The relationship between nesting chronology and vulnerability to hunting of dabbling ducks

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Introduction

There is widespread concern for the well-being of North American duck populations, catalysed by drought and changing land-use practices (e.g. Boyd 1985; Bartonek *et al.* 1984). In addition there is much interest and speculation regarding the impact of sport hunting on duck populations (e.g. Burnham *et al.* 1984; Caswell *et al.* 1985; Tamisier 1985). The effect of hunting on population levels remains controversial, especially for female ducks, because few data exist to enable the issue to be examined adequately. Analyses of mortality of female Mallard *Anas platyrhynchos* suggest that, in some years and in some areas of North America, hunting mortality may be additive to natural sources of mortality (Burnham *et al.* 1984). Recent work by Caswell *et al.* (1985) suggests that the size of the adult Mallard cohort may be affected by hunting pressure, particularly by hunting on the breeding areas of prairie Canada. They found that restrictive hunting regulations had a positive influence on survival of Mallard, enabling the Manitoba population to grow.

Given the degraded condition of natural habitats in the Canadian prairies, management actions are required to improve recruitment and to maintain, or increase, duck populations. Little is known, however, about the relationship between nesting chronology and susceptibility to hunting. Because hunting season opening dates can be adjusted to reflect breeding chronology, such changes have some promise for the management of duck harvests and for sustaining and possibly increasing populations. In a two-year study of Gadwall *Anas strepera*, Hines and Mitchell (1983) estimated that the percentage of young that were unable to fly on the opening day of the hunting season ranged from 5 to 20%. Gilmer *et al.* (1977) presented evidence suggesting that delayed breeding and moult in female Mallard made them more susceptible to hunters. Anecdotal accounts in the case of Mallard prompted Hochbaum (1944:138) to infer that late nesting females and late hatched young were vulnerable to hunting in good weather when hunters shot ducks along marsh edges. Gollop (1965:35) found that more late hatched Mallard were shot within 160 km of their natal area and early in the hunting season (in September and October) than were early hatched Mallard. However, he found no significant difference in the proportions of early and late hatched Mallard killed by hunters up to early in the following winter.

This paper has two main objectives. First, in order to learn more about the potential vulnerability of young ducks to hunting, the relationship between the fledging dates of hatching-year ducks and opening dates of the hunting season was examined. Second, in order to learn how production and re-nesting effort might influence survival, the inter-relationships of indices of brood numbers, late nesting effort and vulnerability to hunting of female, and immature, ducks were examined.

Methods

Nest initiation and clutch size data were collected in 1980 and 1981 and in 1983 to 1986 at the St-Denis National Wildlife Area (NWA), located approximately 32 km east of Saskatoon, Saskatchewan. The NWA encompasses 385 ha, is situated near the southern boundary of the Prairie Parkland, has moderately rolling terrain, and contains over 100 wetlands which vary in permanency (see Sugden and Beyersbergen 1985). Because the NWA is located at the ecotone of the parkland and grassland biomes, the data should be reasonably representative of conditions in south-central Saskatchewan.

Nest searches were conducted three or four times annually between early May and early July. Weather and breeding population levels dictated when searches began and ended. Nests were located by walking through nesting habitat and "beating" the cover, or by using the "cable-drag" method (Higgins *et al.* 1969).

Initiation date was calculated for all nests

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found of Mallard, Gadwall, Northern Pintail *A. acuta*, Blue-winged Teal *A. discors*, Northern Shoveler *A. clypeata* and American Wigeon *A. americana*. To derive a date of fledging for ducklings from each nest, we summed the number of days to lay a clutch using the data in Table 1, i.e. modal clutch sizes, lengths of incubation after Bellrose (1976) and median age at fledging derived from Gollop and Marshall (1954). Though arbitrary adjustments to reflect seasonal changes in clutch size or differential growth rates of early and late hatched ducklings were not made, seven days from fledging dates was considered to represent the period during which newly-fledged ducks become more competent flyers. Northern Pintail and Gadwall nests were not found in 1984 and 1985. No adjustments to the data for other years were made because the values derived from the nests of these two species are to some extent compensatory, Pintail being early and Gadwall late nesters (see Duebbert and Frank 1984).

