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NEST-SITE SELECTION OF THE AMERICAN COOT IN THE ASPEN PARKLANDS OF SASKATCHEWAN[1]

JAMES M. SUTHERLAND AND WILLIAM J. MAHER
Department of Biology, University of Saskatchewan, Saskatoon, Saskatchewan S7N 0W0, Canada

Abstract. Nest-site selection in American Coots (*Fulica americana*) was examined in 1981 and 1982 in pond habitat of south-central Saskatchewan. Breeding coots chose ponds having emergent vegetation in water and a low probability of becoming dry during the nesting and brood-rearing period. Comparison of nests and random sites indicated that nest location on ponds was governed by three factors in order of importance: (1) territoriality, (2) maximizing distance to shore in a large emergent zone width, and (3) vegetation density and height. In ponds having more than one species of emergent vegetation, territoriality and emergent zone width influenced the species in which coots nested. There was no relationship between nest concealment and the incidence of predation.

Key words: American Coot; Fulica americana; *nest-site selection; parklands; Saskatchewan.*

INTRODUCTION

Breeding habitat selection is one of the most crucial factors influencing nest success. Habitat used by breeding American Coots (*Fulica americana*) has been documented (Kiel 1955, Sugden 1979) and Gorenzel et al. (1982) described coot nest location preferences within the chosen habitat. However, little attempt has been made to quantitatively determine differences between the used and unused portions of the available breeding habitat of this species. The objective of this study was to gain a better understanding of coot breeding habitat selection using primarily quantitative methods. This was done by examination of habitat factors measured on used and unused ponds and also at nests and random sites in 1981 and 1982 in south-central Saskatchewan.

STUDY AREA AND METHODS

The study area (52°N, and 106°W) was in the aspen parkland of Saskatchewan, approximately 48 km east of Saskatoon. The area has been described by Sugden (1977). Topography is rolling to gently rolling, and many small ponds and isolated aspen (*Populus tremuloides*) patches of varying size are interspersed amongst the cropland. Emergent vegetation species in ponds used by nesting coots in order of decreasing frequency were *Scirpus* spp., *Typha latifolia, Carex atherodes,* and *Scolochloa festucacea.*

The study site consisted of transects, each of which was 0.8 km wide. In 1981, two transects totalling 48.3 km (15 ponds) were used and in 1982 two transects of 42.9 km were added for a total of 91.2 km (27 ponds). The transects followed roads and were situated to sample the maximum amount of pond habitat. Ponds were selected for inclusion in the study on the basis of emergent vegetation growth. As coots nest only on ponds with emergents, ponds lacking them were not studied.

Ponds were classified using categories described by Martin et al. (1953) and Evans and Black (1956). Types 1 and 3 ponds are least permanent and types 4 and 5 ponds are most permanent. Pond water levels were monitored using 1.5-m steel stakes.

Nest searches were conducted at intervals of about 2 weeks from approximately 1 May to 10 July. A 1.2 m lath placed about 3 m distant was used to mark each nest. Nests were visited one to three times per week until hatching.

The investigation of nest-site selection consisted of three components: (1) nest pond selection, (2) nest spacing, and (3) nest-site selection within nest ponds. Nest pond selection was examined by comparing variables measured at random sites on used and unused ponds. The analysis of nest spacing compared nests, random sites, and maximum spacing, and the nest site selection analysis compared nests with random sites.

The position of random sites was determined by pacing the pond perimeter to divide it into points approximately 1 m apart. For each ran-

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dom site, one random point on the perimeter was selected and the emergent vegetation was divided into quadrats about 0.25 m^2 along a transect extending from shore to open water. The position of the random site was one of these quadrats selected by random numbers. Using this method, the probability of each point of emergent vegetation standing over water being selected as a random site was essentially equal.

The number of random sites equalled the number of nests on each pond where coots nested. For those ponds on which nesting did not occur, the number of random sites was equal to the number of nests that would have been present had nesting occurred. An area of 0.34 ha/nest (Sugden 1979) was used to estimate the number of potential nest sites.

Nest and random site spacing measurements were determined with a rangefinder. Maximum spacing values for ponds with at least three nests were determined by summing distances between nests and dividing by the number of nests. This approximates nest spacing if nests are as far apart as possible. For two-nest ponds, maximum spacing was the distance between the emergent zone width midpoints along the longest axis of the pond.

