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Prairie Dabbling Ducks, 1941–1990

by Hugh Boyd[1]

Introduction

In an attempt to define the principles, objectives and goals of waterfowl management in Canada, the Canadian Wildlife Service (CWS), with the provincial and territorial wildlife agencies, developed a draft Waterfowl Management Plan for Canada. CWS distributed the plan for public comment in June 1980.

Two objectives that are included in the draft plan prompted the study reported here:

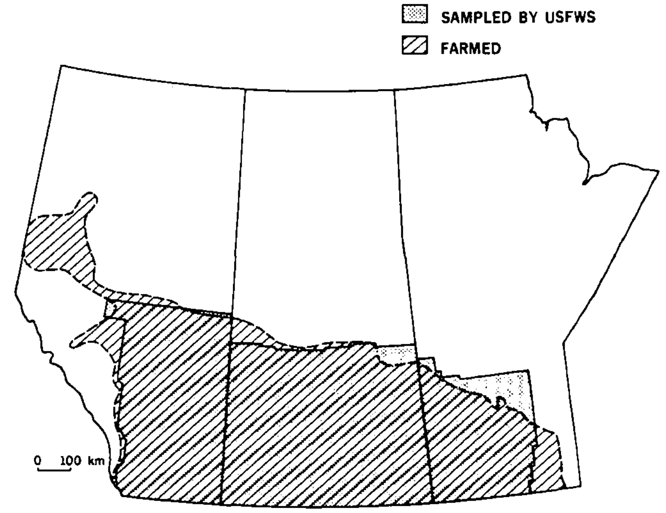
1. To maintain or attain waterfowl populations at desired levels and ensure that no waterfowl species or closely definable population becomes threatened or endangered as the result of human actions;
2. To determine the major environmental factors regulating populations and levels of sport and subsistence harvest which can be maintained and which will ensure sustained populations.

Among the studies most needed if those objectives are to be met is a study of the status of ducks in the southern parts of Alberta, Saskatchewan and Manitoba. That area, to be referred to here as the "prairies", is critical as it harbours a large proportion of the breeding ducks of North America. This report looks at dabbling duck populations on the prairies in the last 40 years and projects population trends for the next 10 years.

Each year since 1955 the US Fish and Wildlife Service (USFWS) has flown extensive sample surveys over much of Canada and the northern states to obtain indices of the size of duck populations in May and of the production of young in early July. Benning (1976) recently described the survey procedures and Bowden (1974) and Martin, Pospahala and Nichols (1979) have discussed reliability of the results. I take the results as given and use them to examine what has happened to the populations of seven species of dabbling ducks, the Mallard *Anas p. platyrhynchos*, Gadwall *A. strepera*, American Wigeon *A. americana*, Green-winged Teal *A. crecca carolinensis*, Blue-winged Teal *A. discors*, Northern Shoveler *A. clypeata* and Pintail *A. a. acuta*. Here I consider the entire prairies as a unit (Fig. 1), comprising aerial survey strata 26–29 in Alberta, 30–35 in Saskatchewan and 36–40 in Manitoba.

There are, of course, many ecological subdivisions within that very large area of 55.5 million ha, but the internal differences are less than those between the prairies and the areas farther north. The segregation of the northcentral states is less justified on ecological grounds, but our immediate concern is a national one.

Figure 1
Alberta, Saskatchewan and Manitoba, showing areas sampled by the USFWS aerial surveys and areas farmed.



In looking at what may influence the size and success of the dabbling duck population, I have concentrated on climate and on agricultural changes in the landscape. I shall not discuss the effects of agriculture because, surprisingly, they have been hard to detect at the macroscopic level. And I reduce the climatic effects to a single parameter, conserved soil moisture, developed by Williams and Robertson (1965) for the purpose of estimating prairie wheat production from precipitation data. Their annual estimator, developed on the basis of empirical studies of soil moisture at Swift Current, southern Saskatchewan by Staple and Lehane (1952), is a form of weighted mean of precipitation in the 21 months preceding 1 May. It gives more weight to precipitation in fall and winter than in summer, even though most rain falls in the prairies in the summer, because rainfall during the growing season contributes relatively little to persistent soil moisture.

The use of soil moisture as an index of habitat conditions seems plausible; and statistically, I have found a far better fit between duck numbers and soil moisture than with the numbers of ponds estimated during the aerial surveys, which have been used previously (e.g. Brown, Hammack and Tillman 1976; Crissey 1969; Geis, Martinson and Anderson 1969; and Henny, Anderson and Pospahala 1972). That is a convenient finding, because the pond counts, like the duck counts, date only from 1955 whereas weather records are available over much longer periods.

