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Populations and nesting success of upland-nesting ducks in relation to cover establishment

Robert G. Clark[1], Thomas D. Nudds[2], and Robert O. Bailey[3]

Introduction

Reductions in habitat patch sizes and increases in patch isolation are often associated with increased nest predation and reduced bird populations (e.g., Whitcomb et al. 1981; Wilcove 1985). Nest predation may increase with increasing habitat fragmentation if the foraging efficiency or numbers of predators are increased (Gates and Gysel 1978; Noss 1983; Andren et al. 1985; Yahner and Scott 1988; Johnson and Temple 1990). Retaining small isolated patches of natural or planted cover might concentrate nesting birds in areas that are easily searched by predators (e.g., Braun et al. 1978). Presumably, foraging efficiency of predators is reduced with increased patch size of nesting habitats because increased spatial heterogeneity or complexity enables birds to select better concealed sites or perhaps because nests can be placed farther apart. Following this reasoning, nest predation and habitat patch size are often assumed to be inversely related.

Many prairie duck populations have declined as drought and an array of human-caused impacts have reduced breeding habitat, rates of nest success, and, possibly, survival (Smith 1971; Stoudt 1971; Sugden and Beyersbergen 1984; Bartonek et al. 1984; Boyd 1985; Cowardin et al. 1985; Caswell et al. 1987). It has frequently been suggested that degradation of natural habitats by agricultural activities has forced ducks to nest in fewer, smaller patches of vegetation, leading to higher predation, reduced nesting success, and, ultimately, declining populations (e.g., Moyle 1964; Fritzell 1975; Oetting and Dixon 1975; MacFarlane 1977; Sargeant et al. 1984; Cowardin et al. 1985; Krasowski and Nudds 1986; Johnson and Schaffer 1987). However, there is some evidence that conflicts with the hypothesis that duck nesting success has decreased from the 1960s to the 1980s as a result of habitat destruction (Klett et al. 1988).

Reduced nesting success consequent upon habitat destruction might be brought about by either reduction of the total amount of potentially favourable nesting cover or reduction of patch sizes, or, most probably, both. Duck nesting success would be expected to be greater in larger patch sizes. Nests that are located in strips or narrow fringes of natural habitat may be less successful than those in larger blocks of cover (e.g., Moyle 1964; MacFarlane 1977; Krasowski and Nudds 1986). In the north-central United States, efforts to increase waterfowl production by planting blocks of land to dense nesting cover have occasionally been successful (Duebbert and Kantrud 1974; Duebbert and Lokemoen 1976; Duebbert et al. 1981; but see Greenwood 1986); higher nest success has been reported from dense nesting cover with some form of predator control (Duebbert and Lokemoen 1980). Greenwood et al. (1987) found that duck nesting success in prairie Canada was positively correlated with the percentage of the area in grassland; moreover, ducks in large pastures had the greatest nesting success, whereas those in rights-of-way had the lowest success. Klett et al. (1988) also reported that duck nests in rights-of-way, in small odd areas, and in cover around wetlands had lower success than those in grassland, idle grassland, and planted cover habitats.

In contrast, Livezey (1981) recorded low nest success in relatively large blocks of dense nesting cover (even though well-concealed nests survived slightly better than poorly concealed ones). Data in Duebbert and Lokemoen (1976: Table 4) indicated that field size (range = 12–54 ha) and nest success were not correlated (r_s = 0.14, n = 8, with data for one heavily grazed field omitted). Gatti (1987) found an inverse relationship between the size of managed habitats and duck nesting success in Wisconsin. Cowardin et al. (1985) showed that rights-of-way were among the poorest habitats for nesting ducks, but that small odd areas were good habitats.

Information about the relationship between plot size of managed habitats and duck nest success is needed to assist habitat managers in deciding which land purchases would be most beneficial. However, it is not clear whether there are consistent effects of patch size on duck nesting success, because most studies have examined this question indirectly, or because results are confounded with effects of nest density and other factors. Patch size appears to influence duck nesting success, but it is not yet possible to determine whether in general success increases (i.e., as expected) or decreases with habitat area.

In this paper, we present population and nest success data for Mallards (*Anas platyrhynchos*), Northern Shovelers (*A. clypeata*), and Blue-winged Teal (*A. discors*) at the St-Denis National Wildlife Area (NWA) in south-central Saskatchewan. Our objective was to examine nest success and population size in relation to cover establishment and predator management on the NWA.

