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SITE TENACITY IN CULVERT-NESTING BARN SWALLOWS IN OKLAHOMA

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Abstract.—Barn Swallow (*Hirundo rustica*) returns to the study area, culverts, and nest sites were investigated. The return rate to the study area was significantly higher for adults than nestlings. Three nestlings returned, but to culverts different from their natal culverts. Forty adults returned, 35 to the culverts in which they had nested previously. The percent of adults returning to culverts where banded was significantly correlated with distance from interstate highway 35, suggesting a possible migratory guideline. The second variable correlating with culvert tenacity was colony size, probably as a social influence. No difference between male and female return rates were found, although, no males changed culverts.

TENACIDAD DE *HIRUNDO RUSTICA* REPRODUCIONDOSE EN ALCANTARILLAS EN OKLAHOMA

Resumen.—Se investigaron golondrinas (*Hirundo rustica*) que regresaron al área de estudio y lugar de anidaje. Los adultos regresaron al área de estudio a una razón significativamente más alta que los juveniles. Tres juveniles regresaron a alcantarillas, pero no a las mismas en que nacieron. Cuarenta adultos regresaron; 35 a las alcantarillas en las cuales habían anidado anteriormente. El porcentaje de adultos retornando a las alcantarillas donde se anillaron correlacionó significativamente con la distancia desde la autopista 35, sugiriendo un posible corredor migratorio. La segunda variable correlacionada con la tenacidad de regrasar a las alcantarillas lo fue el tamaño de la colonia, probablemente una influencia social. No se encontró diferencias entre la razón de regresos de machos y hembras, aunque ninguno de los machos cambió de alcantarillas.

In North America, Barn Swallows (*Hirundo rustica*) primitively nested in rocky caves, crevices, and rock walls (Bent 1942) and later adapted to new nesting sites in man-made structures such as barns and bridges where site tenacity, the return to a former nesting location and geographical locality, has been demonstrated (Mason 1953, Samuel 1971b, Shields 1984, and Stamm and Stamm 1975). In the last few decades, studies have investigated Barn Swallow nesting activities in highway culverts (Martin 1974, Wall 1982). The purposes of this study were to determine the site tenacity of Barn Swallows to a new nesting substrate, culverts, and to investigate factors (habitat variables, colony size, and reproductive success) influencing tenacity.

MATERIALS AND METHODS

The study area was located in Payne County, Oklahoma, along state highway 51, between Stillwater and the intersection with interstate highway 35. The study area was characterized by deciduous forest-grassland

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ecotone (Odum 1971). Rangeland is the dominant land use (United States Department of Agriculture land use maps of Payne Co.). Along a 25.7 km transect, twenty-three rectangular cement culverts ranging in size from 0.9 m (height) × 0.9 m (width) × 19.7 m (length) to 2.1 m × 1.5 m × 112.3 m were used for analyses. Originally twenty-five culverts were included in the study area until extensive flooding in two culverts in 1980, caused banding activities to cease. The data from these two culverts were only included in analyses of male and female attendance at various nest stages.

Adult swallows were banded and recaptured during ten trap nights in each of the 1980 and 1981 breeding seasons, and once (12 Jun.) in 1982. Headlamps covered with red cellophane provided illumination. This type of lighting rarely disturbed the birds which were more sensitive to white light (pers. obser.). Adult birds were removed from nests and sexed by the presence or absence of a brood patch and by tail-length (Samuel 1971a). For birds identified to nest site, the nest location and nest stage (eggs, young, or no contents) were recorded. Nests with no contents were classified as either active (at least one egg) or inactive (no eggs) according to the presence or absence of at least one egg later in the breeding season.

Occasionally, a cloth was used to cover one end of the culvert to hold birds that flushed from nests. Use of a cloth was preferred to a mist net because birds did not become entangled for long periods of time nor did birds become net shy (Stamm and Stamm 1975). This method of capture identified birds to culvert only. Other birds caught in culverts during trapping activities also provided data for culvert tenacity.

