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MOVEMENT AND MORTALITY ESTIMATES OF CLIFF SWALLOWS IN TEXAS

PATRICIA J. SIKES AND KEITH A. ARNOLD

The Cliff Swallow (*Hirundo pyrrhonota*) has been studied extensively in various parts of the country (Buss 1942, Emlen 1954, Myres 1957, Mayhew 1958, Samuel 1971, Grant and Quay 1977, Newnam 1980). Most of these studies deal with growth rates of young, basic biology, and behavior. Only Mayhew (1958) undertook a long term banding project to determine movements and mortality of Cliff Swallows. Samuel (1971) developed life history equations for Barn (*H. rustica*) and Cliff swallows, but based his results on models rather than years of data collection. In this paper we present data which document Cliff Swallow movements through successive years and give estimates of mortality for both adult and juvenile swallows.

METHODS

A trapping and banding operation begun by Newnam (1980) in 1974, has been continued by us through 1983. In our area, Cliff Swallows nest in cement drainage culverts under roads. Adults were captured by closing both ends of the culverts with 6 mm mesh minnow seines, approximately 0.5 h before dawn (Mayhew 1958). Headlamps were used to flush birds from nests. The swallows could then be captured by hand as they clung to the net, and placed in collapsible fish baskets used as holding cages. In 1981 through 1983, adults also were captured while on their nests. We quietly entered the culverts before dawn, without lights, and plugged the openings of the nests with cotton. At daybreak we re-entered the culvert and removed the cotton and the adults. We successfully trapped pairs on the nest only while they were sitting on eggs. Once the eggs hatched, either one or no parent was present. The adults were measured (wing chord, tarsus length, and weight), banded with U.S. Fish and Wildlife Service bands and released.

Young birds were banded when approximately 2 weeks old. They were removed by carefully breaking away the outside and top edges of the nest, enough to get two or three fingers in to remove the young. No measurements were taken on the young except during Newnam's (1980) growth rate study.

Birds were banded in six major colonies near Somerville, Texas: four in Burleson Co. and two in neighboring Washington Co. (Fig. 1). Usually only one colony of approximately 100–150 nests was active each year. An unusually high number of colonies were active in 1975 and 1983 and swallows at all five colonies active in these years were subjected to trapping at least once. Adults were captured in the only two active colonies in both 1981 and 1982.

Mortality estimates were derived using survival tables (Downing 1980). The two estimates acquired were tested in a simulated computer run to determine which estimate best fit our long-term recapture data.

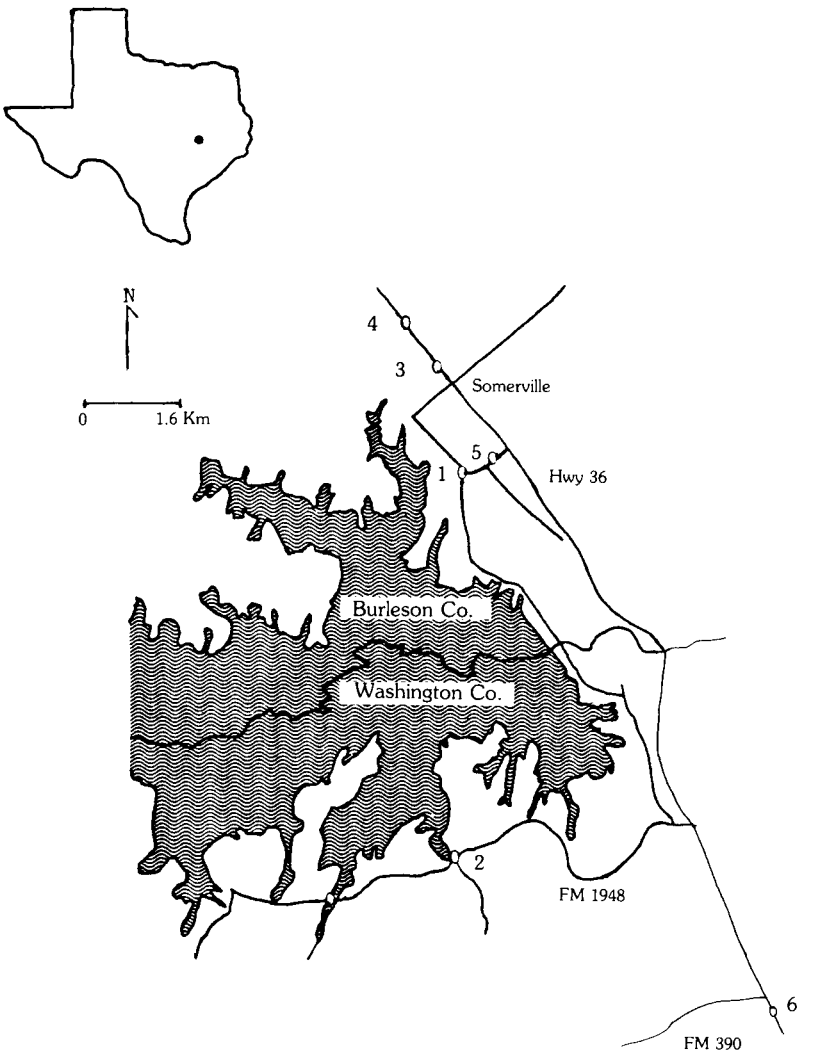

FIG. 1. Locations of colonies in Burleson and Washington counties, Texas.

