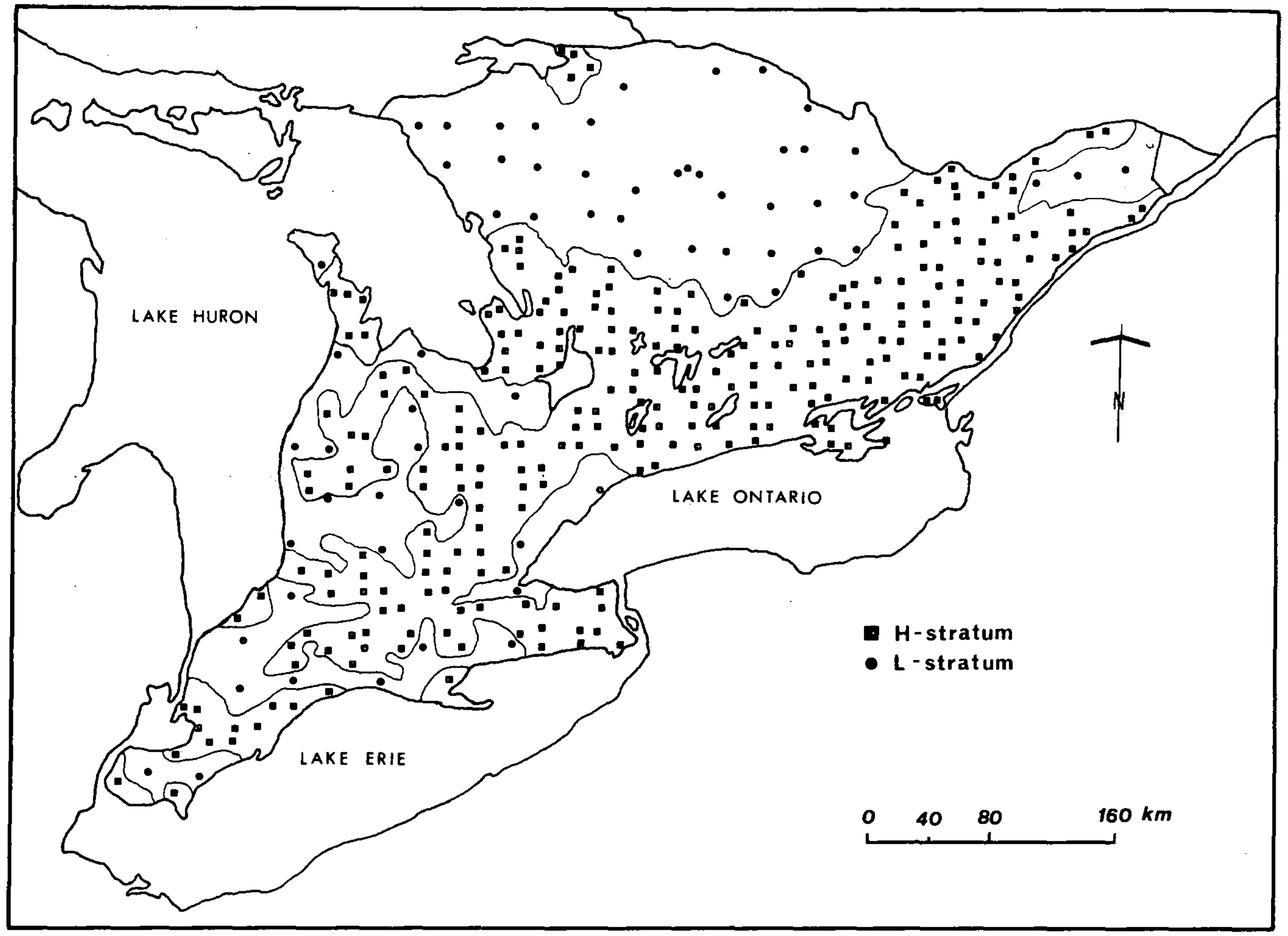
Figure 1
Plot and stratum locations in southern Ontario



of two terms — a measure of the precision of the estimate of trend and a measure of the average index value on the plot.