Nestlings were banded in 1980 only. They were banded 7–12 d after hatching (Samuel 1970) during daytime nest checks. All birds were banded with U.S. Fish and Wildlife Service bands. Birds caught during the same breeding season were classified as recaptures whereas swallows captured in subsequent breeding seasons were classified as returns.

Statistical analyses included the comparisons of proportions and corrections for continuity for the following return rates to the study area: 1981 and 1982, males and females, nestling and adults (Snedecor and Cochran 1980). Chi-square was used to compare the frequencies of returns of adults versus nestlings and males versus females to the same or different culverts, and attendance of males versus females at different nest stages.

Several independent habitat variables including the physical characteristics of the culverts (height, length, orientation), intra-culvert variables (water depth, amount of light, percent humidity), and the area of water and wood within 2.59 km^2 of the culverts were analyzed as part of a study on variables influencing colony size. These variables, along with distance from interstate highway 35, number of nest sites used (indicative of colony size) and percent nest success the previous year (number of nest attempts that fledged at least one young/total attempts) were the independent variables analyzed in stepwise multiple regression analyses to determine factors affecting tenacity to culverts. In these analyses, the 1981

TABLE 1. Barn Swallows banded (1980 and 1981) and returned (1981 and 1982) to the study area by age and sex.

	Number banded		Returns in 1981		Returns in 1982 banded in		Percent returns in 1982 (banded in 1981)
	1980	1981	No.	Percent	1980	1981	
Nestlings	524	0	3	0.57	1	—	—
Adult males	44	26	6	13.6	1	3	11.5
Adult females	100	55	25	25.0	3	6	10.9
Total adults	144	81	31	21.5	4	9	11.1
Total for all classes	668	81	34	5.1	5	9	11.1

and the 1982 percent adult returns to the same culverts as banded were used as the dependent variables.

RESULTS AND DISCUSSION

Banding efforts.—In 1980, all culverts but one contained at least one active nest. Only two culverts in 1981 had no active nests. In 1980, 145 adults and 524 nestlings were banded in 17 culverts. In 1981, 81 adults were banded in 11 of the 17 (1980) culverts. Fifteen nestlings and one adult were found dead during the 1980 season and numbers were adjusted accordingly for calculations (Table 1).

During 1980, 100% of the nestling population was banded. The approximate adult population size study was based on the peak number of active nests: 106 (1980) and 90 (1981). The proportion of the total adult population banded in 1980 was 68% (144/212), 94% (100/106) of the females and 42% (44/106) of the males. The proportion of adults banded in 1981 was calculated by subtracting the number of 1980 returns from the number nesting in 1981. Approximately 54% (81/149) of the total adult population was banded which included 85% (55/165) of the females and 31% (26/84) of the males. These additional adult birds banded (81) in 1981 may have been first-year birds dispersing from distant colonies or adults moving from other nesting locations.

The greatest opportunity to capture adults was during the egg stage of nesting (Table 2). Capturing males was most successful during first clutch attempts. Of the males captured on nests with contents, 79% (22/28) were with first clutches. Smith (1937) has suggested that males tend first-clutch young elsewhere.

Banding activities in this study did not appear to significantly reduce reproductive success by causing desertion as discussed by Burtt and Tuttle (1983) in Tree Swallows (*Tachycineta bicolor*). If banding activities were a significant factor causing nest abandonment, the proportion of abandoned nests would have been similarly high both years. However, the proportion of abandoned nests in 1981 (3.4%) was nearly half the rate

TABLE 2. Barn Swallows identified to nest stage by sex in 1980 and 1981.

	Nest stage			
	Eggs	Young	No contents	Total
Females	125	41	17	183
Males	24	4	14	42
Total	149	45	31	225

observed in 1980 (6.7%) with comparable disturbance levels. Several other factors may lead to desertion including death, competition, and severe environmental conditions.