Study area and methods

From 1980 to 1986, work was conducted on the St-Denis NWA, 35 km east of Saskatoon, Sask.; the NWA is managed by the Canadian Wildlife Service (CWS). The 385-ha NWA is near the southern edge of the prairie parkland in moderately rolling terrain and contains over 100 wetlands of differing permanency; lands surrounding the NWA are intensively farmed, and much waterfowl nesting habitat

[1]Prairie and Northern Wildlife Centre, Canadian Wildlife Service, Saskatoon, Sask. S7N 0X4.
[2]Department of Zoology, University of Guelph, Guelph, Ont. N1G 2W1.
[3]Canadian Wildlife Service, Ottawa, Ont. K1A 0E7.

has been converted to cropland (Sugden and Beyersbergen 1984).

Before 1982, 100 ha of the NWA were untilled upland habitat used by nesting ducks (Sugden and Beyersbergen 1985). In fall of 1980, 53 ha of cropland were sown to dense nesting cover (Table 1). This cover was not used by nesting ducks in 1981 (L.G. Sugden, CWS, pers. commun.). In 1984, the area of potential nesting cover was increased again, by 51 ha; two cropland areas were converted to a mixture of brome grass and alfalfa by seeding the forage mixture with a cereal crop in spring of 1983 (P.S. Taylor, CWS, pers. commun.), so that, in total, area of idle grassland increased 53% from 1980 to 1983 and 104% from 1980 to 1984 (Table 1).

Although we lacked comparable measurements for all years, we were able, in 1985, to compare plant height and vertical concealment in areas of the NWA that had been seeded both before 1981 and in 1983. In dense nesting cover plots, we estimated average maximum height of plants within a 10-cm radius of randomly selected sites. We then carefully placed a black cardboard disk (14 cm diameter) containing five evenly spaced, 2.5-cm^2 white squares on the ground. From 1 m above the disk, the percentage of each square occluded by vegetation was estimated visually; an index of vertical concealment was calculated by summing these five percentages (range = 0–500).

Early-morning censuses of breeding pairs and surveys of water conditions on NWA wetlands were conducted weekly from late April to early July. Pairs, males, and females were counted to estimate number of indicated breeding pairs (IBP) (Dzubin 1969). To determine if there was any association between population trends at the NWA and in the surrounding area, we compared our data with those obtained from the Hanley air-ground transect, conducted in May by CWS and U.S. Fish and Wildlife Service (USFWS) personnel (D.S. Benning, USFWS, unpubl. data). For this comparison, we used Hanley waterfowl ground counts and censuses of the NWA made in May. Hanley is the transect closest to the NWA (50 km south), and annual change in wetland abundance on the two areas was correlated (r_s = 0.99, n = 7, P < 0.01) (Table 1).

Table 1
Upland nesting cover area and abundance of wetlands with water at St-Denis NWA, and number of wetlands along Hanley air-ground waterfowl transect, 1980–1986

	St-Denis NWA			Hanley
	Upland nesting cover			
Year	ha	%[a]	Wetlands on 1 May (%)[b]	No. of wetlands with water in May
1980	100	26	71	208
1981[c]	153	40	23	21
1982	153	40	40	162
1983	153	40	85	220
1984[c]	204	53	28	34
1985	204	53	91	312
1986	204	53	71	200

[a]Percentage of the NWA area (385 ha).
[b]Based on censuses of 110 wetlands conducted annually in early May.
[c]Drought years.

Although the Hanley transect cannot be considered a true control, it provided the best source of reference data to compare with population trends at the NWA.

Nest searches were conducted three or four times annually, except in 1982, when there were no searches. Data collected with identical methods in 1980 and 1981 were provided by L.G. Sugden. Searches usually began in the first week of May and ended in the first week of July in years with warm, dry spring weather; searches began and ended about one week later in years with cool, wet spring weather. In 1980, 1981, and 1983, the entire NWA was searched; these searches indicated that nesting females strongly avoided cropland (Sugden and Beyersbergen 1985). Consequently, cropland was not searched in the other years. We located nests by walking and "beating" the cover in shrub patches and trees or by using a cable-drag in herbaceous cover (Higgins et al. 1969). Nests were visited two or more times (usually every one to two weeks) until fate was determined (see Klett et al. 1986); a nest was defined as a nest bowl containing one or more eggs, and a successful nest was one in which one or more eggs hatched.