Variables measured at nests and random sites were: water depth, distance to open water and to shore, emergent zone width, and vegetation density and height. Distance to open water was defined as the distance between the nest or random site and the nearest point where a coot would have unobstructed access to the open water of the pond. Emergent zone width (hereafter abbreviated EZW) was the distance between open water and the shoreline at the nest or random site. Height of vegetation was measured to the nearest 0.2 m and vegetation density was measured using a board adapted from the design of Nudds (1977). The board was placed 1 m from the nest or random site in the four directions parallel and perpendicular to the shoreline. Vegetation density was read by observing the board from the nest or random site and was recorded as one of six percentage coverage categories for each 0.2-m height class: 0%, 1–20%, 21–40%, 41–60%, 61–80%, 81–100%. Only vegetation density and height measurements taken within 3 weeks of the observed or calculated clutch initiation date were used in analyses. Growth rates of emergents varied between locations on each pond and readings taken after 3 weeks could not be used to compare vegetation density and height at nest initiation. Over 75% of vegetation readings used were taken within 2 weeks of nest initiation. All plant species at the nest or random site were recorded. Variables on random site ponds were measured at the peak of nest initiation. To reduce observer variability, vegetation density and height were measured only by the first author.

To remove the effects of rapid vegetation growth and fluctuating water levels, only nests with a corresponding random site measured the same day on the same pond were included in the discriminant analysis. For nests having paired random sites measured on different days, water depths (adjusted using the rate of water loss for each pond during the respective period) and distance measurements were analyzed using paired *t*-tests. Pairs were obtained by matching each nest with a random site on the same pond. Pairing was necessary as each pond had its own range of values for each of the variables.

Statistical tests were completed using SPSS (Nie et al. 1975) except for paired *t*-tests which were completed using BMDP (Dixon and Brown 1979). Discriminant function analysis was used to determine the relative importance of the nest-site selection variables in distinguishing between nests and random sites. Arcsine transformation (Sokal and Rohlf 1981) was used on vegetation density percent values for all analyses.

Coots were nest trapped for the purpose of age determination. Nest traps were similar to those used by Weller (1957) and were set between 00:00 and 04:00 (Crawford 1977). Aging was based on the tarsal color scheme of Crawford (1978). Trapped birds were not sexed. Age was not studied in relation to nest site selection because usually only one member of a coot pair could be trapped. Since coots within a pair are not always the same age (Crawford 1980), age classes were not assigned to each nest site but were used collectively in examining pond use.

RESULTS

NEST-POND SELECTION

Coot pond use is summarized in Table 1. A larger proportion of type 5 ponds were used by nesting coots ($\chi^2 = 4.2$, df = 1, $P < 0.05$). This was expected, as worsening drought conditions in 1982 left all of the type 4 but only some of the

TABLE 1. American Coot pond use by pond type and year.

Year	Type 4 ponds		Type 5 ponds	
	Used	Unused	Used	Unused
1981	7	2	5	1
1982	0	9	13	5

TABLE 2. American Coot pond use by parental age.

Age-class	Type 4 ponds	Type 5 ponds
1	6 (3)[a]	16 (7)
2	—	10 (6)
3	—	3[b] (3)
Total	6 (3)	29 (10)

[a] Number of ponds.
[b] Includes one bird which may have been 4 years old.

type 5 ponds with insufficient emergent vegetation for nesting coots.

Of the 12 nest ponds used in 1981, only one was used in 1982. This pond was the only one with emergents in water in early May of 1982. The emergent vegetation of the remaining ponds was confined to the shore. These observations suggest that coots were selecting nest ponds on the basis of the amount of emergent vegetation standing in water.

Coot nest-pond selection was examined by comparing random sites on used vs. unused ponds. Each unused pond ($n = 4$) was paired with a nest pond on the basis of similarity in size and the timing of vegetation measurements. Using paired t-nests on each of the six nest variables (water depth, distance to open water and to shore, EZW, vegetation density and height), there were no differences ($P > 0.05$). However, unused ponds were more likely to become dry than nest ponds ($\chi^2 = 6.0$, df $= 1$, $P = 0.01$). Two of three unused ponds in 1981 became dry before 10 of 12 nest ponds. A fourth unused pond studied in 1982 dried up on 14 August when the shallowest nest pond still had a depth of 0.33 m. However, comparison of 1 May pond water depths between used and unused ponds in 1981 using a Mann-Whitney U-test showed no difference ($P > 0.05$). One of the unused ponds was excluded from this test as it had the greatest depth (1.12 m) of all the ponds studied in 1981.