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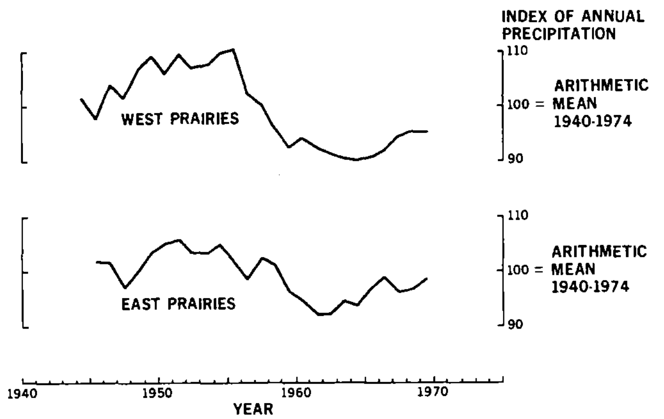
I concentrated upon rainfall after seeing the precipitation trends in the prairies given by Thomas (1975, Fig. 2). Those trends suggested that living should have been easier for prairie ducks in the 1940s and 1950s than since. Technically, they also suggested that a picture based on data from a few representative weather stations (Thomas used three airports each in the west and east) might be sufficient for a first approximation to regional fluctuations.

Figure 2
District trends in annual precipitation in the prairies, 1940–1974. West prairies based on data from Calgary, Edmonton and Medicine Hat airports; east prairies from Regina, Saskatoon and Winnipeg airports. Decadal moving averages with values credited to the midpoint in each decade (Thomas 1975).



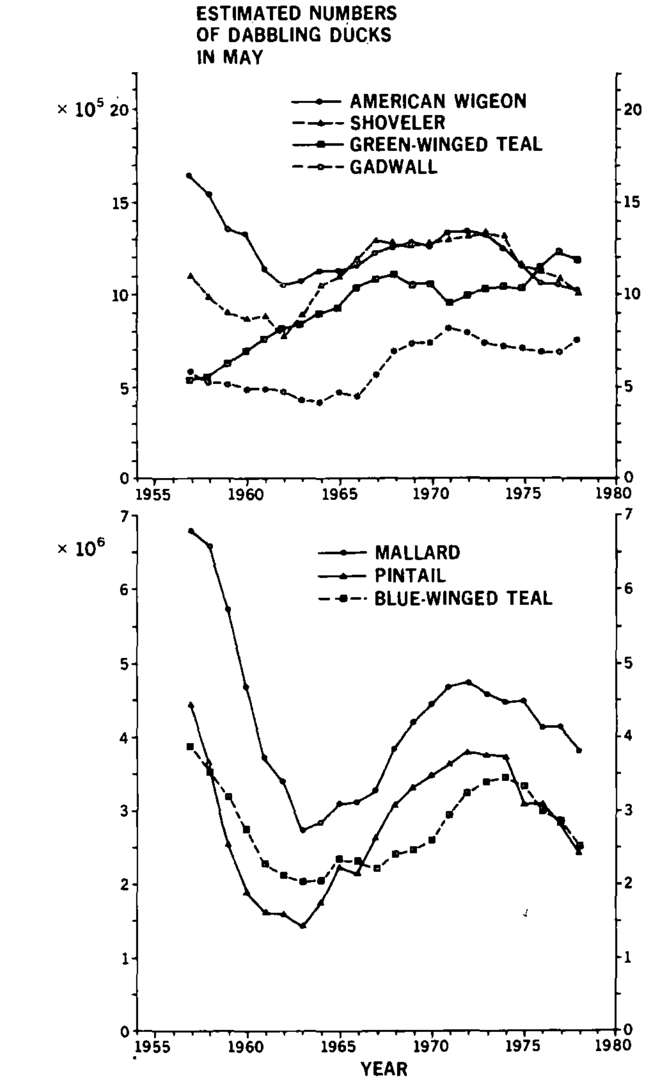
Results

In looking at population changes between 1955 and 1980, it is helpful to smooth out some of the year-to-year variations (few of them likely to be significant) by means of moving averages. Using 5-year means, we find that six of the seven species decreased during the period 1955–1964, the Mallard and Pintail most dramatically (Fig. 3). In the late 1950s and early 1960s Gadwall numbers increased while those for the other six species decreased, but by the late 1960s and early 1970s, Gadwall fell somewhat while five of the other species increased.

Patterson (1979) showed that the species showing the most dramatic change in population size were *r* strategists, in terms of *r*-*K* theory, with high reproductive potential and catholic habitat requirements, so able to react quickly to occupy available breeding habitat. He suggested that Gadwall, wigeon and Green-winged Teal were *K* strategists, with more specialized habitat needs.