Each year, the percentage of broods younger than one week post-fledging was determined during the following periods: before 1 September; 1–6 September; 7–14 September (when hunting has usually opened); 15–30 September and after 30 September. The six species considered here (Table 1) accounted for most of the total estimated retrieved kill of ducks in southern Saskatchewan. Because Mallard typically comprise more than three-quarters of the ducks harvested, we also examined their data separately.

All wetlands on the NWA were censused weekly between spring melt and freeze-up each year, 1983–86. Visits were made to between 111 and 114 wetlands each year and the percentage containing water on 1 May and 1 July was calculated. Based on spring and summer water conditions subjective assessments were made of the potential for renesting each year. Years with good to excellent spring and summer pond conditions were considered to be good years for renesting.

In the prairies, the brood and late nesting indices are derived from aerial census data. Flights are made in the morning in good weather from 1 July to 21 July. The numbers of duck broods (by age class), single lone drakes, and pairs are counted, species being determined where possible. Large counts of lone drakes and pairs indicate much late nesting, while large brood counts indicate good fledging success potential. These duck surveys are made annually (e.g. Benning 1986). Late nesting (renesting) is caused by initial nest failures rather than by hens attempting to raise a second brood. Incidence of late nesting largely reflects wetland abundance in late June and early July which, in turn, is dependent upon the number of ponds in early spring and the rate of drying between early spring and early summer. Nest predation is usually severe, so that when wetlands are abundant in July, and drying is moderate, renesting effort is widespread (e.g. Cowardin *et al.* 1985).

Results of the National Harvest Survey (Metras and Wendt 1986) were used to calculate the ratio of adult females:adult males, and of immatures:adults, killed by hunters. With the exception of 1978 and 1984 when there were sampling problems, reliable data were available from 1972 to 1985 (L. Metras, CWS, pers. comm.). The ratios were calculated for all dabbling ducks, and also separately for Mallard. Because the brood index was based on all species pooled, a separate analysis of Mallard could not be performed.

Table 1. Clutch size, length of incubation, and age at fledging of the most common dabbling ducks nesting at St-Denis NWA, Saskatchewan. Also shown for each species is its percentage representation in the duck harvest in southern Saskatchewan, 1980–81 and 1983–84.

	Clutch size (mode)	Length of incubation (days)	Age at fledging (days)	Representation in harvest (%)	
				Mean	Range
Mallard	9	28	56	79	(73–86)
Northern Pintail	9	24	50	3.7	(1.0–4.9)
Blue-winged Teal	10	23	40	1.8	(1.3–2.3)
Northern Shoveler	10	25	50	2.1	(0.5–3.1)
Gadwall	10	25	50	4.8	(2.5–6.3)
American Wigeon	10	22	49	3.6	(2.7–4.5)

Results

The chronology of nest initiation varied from year to year at the St-Denis NWA (Figure 1). This produced substantial variation in the number of fledged broods across the four time periods (last two periods pooled), for all species (Figure 2) and for Mallard alone (Figure 3). The G-test of Zar (1984), qualitatively similar to the Chi-squared test, was used to see if the proportions of broods fledged in each time period differed across the years. It gave, respectively, G=68.5, P<0.01, df=15; and G=39.3, P<0.01, df=15. Over the six years, 15% of dabbling duck (22% of Mallard) broods were less than one week post-fledging when the hunting season opened. In 1981 and 1983, substantial proportions of young ducks must still have been inexperienced flyers when the hunting season opened (Table 2). In all but one year Mallard were more vulnerable than other species. The trend was most pronounced in