The Mayfield–50% method was used to calculate nest success (Mayfield 1975; Johnson 1979). For consistency, abandoned nests were excluded from the analysis (e.g., Miller and Johnson 1978; Klett and Johnson 1982). We compared nest success across years (Johnson 1979), controlling the alpha-level with Bonferroni's method (Johnson and Wichern 1982). We then repeated the analyses and excluded data for 1981 and 1984. These years were excluded because: (1) there was a smaller sample of nests because of drought (Table 2); and (2) cover establishment was expected to be poor in dry years (1981, 1984) following dense nesting cover plantings (e.g., Higgins and Barker 1982). Excluding these years thus reduced the potentially confounding effects of drought on the relationship between cover establishment and nesting success.

Before the nesting season in 1986, we built an electric fence around the NWA (Lokemoen et al. 1982) and removed many of the nest predators. Skunks (*Mephitis mephitis*), raccoons (*Procyon lotor*), and Franklin's ground squirrels (*Spermophilus franklinii*) were live-trapped and

Table 2
Breeding population estimates (IBP) and nests of Mallards, Blue-winged Teal, and Northern Shovelers at St-Denis NWA (NWA), and counts of the three species on the Hanley air–ground survey transect, May, 1980–1986

	Mallard			Blue-winged Teal			Northern Shoveler		
		NWA			NWA			NWA	
Year	Hanley	IBP	Nests	Hanley	IBP	Nests	Hanley	IBP	Nests
1980	132	NA[a]	59	54	NA	46	24	NA	16
1981[b]	83	NA	36	10	NA	4	8	NA	3
1982	100	61	NA	20	6	NA	18	14	NA
1983	93	41	57	8	43	36	14	48	38
1984[b]	38	40	36	14	25	14	4	18	13
1985	60	26	45	62	40	66	60	28	32
1986	104	37	57	50	46	32	44	36	28

[a]NA = data not available.
[b]Drought years.

removed and American Crows (*Corvus brachyrhynchos*) were shot, but hawks and owls were not controlled. Before 1986, predator control was minimal, with very few crows shot in 1984 and 1985.

Results

Cover establishment

In 1985, height of vegetation in areas seeded before 1981 (n = 29, $\bar{x}$ = 46 cm, SD = 13) was less than that of plants seeded in 1983 (n = 46, $\bar{x}$ = 59 cm, SD = 16) (t-test, t = −3.54, 73 df, P < 0.01). Indices of vertical concealment (before 1981: $\bar{x}$ = 120, SD = 123; 1983: $\bar{x}$ = 125, SD = 98) did not differ (t-test, P > 0.5). Based on these measurements, quality of cover established in 1983 was similar to that of older cover (minimum five years old) by 1985.

Population levels

Mallard IBPs on the NWA declined from 1982 to 1985 (Table 2). Numbers of breeding teal and shovelers varied considerably and were highest in 1983, 1985, and 1986, when spring wetlands were most abundant (Table 1). The number of teal nests found in 1980, a moderately wet spring, was surpassed only by the number found in 1985 (Table 2). Because wet years (1980, 1983, 1985) occurred before and after dense nesting cover area increased, it appears that cover establishment had little influence on breeding populations.

Nest initiations were associated with estimates of IBPs each year during the period in which 90% of nests were initiated (1983–1986: three species pooled, r_s = 0.63, n = 12, P < 0.05; Mallards excluded, r_s = 0.89, n = 8, P < 0.01); this period was chosen to increase the likelihood that IBPs would represent ducks breeding on the NWA. When spring wetland conditions were good (1983 and 1985), the number of Mallard nests exceeded the estimates of IBPs (Table 2), possibly because renesting occurred more frequently than in a dry year (1984) (Swanson et al. 1986) or because females were attracted to the cover from wetlands outside the NWA. On the NWA, numbers of nests initiated by teal and shovelers were related to May wetland abundance (both species, r_s > 0.89, n = 6, P < 0.05), but the trend for Mallards was nonsignificant (r_s = 0.64, P > 0.05).

Waterfowl counts on the NWA followed the pattern recorded on the Hanley transect, but the association was nonsignificant (1982–1986: Mallards, r_s = 0.70; Northern Shovelers, r_s = 0.10; Blue-winged Teal, r_s = 0.60; n = 5, all P > 0.05) (Table 2). When Hanley counts and NWA nest initiations were compared, trends were stronger and more consistent (1980–1981 and 1983–1986: Mallards, r_s = 0.71; Northern Shovelers, r_s = 0.60; Blue-winged Teal, r_s = 0.66; n = 6, all P > 0.05).

Nesting success

The general pattern for each species was one of decreasing nesting success from 1980 to 1983, followed by low success rates until an increase in 1986 (Table 3). Not all of these changes were statistically significant (P < 0.05). Nesting success of Mallards was significantly lower in 1984 than in other years, except 1983. Nesting success of Northern Shovelers declined from 1980 to 1985. Blue-winged Teal nesting success decreased from 1980 to 1984 and was higher in 1986 than in 1984 or 1985.