Adult returns to the study area.—The frequency of adult returns (Table 1) in 1981 (21.5%) and 1982 (11.1%) was not significantly different ($z_c = 1.82$, $P_c > 0.05$). The lower return rate in 1982 may have resulted from only one trap night. Therefore, the 1981 return data, which included more trap nights was used for most analyses. However, the 1982 returns yielded additional data on site tenacity.

The 1981 and 1982 return rates to the study area were considerably lower than other North American Barn Swallow studies that reported 29.7% (Stamm and Stamm 1975), 34% (Mason 1953), and 40% (Shields 1984) return rates. These studies were conducted at buildings where Barn Swallows have nested over many generations and, perhaps, are more tenacious.

In 1981, the frequency of male (14%) and female (25%) return rates did not differ ($z_c = 1.32$, $P_c > 0.10$). However, the lower return rate for males may have resulted from sampling because more females were banded and recaptured during the study.

Nestling returns to the study area.—In 1981, the return rates between adults (21.5%) and nestlings (0.57%) differed significantly ($z_c = 10.06$, $P_c < 0.01$). This is consistent with other studies, which found low return rates for yearling Barn Swallows to their natal areas (Barrentine 1978, Boyd and Thomson 1937, Davis 1965, Mason 1953, Shields 1984, Stamm and Stamm 1975). Although the first-year return rate in this study was even lower than these studies, one contributing factor may be the short duration (2 yr) of this banding project compared to previous studies (4–54 yr). In these longer banding projects, additional birds banded as nestlings were recovered during nonconsecutive years, a phenomenon that was also observed in one instance during this study.

In addition, one first-year bird was recovered 3.2 km outside the study area suggesting that first-year breeders probably disperse as shown in other studies (Davis 1965, Shields 1984). This dispersal of first-year birds may be attributed to their inability to displace older birds (Hilden 1965). Older Barn Swallows arrive on the breeding grounds first and occupy "best" nests (Barrentine 1978, Moller 1982).

Returns to culverts.—The age (adult or nestling) of individuals at band-

TABLE 3. Barn Swallows banded in 1980 and returned in 1981, and banded in 1981 and returned in 1982 to the same and different culverts of banding, by age and sex.

	1981 Returns		1982 Returns	
	To same culverts as banded	To different culverts than banded	To same culverts as banded	To different culverts than banded
Nestlings	0	3	—	—
Adult males	6	0	3	0
Adult females	21	4	5	1

ing significantly affected their return to the same or different culverts in 1981 ($\chi^2 = 12.69$, df $= 1$, $P < 0.01$) (Table 3). Significantly more nestlings returned to different culverts, contributing 72% to the total Chi-square. Adults (all females) that returned to different culverts moved an average distance of 1.6 km, all moving to the nearest active culvert with at least ten breeding pairs. Three adults (two females and one male) nested in the same culverts for three consecutive years.

Although the 1981 male and female adult returns to the same and different culverts did not differ significantly ($\chi^2 = 1.1$, df $= 1$, $P > 0.25$), no adult males returned to different culverts either year indicating strong tenacity. All nestlings recovered in this study were males and returned to culverts other than their natal culverts. These observations are similar to other studies in buildings where a very low number of adult males were found switching colonies and nestlings that returned to the study area were usually males (Mason 1953, Shields 1984). Males probably select nest sites and have a greater fidelity to them. This probably was a factor explaining the significant difference ($\chi^2 = 17.81$, df $= 2$, $P < 0.01$) found between males and females captured at various nest stages (Table 2). More males were observed on nests with no contents, contributing 65% to the total Chi-square. Approximately half of these empty nests remained inactive throughout the breeding season, perhaps as a result of the males being unmated or losing a mate.

In stepwise multiple regression analyses, distance from interstate highway 35 was the most significant variable explaining over 61% of the variation in tenacity between culverts in 1981 and in 1982 (both cases df $= 22$, $P < 0.01$) (Fig. 1). In 1981, the only other significant variable that influenced percent returns was colony size. Collectively, both variables explained over 71% of the variation in tenacity between culverts (df $=$ 22, $P < 0.01$). In 1982, no additional variables correlated with percent return.