Pooling the numbers of all seven species and comparing changes in abundance on the prairies with the numbers found elsewhere in the surveyed area (Fig. 4), we see that, in accordance with popular belief, the numbers have fluctuated far more in the prairies than

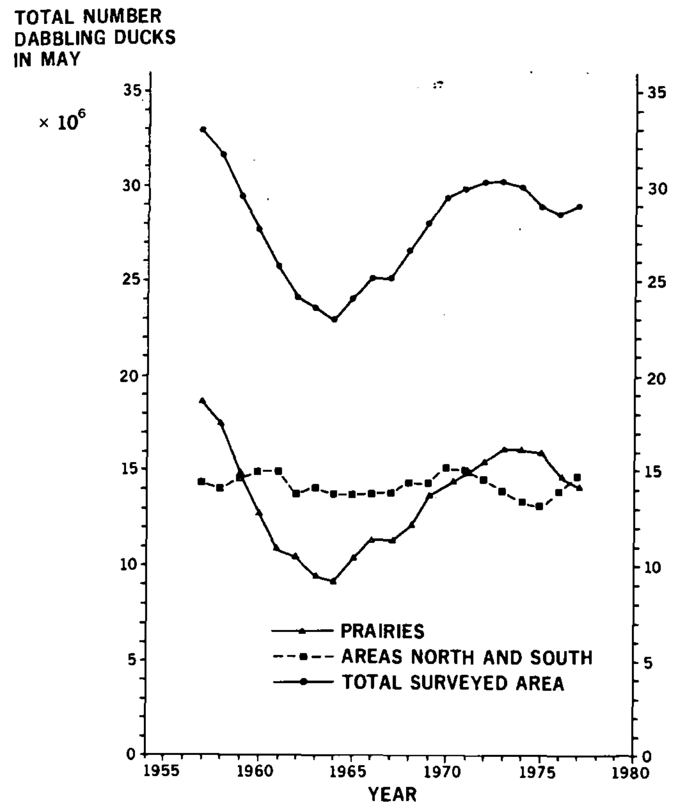
Figure 3
Estimated numbers of seven species of dabbling ducks in May in the Prairies 1955–1980, shown as 5-year moving averages.



outside them. Thus, variations in population numbers on the prairies have a dominant effect on variations in total abundance, even though prairie populations make up only half the total sampled population. (Changes in the northern parts of the western provinces were as great as in the prairies, though far smaller numbers are involved.)

The July surveys provide three types of information about breeding success. The number of early-hatched broods seen and the average size of class II and III broods are straightforward, except that broods often cannot be identified by species so that the index refers to broods of all species, including some early-hatched diving ducks (though the latter are probably too few to have a decisive influence on the number of broods recorded).

Figure 4
Estimated total numbers (in millions) of dabbling ducks in May in the prairies and in areas to the north and south which were included in the aerial surveys, shown as 5-year moving averages for the period 1955–1980.



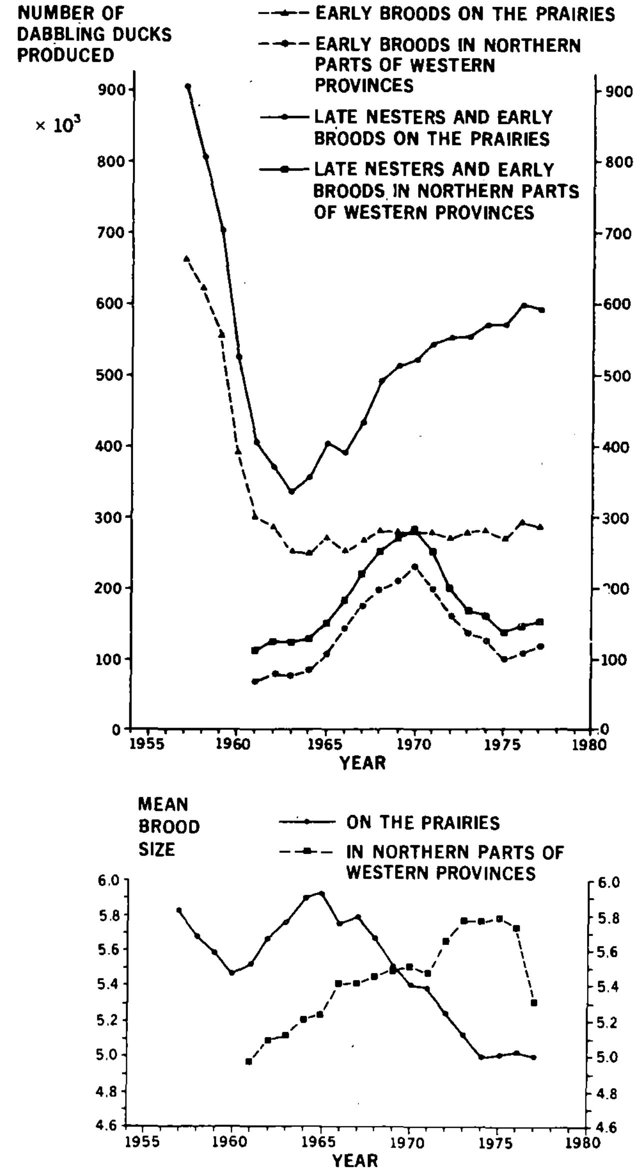
The late-nesting index (LNI) consists of recorded "lone drakes and pairs which by their behaviour indicate they may be in breeding condition" and hence "a crude measure of broods to come" (Benning 1976).

Again using 5-year moving averages in preference to annual values, Figure 5*a* suggests some dramatic changes in the output of young between 1955 and 1980, corresponding to the general change in May numbers (Fig. 4), though with a greater decrease in the first 8 years or so. Thereafter the numbers of early broods have remained remarkably steady, so that the resurgence of total production, if it really exists, must be due almost wholly to increased late nesting by dabbling ducks.