When we excluded estimates for 1981 and 1984 (dry years), results for shovelers and teal were unchanged; success of teal increased from 1985 to 1986, and that of shovelers decreased from 1980 to 1985. In this analysis, nesting success of Mallards decreased significantly from 1980 to 1983.

Uncorrected estimates (raw percentages) of nest fates indicated that most (56.0%, n = 250 nests) Mallard nests were destroyed by predators, whereas 5% were abandoned; 53.4% of Blue-winged Teal nests (n = 176) were destroyed, and 5% were abandoned; and 62.0% of Northern Shoveler nests (n = 112) were destroyed, and 7% were abandoned.

Discussion

Habitat managers usually plant areas to dense cover based on the premise that production of ducks will improve. We found that duck nest success either failed to increase or decreased when area of dense nesting cover was increased on the NWA. Predation was an important cause of nest failure in all three species.

Given that Mayfield nest success of 15% (and hen success of 31%) is thought to maintain stability of Mallard populations in the Dakotas (Cowardin et al. 1985) and that Mallards exhibit female-biased philopatry (e.g., Gatti 1981; Lokemoen et al. 1990), breeding Mallard populations may have declined as a result of predation. At the NWA, Mallard nest success was low (usually < 15%) from 1983 to 1985 (Table 3), so that few young Mallards were produced. Unsuccessful hens were probably less likely to return than successful hens (Lokemoen et al. 1990; Majewski and Beszterda 1990). Spring wetland abundance seemed to be the most important factor influencing the abundance of Blue-winged Teal and, to a lesser extent, Northern Shovelers at the NWA (see Johnson and Grier 1988:21–24, and references therein).

Attempts to secure and manage relatively small parcels of good habitat in intensively farmed landscapes in the

Table 3
Mayfield estimates of nesting success (% of nests that hatched) and 95% confidence limits (CI) for Mallards, Northern Shovelers, and Blue-winged Teal at St-Denis NWA, 1980–1986

	Mallard		Blue-winged Teal		Northern Shoveler	
Year	Success[a] (%)	CI	Success[a] (%)	CI	Success[a] (%)	CI
1980	45 (44)	30–66	56 (40)	40–78	43 (12)	20–91
1981	23 (23)	10–53	NA[b]		NA	
1983	14 (29)	6–34	29 (25)	14–61	12 (25)	4–34
1984	1 (30)	1–6	3 (12)	1–24	6 (13)	1–32
1985	19 (33)	9–39	11 (55)	5–22	6 (27)	2–18
1986	37 (39)	23–61	63 (17)	39-99	20 (24)	8-50

[a]Number of nests used to calculate success shown in parentheses.
[b]NA = too few nests to calculate reliable estimates (see Table 2).

manner used at St-Denis may not produce ducks. The NWA was gradually transformed from cropland to dense nesting cover based on the expectation that increased cover availability would improve the success and size of upland-nesting duck populations (Duebbert and Lokemoen 1976). However, nest success did not increase and was no better than on unmanaged areas of the prairies (Greenwood et al. 1987). From 1983 to 1985 (when fieldwork overlapped), our Mallard nest success estimates (Table 3) were remarkably similar to Mayfield estimates obtained from other areas of the Canadian parklands, where, on average, success ranged from 14 ± 6% (SD) in 1983 to 6 ± 4% in 1984 and 13 ± 7% in 1985 (Greenwood et al. 1987).

Areas of good habitat may be heavily used by nest predators, especially when surrounding areas are severely degraded by agriculture. Our study shows that providing more dense nesting cover does not always result in higher nest success or in population increases. At the NWA, ducks were abundant and successful in 1980 before habitat or predator numbers were manipulated, suggesting that nest success may have been influenced by interactions among habitat area, habitat composition, and predator activity.

Our findings do not support the notion that site-specific cover establishment increases duck productivity. Indeed, when considered together with conflicting results of other studies (above), we are forced to the conclusion that the merits of establishing moderately large (e.g., 50–200 ha) tracts of cover are unpredictable. However, owing to high costs of land purchase and predator control, it remains important to determine which vegetation and patch sizes are most cost-effective for duck production. There is an urgent need to examine duck and predator responses to habitat manipulations (cover establishment and composition) in the Canadian prairies to improve our ability to manage nesting habitat and increase duck breeding success. Implementation of management programs, executed in an experimental framework that involves sufficient replications and appropriate controls, is needed to examine these questions.

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