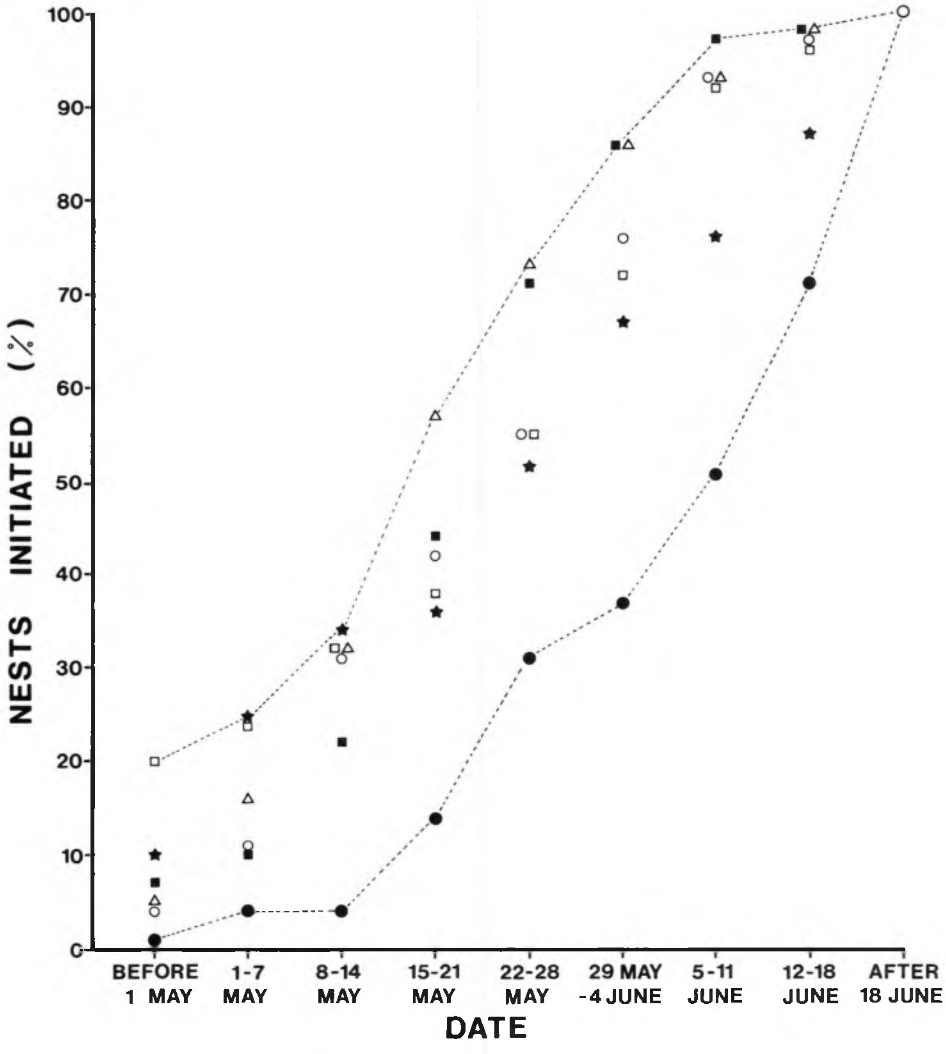

Figure 1. Nest initiation chronology of dabbling ducks at the St-Denis NWA, Saskatchewan in 1980 (■), 1981 (□), 1983 (●), 1984 (★), 1985 (○) and 1986 (△). Shown is the cumulative percent of nests initiated during the spring. The dotted lines join the minimum and maximum percentage of nests initiated within each time period.