The precision of the estimate of trend is a function of the number of counts on the plot and the time between them. The first term in the weighting factor gives greater weight to those estimates that have more observations or are more spread out over the period of the survey. The factor used to weight for the precision of the estimate was

$$\sum_{j=1}^{m_i} (x_{ij} - \bar{x}_{i.})^2$$

where $\bar{x}_{i.}$ is the average of the m_i years plot i was measured. A given change in the population of waterfowl along a plot is of more concern in high-density than in low-density areas. The second term in the weighting factor, the predicted value for the index at the mid-range of the years of the survey, gives greater weight to those areas with a larger population of waterfowl.

Occasionally very large numbers of non-nesting waterfowl are observed on a survey plot in a staging area for migration. These large counts can distort the measurements of trend. To reduce this problem, all counts greater than 50 birds were reduced to 50 (i.e., winsorized at 50). The same procedure was followed for the second term of the weighting factor, the predicted count at midyear.

The significance of the estimate of trend was assessed using a permutation test (Collins and Wendt, unpubl.). In this procedure, the hypothesis that there had been no trend is tested by randomly rearranging the observations within each plot. The proportion of times the randomized estimate is larger than the observed estimate measures the probability that the observed trend could have arisen if the year-to-year differences in count had been due solely to random errors.

Results and discussion

Table 2 shows the number of potential breeding pairs for the major species as determined from 266 survey plots in the H stratum and for 64 plots in the L stratum during 1971–87.

Table 3 shows the estimated waterfowl population trends between 1971 and 1987. The trends in Table 3 are based on data gathered over a relatively long time over a large area of production habitat. Similar data are not available for other large areas of eastern North America.

A number of factors must be considered when assessing the results of the trend analysis. First, considering that the survey has been conducted over 17 years, there has been fair consistency of observers. Two of the crew leaders (DGD and GBM) have been present for all surveys, while the third (NRN) missed only 1971 and 1972. As for assistants, seven participated

Table 2
Potential number of breeding pairs on 266 plots in H stratum and 64 plots in L stratum

		Species					
Year	Stratum	Mallard	Black Duck	Mallard with Black Duck	Green-winged Teal	Wood Duck	Canada Goose
1971	H	185	54	1	45	24	7
1971	L	10	10	0	3	5	0
1972	H	236	49	1	42	22	2
1976	H	248	40	2	12	62	6
1981	H	278	17	5	15	81	11
1982	L	31	3	2	0	15	0
1985	H	330	18	1	11	65	20
1985	L	23	4	1	0	14	1
1987	H	345	14	0	9	88	30
1987	L	22	6	0	3	7	2

for two surveys, one for four years; all others were present for one year.

The study period encompassed the rapid conversion in southern Ontario from mixed farming to grain farming during the 1970s as a result of high world grain prices, which led to some destruction of habitat. We suspect, however, that much of the habitat destroyed was of marginal quality for breeding waterfowl and that the expansion of grain farming during the 1970s had little impact on the capacity of southern Ontario to produce waterfowl. Most of the destruction of production areas in agricultural southern Ontario probably occurred during earlier periods of agricultural expansion.

Our breeding-pair survey apparently subtends the major area in eastern North America where the fastest change in Black Duck abundance occurred during the study period. Trend analysis in Table 3 suggests that the population is decreasing by half in 11 years. In absolute numbers, Black Ducks declined from 93 to 26 on plots surveyed in both 1971 and 1987. General observations during the surveys suggest that habitat available for Black Ducks, especially beaver ponds, improved over the study period. These observations are supported by surveys by GBM (in prep.) that found that beaver ponds on the study plots had increased from 146 totalling 558.1 ha in 1981–82 to 158 totalling 590.5 ha by 1987.

We believe that hybridization with Mallards is the single factor most responsible for the decrease in Black Ducks — a hypothesis discussed in detail by Ankney *et al.* (1987). Despite the high rate of Mallard expansion in Ontario (the trend analysis indicates a population doubling in 43 years), continental Mallard populations have declined significantly. According to Durham (1985), the continental Mallard population declined from 9 845 000 in 1971 to 5 475 000 in 1985. By 1987 it had recovered slightly to 6 691 000 (Durham 1987).