The tendency for Barn Swallows to return to culverts nearest interstate highway 35 may indicate their ability to readily locate culverts near large highway systems. During migration, other birds navigate using rivers and coastlines as guiding lines (Welty 1979). Barn Swallows may navigate using large highway systems, especially north-south routes, which are

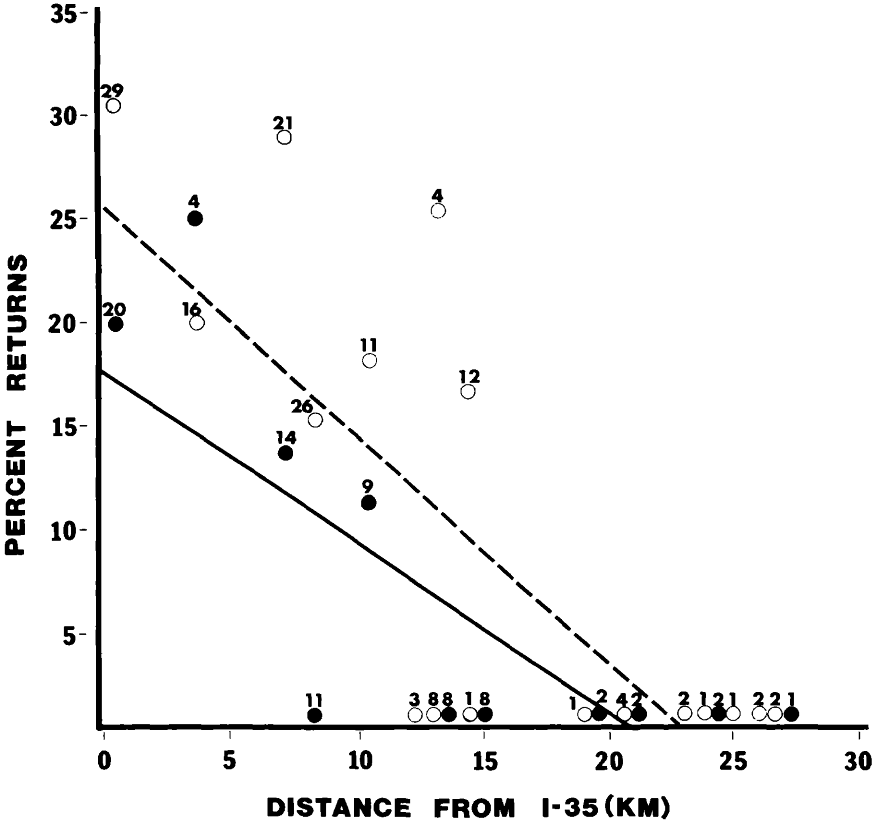

FIGURE 1. Percent returns (number returns/number banded) the following breeding season of adult Barn Swallows to the same culverts as banded at distances from interstate highway 35. Birds banded in 1980 and recovered in 1981 are represented by open circles. Solid circles indicate birds banded in 1981 and recovered in 1982. Numbers above circles designate the number of adults banded. The broken line represents the regression:

$$\text{PERCENT RETURNS 1981} = 0.263 - 0.0113 \text{ (KM FROM I-35)}$$
$$(r^2 = 61.6, F = 27.2, P < 0.01).$$

The solid line represents the regression:

$$\text{PERCENT RETURNS 1982} = 0.180 - 0.00862 \text{ (KM FROM I-35)}$$
$$(r^2 = 61.1, F = 14.2, P < 0.01).$$

quite visible from the air. In this study, social influences may be a secondary factor affecting tenacity to culverts.

Returns to nest sites.—Of adults identified to nest sites during consecutive years ($n = 12$), only one male and one female returned to the same nest sites. Neither adult had fledged any young in 1980 indicating that prior reproductive success (Freer 1979) was not a factor in returns to nest sites. In addition, prior reproductive success was not a significant factor in returns to culverts in the previous stepwise analyses.