One pond was used by coots in 1982 but not in 1981. For the six random sites measured on this pond each year, the mean vegetation height was less ($P < 0.01$) in 1982 than 1981. The lower vegetation height in 1982 is contrary to what would be expected, as the nest-site selection analysis shows that coots select for taller vegetation. Weather would not have inhibited nesting in 1981 as the mean daily temperatures during April and May of 1982 were lower by 3.3 and 2.8°C, respectively.

Although selection of ponds by coots appeared to be related to age (Table 2), there was no relationship between pond type and age ($\chi^2 = 4.3$, df $= 2$, $P = 0.12$). Older coots nested only on the more permanent type 5 ponds which were probably preferred habitat. Presumably, the yearlings on type 4 ponds were returning to their natal pond or they were excluded from the more permanent ponds by older birds. We assume there is no between years bias as 7 of the 12 (58.3%) nest ponds studied in 1981 were type 4 ponds and all of the nest ponds studied in 1982 were type 5.

NEST SPACING

Spacing data were collected for 63 first nests and 63 random sites on 15 ponds. Four of the ponds had two nests. Nest spacing was compared with random site spacing and maximum spacing (Table 3). Nest spacing variance was less ($F = 2.86$, $P < 0.001$) than random site spacing variance, indicating that coots do not space themselves randomly along the pond perimeter. Maximum spacing variance could not be compared statistically with that of nests and random sites as it had a non-normal distribution. However, the results of the F-test and comparison of 95% confidence intervals and coefficients of variation indicate that nest spacing was more closely approximated by maximum spacing than if nests were located at random. Coots tended to maximize distances between nests and this was presumably caused by territoriality.

Mean values for EZW and vegetation density and height for each pond were regressed against the corresponding mean nest spacing as a test of the hypothesis that nest spacing will decrease with more or denser cover because of reduced interpair contact. Coot pairs would be less visible to each other in a larger EZW in this study as there was a positive correlation between nest to open water distance and EZW ($n = 110$, $r = 0.42$, $P < 0.01$). When nest spacing was plotted against EZW, the regression was significant only when ponds with two nests were excluded. This is because spacing on two-nest ponds is largely dictated by the size of the pond (Sugden 1979). The

TABLE 3. American Coot nest spacing compared with random site spacing and maximum spacing.

	n	$\bar{x}$ (m)	Range (m)	95% CI (m)	CV (%)
Nests	63	69.7	17–158	61.2–78.3	49.5
Random sites	63	68.0	4–264	53.5–82.4	85.9
Maximum spacing	63	71.9	47–152	66.5–77.4	30.1

regression is (Y = mean nest spacing (m), X = EZW (m)): $Y = -1.99X + 104.1$, $r = -0.59$, $P < 0.05$. Thus nest spacing will decrease with more cover represented by a larger EZW. Regressions of nest spacing on vegetation density and height were not significant ($P > 0.20$).

NEST-SITE SELECTION

In comparing variables measured at nests and random sites, means of five of the six variables measured at nests were higher than for those measured at random sites (Table 4). Paired t-tests of water depth, distance to shore, and EZW were all highly significant (df = 93, $P < 0.001$). Significance levels for vegetation density and height (df = 54) were 0.002 and 0.02, respectively. Distance to open water was not significant ($P = 0.13$), and this is explained by patchy emergent vegetation on most ponds. As several of the significant variables are correlated (e.g., distance to shore and water depth), coots are probably not using all of these variables as cues in nest site selection.

The discriminant function analysis of the difference between nests and random sites was highly significant ($P < 0.001$). Distance to shore had the highest correlation with the discriminant function (Table 4) indicating that this variable was most important in distinguishing between nests and random sites. Of the 94 nests, 45% were more than 10 m from shore whereas only 11% of the corresponding random sites exceeded this distance. The larger EZW for nests is evidence that coots were not simply selecting a nest site that is several meters in from the edge of the emergent vegetation. Coots were selecting for a large nest-to-shore distance in a large EZW.