The production curves for the northern parts of the western provinces (Fig. 5*a*) look quite different, starting from a low base in 1959 (data were not collected there between 1955 and 1958), peaking in 1970 and then dropping again, with potential late nesters making up only a small, and not increasing, fraction of production.

Perhaps surprisingly, in view of the steady number of early broods in recent years, the average brood size, after an early decline, rose in the early 1960s but then declined steadily for a decade. It may now have

Figure 5
Indices of production by dabbling ducks in the prairies and in the northern parts of the western provinces: (a) numbers in thousands, of early broods and of late-nesting dabblers and early broods combined; (b) mean brood-size.



settled at around 5.0, appreciably below the values in the earlier years. (Again, in the northern parts of the provinces mean brood size has varied quite differently, tending to increase until very recently.)

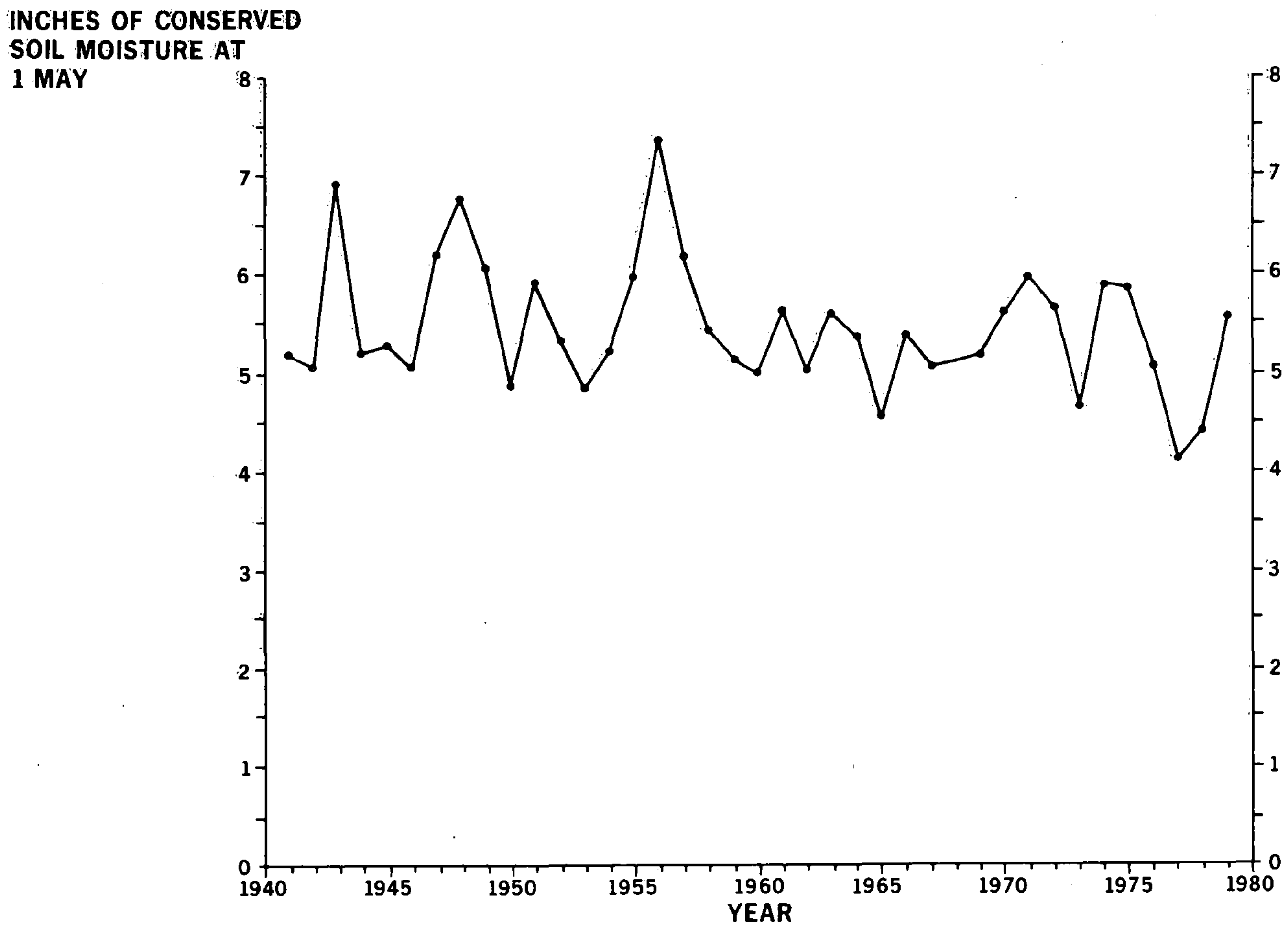
Having earlier announced my intention to ignore man-made landscape changes as an influence on duck population in this paper, and because I have so far been unable to demonstrate their effects, I now turn to the association between my preferred environmental state variable and duck numbers and breeding success.