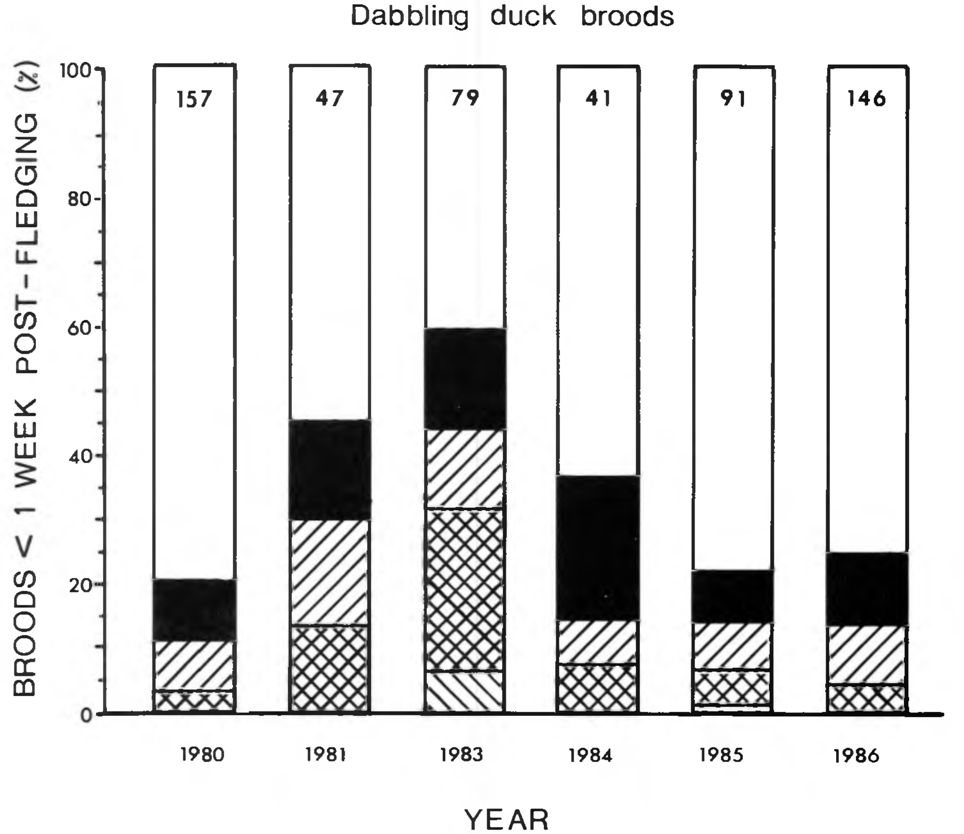

Figure 2. Percentages of dabbling duck broods younger than one week post-fledging during the late summer and fall in south-central Saskatchewan. Numbers of nests found each year are indicated within the histograms. The percentage of broods is shown for the following periods: before 1 Sept (□); 1–6 Sept (■); 7–14 Sept (▨); 15–30 Sept (▩); after 30 Sept (▧). Hunting season usually opened during the period 7–14 Sept. (Table 2).

Table 2. Pond conditions at St-Denis NWA and in Survey strata 30 and 32, southern Saskatchewan, subjective assessment of renesting potential, hunting season opening dates, and percentages of broods less than one week post-fledging when hunting season opened.

	St-Denis NWA % wetlands with water		Strata ponds × 10^3 May		Renesting potential	Season opening	% of broods <1 week post fledging	
	1 May	1 July	30	32				
1980			265	358	moderate	8 Sept	9.4	(19.2)*
1981	23	8	146	126	poor	7 Sept	30.0	(32.0)
1983	85	60	385	712	good	8 Sept	41.8	(55.6)
1984	28	11	283	267	poor	5 Sept	14.6	(13.8)
1985	91	45	622	722	good	11 Sept	9.7	(21.9)
1986	71	29	343	614	moderate	15 Sept	4.3	(9.8)

*Percentage of Mallard broods shown in parentheses. Derived from Figures 2 and 3. In 1980 and 1983, the percentage of broods in the 7–14 September range was multiplied by a factor of 0.8 before adding to the percentages in later groups; the factor in 1985 was 0.4. These factors were used to compensate in part for differences among years in the overlap of opening dates and the selected time period.