Nest-site selection was apparently not influenced by the availability of nesting material. Most coot nests were composed of the same plant species that provided support for the nest. Several nests primarily composed of and supported by *Scirpus* were lined with *Typha* which had to be obtained up to 15 m away. Sugden (1979) observed that coots carried material several meters to nests in willow. Willows provide support for the nest but not materials for it. Low water levels prevented nesting in willows in the present study.

On 19 of 24 nest ponds, coots had little or no choice of nesting cover because a single species almost entirely dominated the emergent vegetation. In order of decreasing frequency, coots nested in *Scirpus lacustris, Carex atherodes, Typha latifolia,* and *Scolochloa festucacea.* For the five ponds which had mixed vegetation species (Table 5), territoriality and EZW appeared to be as important as vegetation species in determining nest placement. Although the *Typha* on pond 1 had the best cover in terms of height and density, none of the four nests was in *Typha,* probably because of its small EZW (<2 m). Territoriality would not be a factor in this case as the *Typha* was farther away from all of the nests than

TABLE 4. Means (95% CI) and correlations with discriminant functions of variables measured for American Coot nests and random sites.

Variable	Nests (n = 55)	Random sites (n = 55)	Correlation with discriminant function[a]
Distance to shore (m)	12.4 (10.2–14.6)	5.5 (4.3–6.7)	+0.667
Water depth (m)	0.33 (0.31–0.35)	0.25 (0.23–0.25)	+0.573
Vegetation density (%)	52.7 (50.5–54.9)	47.3 (44.3–50.3)	+0.348
Emergent zone width (m)	15.2 (12.6–17.8)	10.5 (8.2–12.8)	+0.336
Vegetation height (m)	0.68 (0.63–0.73)	0.61 (0.55–0.67)	+0.228
Distance to open water (m)	1.5 (1.0–2.0)	2.2 (1.5–2.9)	−0.181
Wilk's lambda = 0.628; df = 6, 103 ($P < 0.001$)			

[a] The highest absolute value is most important.

TABLE 5. Vegetation occurrence and use of American Coot nest ponds having mixed species vegetation.

Pond number[a]	Vegetation species	Estimated % occurrence	No. of nests	% occurrence
1	*Typha*	20	0	0
	Carex	10	1	25
	Scolochloa	70	3	75
2	*Typha*	60	3	75
	Carex	40	1	25
3[b]	*Scirpus*	60	1	25
	Typha	40	3	75
4	*Scirpus*	60	2	100
	Typha	40	0	0
5	*Scirpus*	60	3	50
	Typha	40	3	50

[a] Ponds studied in 1982 only excepting Pond 3 which was studied in both years.
[b] Vegetation occurrence and use was the same both years.

the greatest internest distance. Territoriality may have been a factor on pond 2. The nest in *Carex* was initiated after the other three nests which were in *Typha.* If this pair had nested in *Typha,* the adjacent nest distance would have been halved. Territoriality probably forced this pair to nest in the sparse *Carex* cover. On pond 3, three of four nests in both 1981 and 1982 were in *Typha* which made up less than half the cover. Patches of *Typha* occurred farther from shore than the *Scirpus,* and it was in these patches that four of the six *Typha* nests occurred, emphasizing the preference by coots for a large nest-to-shore distance. On pond 4, however, *Scirpus* was the preferred nesting cover, perhaps because it formed a larger EZW than the *Typha.* This pond had only two coot pairs and both nests were at one end of the pond with a spacing of 55 m. Pond 5 had a large number of pairs ($n = 6$) for the pond perimeter available and territoriality forced equidistant nesting around the pond. Gorenzel et al. (1982) found that percentages for vegetation occurrence and use by coots corresponded on larger ponds (i.e., ≥ 14 nests). His ponds in Colorado had more stable water levels than those of this study resulting in more substantial and permanent emergent development. This allowed coots to nest with equal spacing along the pond perimeter. In the present study, territoriality and EZW were important factors influencing the vegetation species in which coots nested.

Roads adjacent to a pond did not seem to influence nest placement. In five of eight ponds adjoining roads, territory, EZW, and vegetation density and height took precedence in nest location, with nest-to-road distances ranging from 5 to 10 m. In the other three ponds, however, coots may have been avoiding the roads as two of these ponds had only one nest and these were a minimum of 30 m from a road. The emergent growth on these ponds was homogeneous and nest placement away from the road may also have occurred by chance. The third pond had two nests each about 15 m from the road. Better nesting cover or avoidance of intraspecific aggression would not have resulted from nesting closer to the road. These results suggest that coots may nest away from a road if there is no territorial intrusion or loss of superior emergent vegetation.