Following Williams and Robertson (1965), I estimated conserved soil moisture in early May each year from the equation:

$$\hat{M} = 0.36A + [0.37B - 0.2(0.36A)] + 0.13C + \{0.30D - 0.2[0.36A + (0.37B - 0.2(0.36A)) + 0.13C]\},$$

where A = total precipitation during first fall of the summer fallow period (August, September and October in year $t-2$),
B = total precipitation during the first winter of the summer fallow period (November, $t-2$, to April, $t-1$),
C = total precipitation during the summer of the summer fallow period (May to October, $t-1$),
D = total precipitation during the second winter (November, $t-1$, to April, year t).

Figure 6
Estimated conserved soil moisture, in inches, at 1 May, 1941–1979, derived from precipitation records in the preceding 21 months, following Williams and Robertson (1965). These 'prairie' estimates are based on data from Edmonton, Saskatoon and Winnipeg airports.

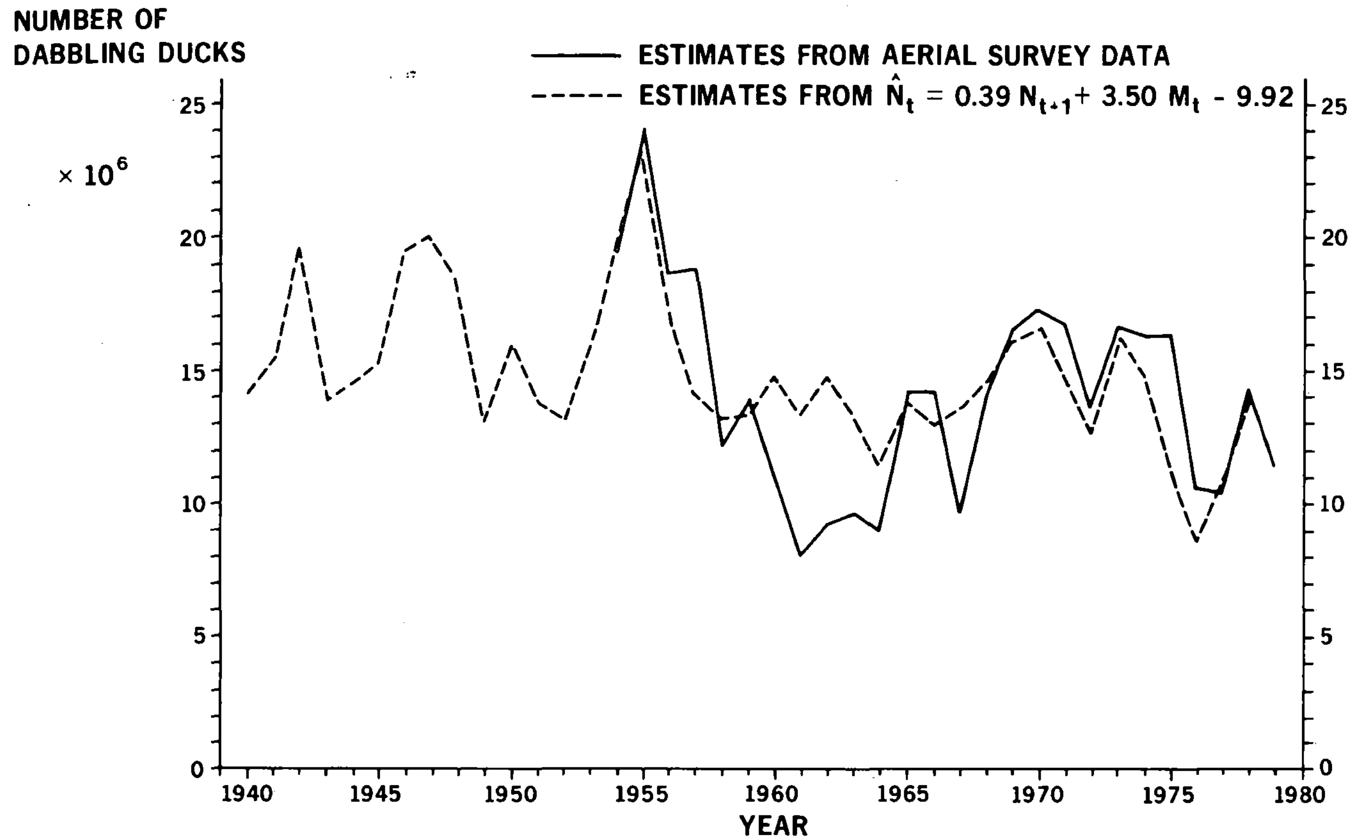


Williams and Robertson used 65 weather stations and some elaborate weighting procedures involving distances from those stations. I have begun with only three stations, though it may prove worthwhile to use a larger system.