As for the decreasing trend in Green-winged Teal (*Anas crecca*) numbers, midwinter inventory figures for the Atlantic Flyway suggest a decline from 1971 to 1987, although the trend is rather erratic. Numbers counted in the flyway in January 1971 were 107 200; in January 1988 they were 60 900. These data are similar to the trend in breeding pairs in the survey plots, where the population shows a half-life of 19 years.

The majority of the breeding Wood Ducks (*Aix sponsa*) in Ontario occur in the area in which the plots were located. For

Table 3
Estimated trends[a] in southern Ontario waterfowl 1971–87: species ranked from greatest rate of increase to greatest rate of decrease

Species	Number of plots used in analysis	Total birds observed	Total birds observed winsorized at 50	Estimate of trend
Canada Goose	52	1 575	575	0.0225 (d13)[b]
Wood Duck	132	754	754	0.0171 (d17)[b]
Mallard	267	3 034	2 879	0.0071 (d43)[b]
Common Goldeneye	21	133	114	−0.0043 (h69)
Common Merganser	26	341	329	−0.0046 (h65)
Ring-necked Duck	34	203	203	−0.0069 (h43)
Blue-winged Teal	114	958	953	−0.0087 (h34)
Green-winged Teal	63	290	290	−0.0157 (h19)[b]
Black Duck	108	454	454	−0.0269 (h11)[b]
All ducks	298	6 167	5 853	0.0033 (d92)

[a] The estimate of trend is the slope of the trend across time on the log scale. The number in parentheses denotes the corresponding time to decline by one-half (h) or to double (d) in years.
[b] Significant ($p \leq 0.05$).

that reason, the increasing number of Wood Ducks should be directly correlated with a change in kill. According to the CWS harvest survey, the 1971 kill was 81 587, while the kill in 1987 was 115 380. The trend in kill probably under-represents the increase in the Ontario breeding population, because the kill of Wood Ducks in Ontario includes a rather large portion of moult migrants (largely adult males) from the U.S., which distorts the local stock at risk. The trend analysis suggests that Wood Ducks breeding in southern Ontario double in 17 years.

Species such as the Ring-necked Duck (*Aythya collaris*), Common Merganser (*Mergus merganser*), and Common Goldeneye (*Bucephala clangula*) were mostly found in a few plots on the northern boundary of the survey area. Thus, the lack of clear trends in their numbers is not surprising.

The plot surveys were designed to survey early nesters such as Mallards, Black Ducks, Green-winged Teal, and Wood Ducks. Blue-winged Teal (*Anas discors*), as well as Ring-necked Ducks, are late nesters; therefore, they may have been sampled erratically, subject to variations in the proportion that had returned to the vicinity of breeding locations at the time of the survey.

When the surveys were designed there was little thought that they might be useful for Canada Geese, which in 1970 did not commonly nest in the survey area. However, the plots covered the entire area in which Giant Canada Geese (*Branta canadensis maxima*) were expanding in southern Ontario. The sample plot analysis suggests that the population doubles every 13 years; independent CWS surveys of Giant Canada Geese in southern Ontario suggest that numbers increased from 19 285 in August 1977 to more than 61 610 in August 1986.

Ross *et al.* (1984) published results of the plot surveys for 1971–76 with emphasis on Mallards, Black Ducks, Wood Ducks, Blue-winged Teal, and Green-winged Teal. The trends to 1987 continue those forecast by Ross, with the exception of Blue-winged Teal. As mentioned earlier, the surveys occur too early to adequately sample Blue-winged Teal, and thus may be a measure more of the timing of migration than of population changes. The decreasing trend may represent reductions in the prairie populations rather than those in Ontario.

Due to concerns about the status of Black Ducks, these surveys may be repeated at more regular intervals in future. The authors see little reason for present population trends to change in the foreseeable future, except perhaps that the rate of decrease of Black Ducks may be slowed by restrictive hunting regulations established in Canada and the U.S. in the mid 1980s.

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