Coots selected nest sites in tall and dense emergent vegetation. Although this would decrease the chances of a predator finding a nest, it could be less important than nest attentiveness in reducing predation. Fifty-one of 111 nests of this study were destroyed by American Crows (*Corvus brachyrhynchos*) or Black-billed Magpies (*Pica pica*). As a test of the hypothesis that nest-site selection has evolved to maximize concealment from predators, concealment variables (open water distance, EZW, and vegetation measurements) were compared for destroyed nests vs. randomly chosen undisturbed nests on each pond. The same pond pairing removed the effects of any differing predation pressure between ponds. Using paired t-tests, there were no differences ($P > 0.55$) between each of the four variables for the two groups. These variables may not represent nest concealment on a relative basis, but this seems unlikely as nest searches were more difficult where these variables had larger values. However, lateral measurements of cover were used and thus overhead concealment to the avian predators that predominated in this study was probably not represented (Sugden, pers. comm.). If our cover data represent nest concealment on a relative basis, the more concealed nests had no advantage in terms of predator avoidance.

DISCUSSION

Coots are probably selecting ponds on the basis of availability of emergent vegetation and this characteristic is a proximate factor in providing nesting cover. Its ultimate nature is that it indicates a more permanent pond which is less likely to become dry. The ability of coots to select ponds that maintain water throughout the breeding season was documented by Sugden (1979), who found that only two of 1,991 (0.001%) nests were in ponds that became dry before the young could have fledged. The corresponding figures in this study were 12 of 26 (46.2%) nests in 1981 and none of 56 nests in 1982. The incidence of reproductive failure due to pond drying was high in 1981 as this was the first of several years of drought. Additional factors such as water depth and philopatry are probably involved in pond selection, as coots will delay nesting until nesting cover growth is sufficient (Fredrickson 1970). Philopatry is a more probable factor than water depth since there was no significant difference in water depth between used and unused ponds in this study. Food would not be a proximate factor in coot habitat selection as only associated factors early in the year would indicate availability of this resource during the breeding season.

Coot nest location on ponds is governed by three factors in order of importance: (1) territoriality, (2) maximizing distance to shore in a large EZW, and (3) vegetation density and height. The smaller internest distances with larger EZW in this study emphasize the importance of intraspecific aggression in coot nest-site selection. Visual contact is reduced between pairs nesting in a large EZW, resulting in smaller territories and closer nest spacing. Although coots appear to select deeper water for nest location, the greater water depth at nests correlates with distance to shore. Emergent vegetation structure probably takes precedence over water depth in nest site selection.

Two of the ponds in this study had large areas of emergents interspersed with small patches (ca. 25 m^2) of open water. There were no nests in these areas even though water depths were similar to those at coot nests. We suggest this was because coots nesting in these areas would have had limited access to the central open water of the pond where most feeding would take place. Another possibility, however, is that coots respond to a narrow range of environmental cues in nest-site selection. Lack (1940) suggested that a species' nest-site selection preferences may be so fixed that it is unable to take advantage of alternative sites which are equally adequate.

The small distances between nests and open water may be the result of the means by which coots select a nest site. Tinbergen (1953:128), studying nest-site selection in Herring Gulls (*Larus argentatus*), found that when nest building commenced, the gull would begin to build at several close sites. This acted as a positive feedback system so that the gull would be more likely to build its final nest somewhere in that area. Tinbergen termed this "conditioning dependent on accident" and the same may be occurring with the coot since Gullion (1954) found that coots would often build several nests before one was finally selected. Klopfer and Hailman (1965) found that Laughing Gull (*Larus atricilla*) nests were closer to the edge in dense vegetation patches and the ease with which the bird could penetrate the cover determined how far in the nest would be located. These studies suggest two explanations which may act in concert: (1) coots place nests far from shore primarily as a result of proximity to their center of activity, and (2) nests are close to open water to minimize energy expenditure in travelling to and from nests. The advantages of this behavior include ease of access to open water feeding, reduced likelihood of nests ending up on land as a result of pond drying, and reduced mammalian predation. Disadvantages are increased visibility to avian predators and damage by windstorms with the associated waves. Presumably, natural selection has favored coots nesting far from shore.

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