Figure 6 shows annual estimates of conserved soil moisture. There are peaks in 1956 (when the duck numbers were by far the highest recorded between 1955 and 1990) and in 1943 and 1948. By contrast the values in 1977 and 1978 were very low, with those of 1965 and 1978 also below any recorded between 1941 and 1954.

There are few significant correlations between May numbers, production indices, May and July ponds and weather variables, with or without lags. Yet N_t is correlated with M_t (coefficient of correlation, $R^2 = 0.544$), almost as highly as the production index

Figure 7
Annual estimates (in millions) of total number of dabbling ducks in the prairies, 1955–1980 from aerial survey data, with estimates for 1941–1978 from retrodictive equation.



Y_t is correlated with N_t ($R^2 = 0.586$); and the regression equation:

[1] $\hat{N}_t = 0.42\ N_{t-1} + 3.33\ M_t - 9.77$

(where N is measured in millions of ducks and M in inches of moisture) has an adjusted R^2 of 0.666. This result encourages the possibility of estimating May duck numbers in the years before 1955, using the available estimates of conserved soil moisture.

For retrodiction, we replace equation [1] by

[2] $\hat{N}_t = 0.39\ N_{t+1} + 3.50\ M_t - 9.92$

(though it may seem odd to use next year's population to estimate this year's).

In Figure 7, the annual estimates of total numbers in May calculated by the USFWS are compared with the numbers calculated from equation [2], running back from 1980. For much of the period the fit is quite good, but equation [2] fails to predict the low 'observed' values in 1961 to 1965, the soil moisture being close to the mean for 1961–1964. That discrepancy requires further investigation, because the early 1960s were the times of lowest output (Fig. 5*a*).

For my immediate purpose, I focus attention on the estimates from 1955 back to 1941. They suggest year-to-year fluctuations no greater than those observed in the 1970s, but about a higher mean ($\overline{N}_{71-80} = 14.44$ million, $s = 2.69$; $\overline{N}_{41-50} = 16.20$ million, $s = 2.57$).

Forecasts for 1981–1990 and discussion

From a management point of view, the most important reason for analysing past trends is to be better able to anticipate future events and needs. It is difficult to predict the numbers of dabbling ducks likely to be found in the prairies during the 1980s from the data that are available because those data are meagre, imprecise, and affected by autocorrelation and collinearity.

While it is not yet possible to produce forecasts in a rigorous way, there are some general considerations that are useful. Two concerns are uppermost. First, are climatic variations likely to produce less favourable conditions for ducks in the 1980s and beyond than

Figure 8
(*a*) Ten-year moving average of mean annual temperature for the prairies south of 55°N, plotted for the last year of the decade (Longley 1972, Fig. 55) and (*b*) ten-year moving average of annual precipitation for the prairie provinces (Hare and Thomas 1974).