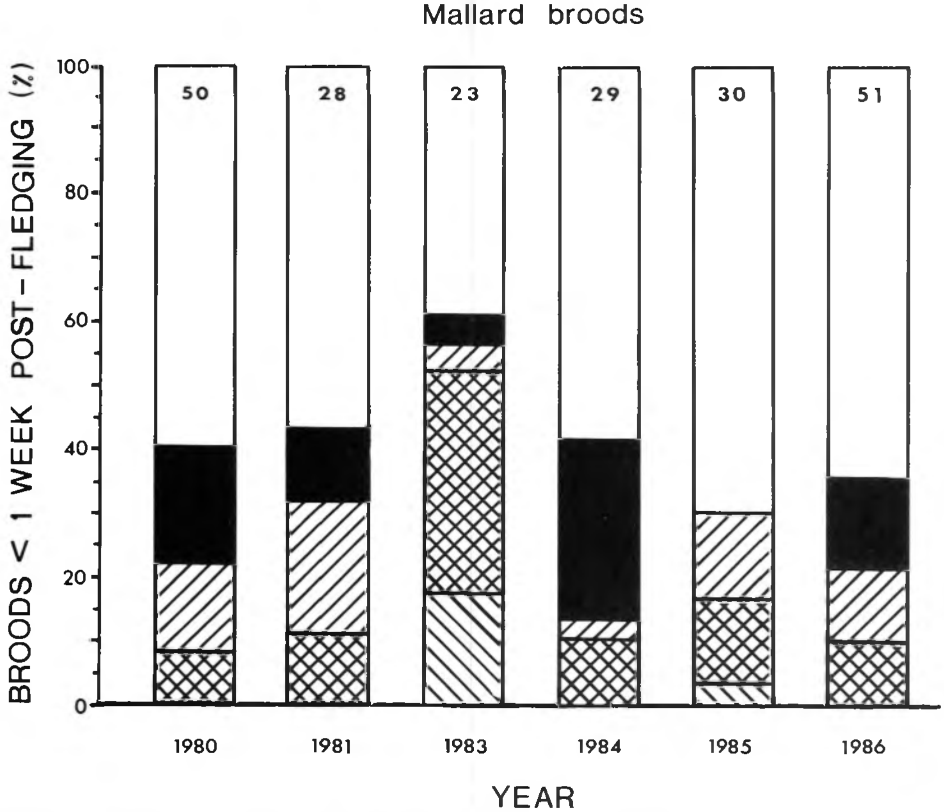

Figure 3. Percentages of Mallard broods younger than one week post-fledging. Details follow Figure 2.

1980, 1983 and 1985 when renesting potential at the NWA was either moderate or good (Table 2). The data on spring pond conditions obtained at the NWA were comparable with those in adjacent survey strata (Table 2) derived from Benning (1986). The years 1981 and 1984 were dry, whereas 1983, 1985 and, to a lesser extent, 1986 were relatively wet.

Based on the National Harvest Survey statistics and indices derived from annual production surveys, some potentially important associations were found with the ratios of ducks killed by hunters. The ratio of adult female:adult male dabbling ducks was positively and significantly associated with the brood index (Table 3). Thus, when the breeding effort was strong (and hens

Table 3. The association between brood and late nesting indices, and the ratio of adult females:adult males, and immatures:adults, in hunter survey samples. Shown are Spearman rank correlation coefficients.

	All species pooled	Mallard alone
Brood index correlated with:		
Adult females:adult males	0.85**	†
Immatures:adults	0.38	
Late nesting index correlated with:		
Adult females:adult males	0.56*	0.13
Immatures:adults	0.55*	0.73**

*P<0.05; **P<0.01; N=12 years (Zar 1984)
†Not available because Mallard broods were not recorded separately.

were generally successful), a higher proportion of adult females was included in the harvest. The association with the late nesting index also was positive. The ratio of immatures:adults in the harvest was associated positively, but not significantly with the brood index; however with the late nesting index the association was significant. Thus, in years when breeding was prolonged, the number of immatures killed relative to adults increased.

Because the kill of immature ducks may have been associated both with late nest frequency and with overall production (brood index), the association between the ratio of immatures:adults harvested and the late nesting index was gauged while controlling for the effects of the brood index. The strength of the association was then diminished (species pooled, partial r_s= 0.44, P<0.07). Assuming that the dabbling duck brood index was also indicative of Mallard brood production, the relationship was significant for that species alone when the brood index was removed statistically using a partial rank correlation analysis (partial r_s=0.68, P<0.05).