More females ($n = 10$) than males ($n = 2$) changed nest sites. All but one female stayed within the same half of the culvert and moved a mean distance of 12.1 m from the original nest site. Fidelity to culvert halves may be due to birds cueing on environmental surroundings and using the same entrances as the previous year. Furthermore, birds escaped via the nearest entrances when disturbed to avoid flying completely through the longer culverts.

Recaptures.—Within the same breeding season, 16 females were recaptured during successive clutch attempts and 81.3% ($n = 13$) were at the same nest sites showing a strong tenacity for successive clutches. Ten (76.9%) of the 13 were successful at fledging young during their previous attempts. This is in contrast to Shields (1984) who found successful birds tended to move to different nests for second clutch attempts.

The females ($n = 3$) that switched nest sites for successive clutches remained nearby. One nest was occupied by House Sparrows (*Passer domesticus*) within a week of Barn Swallows fledging and the female swallow was recaptured on a nest 5.0 m from the original nest. Another successful female was recaptured on a nest 1.6 m from the original fledging site which remained unoccupied. The other female was unsuccessful in hatching first-clutch eggs and was recaptured on a new nest built 0.8 m from the previous site.

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LITERATURE CITED

BARRENTINE, C. D. 1978. The biology of bridge-nesting Barn and Cliff Swallows in central Washington. M.S. thesis, Central Washington Univ., Ellensburg, Washington.

BENT, A. C. 1942. Life histories of the North American flycatchers, larks, swallows, and their allies. Smithsonian, U.S. Mus. Bull. 179.

BOYD, A. W., AND A. L. THOMSON. 1937. Recoveries of marked swallows within the British Isles. Brit. Birds. 30:278–287.

BURTT, E. H., JR., AND R. M. TUTTLE. 1983. Effect of timing on reproductive success of Tree Swallows. J. Field Ornithol. 54:319–323.

DAVIS, P. 1965. Recoveries of swallows ringed in Britain and Ireland. Bird Study 12: 151–168.

FREER, V. M. 1979. Factors affecting site tenacity in New York Bank Swallows. Bird-Banding 50:349–357.

HILDEN, O. 1965. Habitat selection in birds. Ann. Zool. Fenn. 2:53–75.

MARTIN, R. F. 1974. Syntopic culvert nesting of Cave and Barn Swallows in Texas. Auk 91:776–782.

MASON, E. A. 1953. Barn Swallow life history data based on banding records. Bird-Banding 24:91–100.

MOLLER, A. P. 1982. Clutch size in relation to nest size in the swallow *Hirundo rustica*. Ibis 124:339–343.

ODUM, E. P. 1971. Fundamentals of ecology. W. B. Saunders Co., Philadelphia.

SAMUEL, D. E. 1970. Banding, paint-marking and subsequent movements of Barn and Cliff Swallows. Bird-Banding 41:97–103.

———. 1971a. Field methods for sexing Barn Swallows. Ohio J. Sci. 71:125–128.

———. 1971b. The breeding biology of Barn and Cliff Swallows in West Virginia. Wilson Bull. 83:284–301.

SHIELDS, W. M. 1984. Factors affecting nest site fidelity in Adirondack Barn Swallows (*Hirundo rustica*). Auk 101:780–789.

SMITH, W. P. 1937. Further notes on the nesting of the Barn Swallow. Auk 54:65–69.

SNEDECOR, G. R., AND W. G. COCHRAN. 1980. Statistical methods. 7th edition. Iowa State University, Ames.

STAMM, A. L., AND F. W. STAMM. 1975. A Barn Swallow banding project. Kentucky Warbler 51:3–9.

WALL, W. A. 1982. A nesting study of Barn Swallows in north Louisiana. M.S. thesis, Louisiana Tech Univ., Ruston, Louisiana.

WELTY, J. C. 1979. 2nd edition. The life of birds. W. B. Saunders Co., Philadelphia.

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