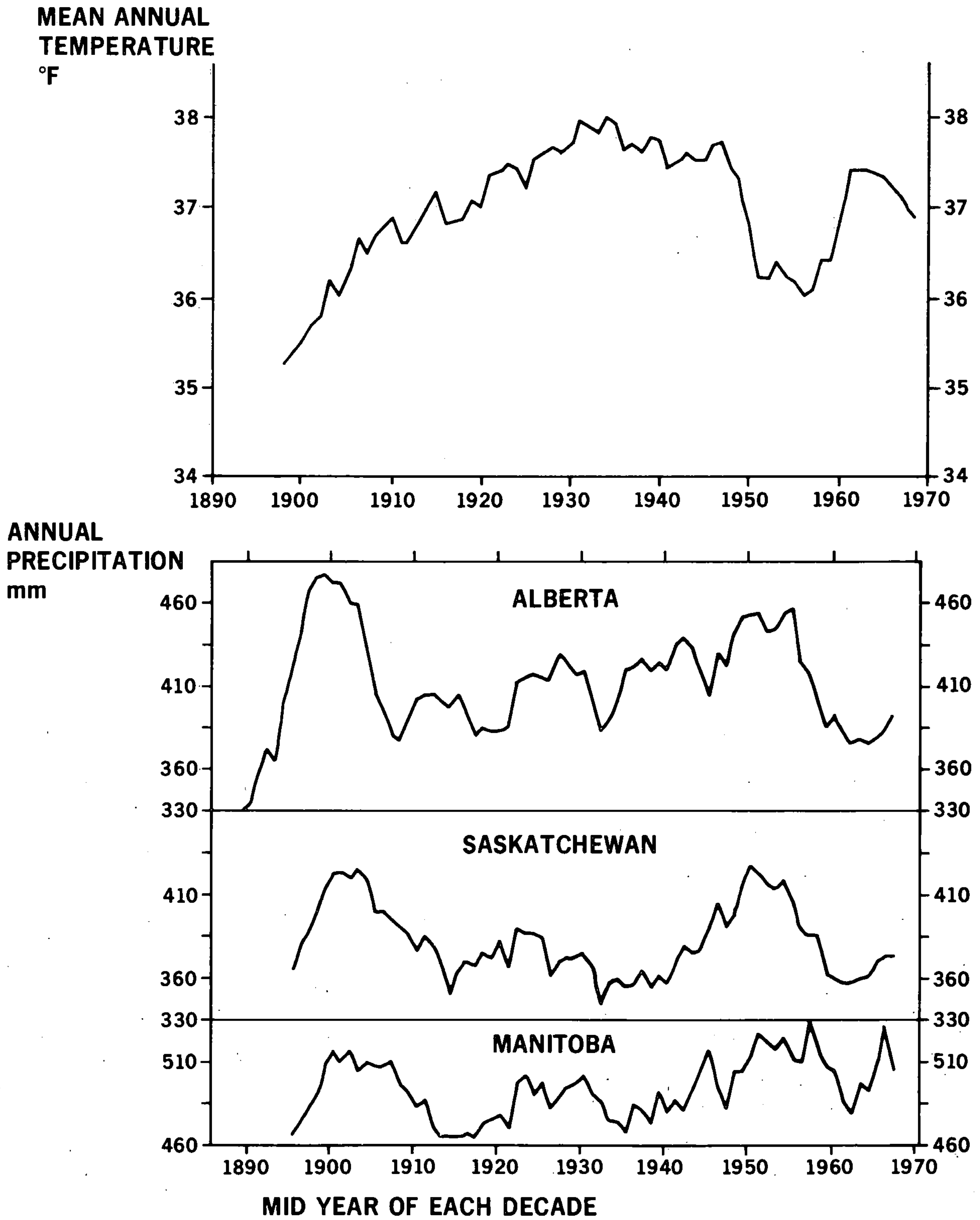
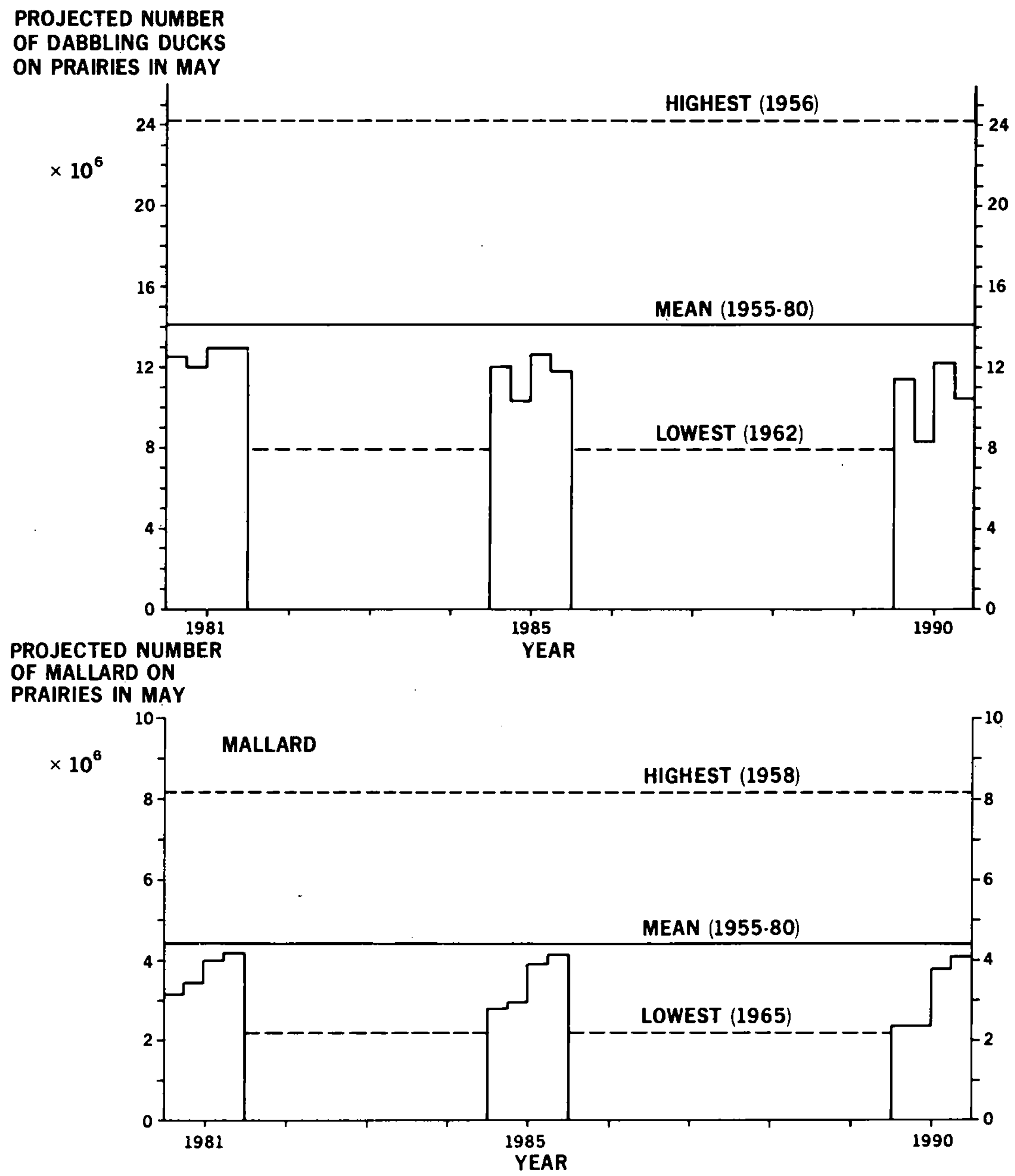