Discussion

Heavy egg predation on early nesting species such as the Mallard increases the importance of renesting in reproductive success and recruitment (Sargeant *et al.* 1984; Cowardin *et al.* 1985). In years when renesting was widespread, large numbers of young Mallard and, to a lesser extent, other dabbling ducks would scarcely be able to fly when hunting seasons opened, a situation similar to that found in many regions of Europe (Tamisier 1985). These results also suggest that late nesting may result in relatively high harvests of immature dabbling ducks, irrespective of the level of production indices. The higher vulnerability of hatching-year ducks is well known (e.g. Gollop 1965; Hochbaum and Walters 1984), and was apparent in data collected 100 km south of the St-Denis NWA where young Mallard were 1.2-2.4 times more vulnerable to hunting than adults (Greenwood *et al.* 1986). Cooch and Boyd (1984) found a highly significant positive relationship between Mallard production and (hunter) kill in southern Saskatchewan. Nichols and Hines (1983) reported that young female Mallard survived better during years of low harvest rate than during years of high harvest rate. Their conclusion was based on data collected in major Mallard production areas of central Canada and the United States. However, results from southern Manitoba indicated no substantial improvement in survival of *young* females in years when liberal regulations were changed to restrictive harvest regulations (Caswell *et al.* 1985).

The present analysis suggests that successful breeding may predispose adult females to increased hunting mortality. One plausible explanation is that, owing to high predation rates on early nests, most females nest successfully relatively late in the year after which they accompany young and moult late in the summer or early autumn. These hens would be in relatively poor physical condition when hunting opened. In Minnesota, high predation on Mallard nests led to renesting and late moult (Gilmer *et al.* 1977); compared with early and unsuccessful breeders, these renesting females were more vulnerable to hunters. Several other studies have found that ducks with good body conditions are less vulnerable to hunters than those with relatively poor condition (Greenwood *et al.* 1986; Haramis *et al.* 1986; Hepp *et al.* 1986). In the present study, there was some indication that late nesting resulted in higher harvest rates of adult female dabbling ducks relative to adult males (Table 3).

The associations observed between nesting chronology and hunting mortality of dabbling ducks are interesting, but must be viewed with caution. More data are needed to determine adequately the impact of hunting mortality on survival of young ducks and adult females, and consequent changes in duck population size. The authors are unaware of any analysis which has examined the influence of hunting mortality on survival of young and females (and change in population size) *while controlling* for the influence of breeding chronology.

Small changes in the timing of the opening day could greatly alter the number of young ducks which are poor flyers on the opening day of hunting season. Indirectly, these findings suggest that adjustment of opening day can affect the body condition of ducks shot by hunters, particularly that of breeding hens. Delaying of opening dates has potential for protecting breeding hens, and would probably be most effective where over-water hunting is common. Manipulating the date of opening is preferable to changing bag limits. It is much more difficult to enforce bag limits than to detect "out of season" shooting violations.

At present, brood and late nesting survey results are reported in July. In prairie Canada decisions regarding the likelihood of late nesting must be made before mid-June because of the long time that it takes to get the government to approve hunting regulations. This used to be completed in less that two weeks, but now takes a minimum of four to six weeks. An approach which provided information by mid-June on wetland conditions and hence potential for late nesting and breeding success would improve the setting of Canadian hunting regulations.

To conclude, interesting associations were found between nesting chronology, breeding effort and vulnerability to hunting which have important implications for duck population management in prairie Canada, and possibly elsewhere. The strength of the relationships found are also noteworthy because, in Saskatchewan, most ducks are killed in the last week of September through mid-October (D.J. Nieman, unpubl.). Given nesting chronology similar to that described here, it is predicted that these relationships would be stronger in areas where greater proportions of ducks are killed early or where hunting over water (rather than in stubble fields) is widespread. Later season opening dates offer one alternative for managing harvest rates which may have a direct bearing on survival of young ducks and adult females. Further work is needed concerning: (1) the relationships between breeding effort, physical condition and hunting mortality in adult female dabbling ducks, especially the Mallard; and, (2) the impact of hunting mortality on recruitment and duck population size.

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Summary

Between 1980 and 1986 in south-central Saskatchewan, Canada, the percentage of broods younger than one week post-fledging when the hunting season opened was 15% (22% for Mallard), and ranged from 41% (55% Mallard) in 1983 to 4% (9% Mallard) in 1986. The associations between the relative proportion of adult females killed and both the brood index and late nesting were significant. The ratio of immature:adult ducks killed by hunters was positively associated with the late nesting index, but not with the brood index. The results suggested that, depending on the cohort examined, hunting mortality was related to breeding chronology and effort. Delaying the opening day of hunting holds promise for reducing the kill of adult hens in years when breeding effort is prolonged.

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