Figure 9
(*a*) Projected total numbers of dabbling ducks in the prairies in May in 1981, 1985 and 1990, compared with mean for the period 1955–1980 and with the highest and lowest estimates recorded in that period. The four projections for each year appear from left to right in the sequence: from time series of numbers for 1955–1980 (1) and for 1969–1980(2); from time series of soil moisture and regression of duck numbers on soil moisture for 1955–1980(3) and for 1969–1980(4).
(*b*) Same as Figure 9*a*, with 'Mallards' substituted for 'dabbling ducks'.



have been encountered in the last 40 years? Second, will human changes to the landscape or attempts to reduce the numbers of ducks override the capacity of the ducks to look after themselves?

The most recent authoritative discussions of climatic variation in the prairie provinces are those of Longley (1972), Hare and Thomas (1974) and Thomas (1975). For our purpose Longley (*loc. cit.*, p. 74) is the most cautiously unhelpful: "... it is not considered possible to forecast with useful skill what the weather will be like in the coming decade."

Figure 5 illustrated precipitation trends since 1941. Figure 8 displays temperature as well as precipitation trends for the prairies since 1880. The 1960s, when the ducks were doing rather poorly, were rather cool and dry. The late 1970s were even drier, though not as harsh as the hot-and-dry 1930s, and we recall the winter drought of 1979–80.

Taking a short view, the early 1980s may be drier yet; the longer view suggests that wetter conditions should return well before 1990. There seems, however, to be no reason to expect an increase in annual temperatures, returning to the regime of the between-war years.

For ducks, as for crops, the effects of runs of dry or wet years are greater than those of a single season. In the prairies, precipitation shows much less persistence than does temperature. Using a 75-year run of data from the Dakotas assembled by Donald Gilman of the U.S. National Weather Service (Roberts and Lansford 1979, Fig. 7, page 136), I found two cases of 3 dry years in a row, only one case of 3 unusually wet years in a row and only three more pairs of successive years unusually wet or dry.

Increased precipitation may not in itself be enough. One possibility that needs further study is that the effects of recent agricultural practices have damaged the capacity of the soil to hold moisture, as well as accelerating run-off, so that more precipitation than formerly may now be needed to produce a given amount of useful moisture.

Looking ahead, destruction of the land may tend to diminish in the near future in favour of zero-tillage and other frugal techniques, because of the greatly increased costs of energy. In this respect the future of summer fallowing may prove crucial. Because it fails to provide good cover, the practice is usually thought of as unhelpful to waterfowl and other wildlife, but continuous cropping might be worse, accelerating soil loss and damage.

Changing land use may turn out to be damaging in other ways, as is evident from local studies showing the filling-in of water bodies or bulldozing of scrub and other cover or the conversion of grasslands to arable land, though many of these changes have proved to be more temporary and reversible than had been feared earlier (Adams and Gentle 1978).

The total numbers of small wetlands, as estimated from the USFWS aerial surveys in May and July, have fluctuated greatly but have not shown a persistent downward trend. The whole subject of the relationships between ducks and habitat in the prairies is, of course, a controversial one (Pospahala, Anderson and Henny 1974).

The macroscopic approach I have used is inherently unlikely to establish links between causes and effects, as Trauger and Stoudt (1978) sought to do, using the long-term results from USFWS study areas in the Canadian parklands. Gollop (1965) found that "to date it appears that pothole destruction by man has had no significant effect on waterfowl production in Canada ...".

Trauger and Stoudt (*loc. cit.*) concurred in the negative inference, while reminding their readers of how many factors and interrelationships may be involved. They argued that the duck populations were being held below the capacity of the breeding habitat by outside pressures exerted chiefly by hunting. On that argument, the anomalously poor performance of dabbling ducks in the late 1950s and early 1960s (as indicated by Fig. 7) may not have been due to events on the prairies. If so, there is no way that forecasts based on prairie habitat data can predict the recurrence of a similar slump.

Another important and unresolved issue is whether the ducks used in compiling the late-nesting index do contribute to the number of flying young in the way they are supposed to. If they do not, but are largely failed- or non-breeders that have not, for some reason, moved into pre-moulting aggregations at the time of the July surveys, their increase during the 1970s may not have helped restore the productivity of the stocks, as I inferred from Figure 4.

All the alternative estimates (Fig. 9) indicate that dabbling duck numbers will fall below the mean values for 1955–1980, but not very far below. Thus even 10 years from now it may be difficult to show a decline in duck numbers (unless there is a protracted drought). From the point of view of those who wish actively to intervene this is an undesirable forecast. For governments that do not wish to spend money it may be more agreeable.

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