RESULTS AND DISCUSSION

Movement.—Mayhew (1958), Samuel (1971), and Newnam (1980) have documented year-to-year movement of Cliff Swallows. For our study, Table 1 shows the percentage of adult and young Cliff Swallows returning to their banding culvert in subsequent years. Analysis of the first year's

TABLE 1

PERCENTAGES OF CLIFF SWALLOWS RETURNING TO THEIR BANDING CULVERT IN THE YEARS FOLLOWING BANDING

Year	% adults	% young
1st	45 (150/336)[a]	48 (136/285)
2nd	13 (17/132)	10 (13/132)
3rd	10 (5/50)	5 (2/38)
4th	34 (12/35)	55 (11/20)

[a] Numerator represents actual number of swallows recaptured in banding culvert, denominator represents total number of swallows recaptured in that age class.

returns reveals that only 45% (150) of the 336 recaptured adults and 48% (136) of the 285 recaptured juveniles nested in the same culvert as the previous year. In subsequent years, both adults and young tended to nest in other culverts. Possibly, this is a result of an increase of swallow bugs (*Oeciacus vicarius*) in the culverts. As suggested by Chapman (1973), the birds seem to change culverts to avoid these ectoparasites.

The movement of both adults and young to other culverts in the years after banding does not seem to follow Mayhew's (1958) loyalty hypothesis, which states that once a swallow nests in a particular culvert it has a strong desire to return to that culvert. However, four of the six culverts in our study area are within 2.0 aerial km of each other and thus lie within the same 10 min lat.-long. block. Only one of these culverts was active in each year of the study, except 1975 and 1983 when two were active, but the second culvert had fewer than 100 birds in each year and these birds mostly comprised renesters. In any one year, the majority of the population was concentrated in one of the four culverts. We have shown that individual birds will use different culverts in successive years and

TABLE 2

PERCENTAGES OF CLIFF SWALLOWS RETURNING TO CULVERTS IN THE SAME 10 MIN LAT.-LONG. BLOCK AS THEIR BANDING CULVERT IN THE YEARS FOLLOWING BANDING

Year	% adults	% young
1st	79 (267/336)[a]	74 (211/285)
2nd	80 (106/132)	58 (77/132)
3rd	76 (38/50)	37 (14/38)
4th	76 (26/35)	60 (12/20)

[a] Numerator represents actual number of swallows recaptured in same block, denominator represents total number of swallows recaptured for that age class.

TABLE 3
NUMBER OF ADULT CLIFF SWALLOWS CAPTURED OR KNOWN TO BE ALIVE

Age (years)	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
0–1[a]	13	363	100	120	134	146	119	176	393	528
1–2		3	125	10	36	33	30	21	58	109
2–3			3	73	5	18	21	17	18	22
3–4				2	31	1	9	14	14	8
4–5					2	22	1	6	14	4
5–6						—	11	—	5	10
6–7							—	3	—	3
7–8								—	3	—
8–9									—	2

[a] Represents number of unbanded adults captured, banded, and released each year.

thus we consider these four culverts to be used by one breeding population. Table 2 shows the change in percentages of returning birds if the four culverts are treated as the same "colony." The adults and juveniles seem to remain loyal to their breeding "colony" even though the actual culvert may be different. Approximately 79% (267) of the 336 recaptured adults and 74% (211) of the 285 recaptured juveniles return to the same "colony" to breed in the first year after banding. The percentage of returns remains high in subsequent years. No differences were found between the rate of return of each sex. Apparently, dispersal is not linked to sex or age.

Mortality.—Few estimates of the mortality of Cliff Swallows exist. Mayhew (1958) estimated a 50% annual adult mortality, based on recaptures. Samuel (1971) estimated a 65% annual mortality for young swallows over their first winter. He arrived at this percentage through estimated life equations. Harwood and Harrison (1977) estimated a 60% adult and 80% juvenile mortality of Sand Martins (=Bank Swallow [*Riparia riparia*]) based on recovery data. Mead (1979) estimated 65% adult and 77% juvenile mortality of Sand Martins based on recoveries. As Cliff Swallow recovery data are scarce, our data are based on recaptures.

Tables 3 and 4 show the number of adults and juveniles, respectively, that were captured or known to be alive from subsequent recaptures for each year. Age 0–1 represents the number of unbanded adults and nestlings, respectively, that were captured, banded, and released each year. We used these data to calculate calculate survival tables (Downing 1980). Table 5 shows the survival rates based on a composite of all adult and all juvenile cohorts. Survival rates averaged 0.460 for adults and 0.537 for juveniles. Another method used was to determine the overall mean

TABLE 4
NUMBER OF JUVENILE CLIFF SWALLOWS CAPTURED OR KNOWN TO BE ALIVE

Age (years)	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
0–1[a]	315	455	0	0	75	74	175	670	706	755
1–2		37	67	—	—	7	4	26	104	137
2–3			36	58	—	—	4	3	21	39
3–4				26	19	—	—	4	2	9
4–5					16	16	—	—	3	1
5–6						12	10	—	—	1
6–7							8	6	—	—
7–8								6	5	—
8–9									5	—
9–10										4

[a] Represents number of nestlings banded and released each year.

of each cohort's annual survival rate. For example, 363 unbanded adults were captured in 1975 (Table 3). Of these, 125 were recaptured or known to be alive in 1976, 73 in 1977, etc. The calculated survival rate was 125/363 or 0.344 and 73/125 or 0.584, etc. This calculation was done for each cohort through each year. These individual survival rates were summed and then divided by the total number of calculations or the total number of yearly intervals for each cohort. The adult mean survival rate was 2020.8/37 = 0.546. The juvenile mean survival rate (Table 4) was 1729.4/31 = 0.558.

To determine which of the two calculations of adult survival (0.460 vs 0.546) was more realistic, we tested each in a simulated computer run against our data. The computer run allowed us to compare the theoretical number of adults that should survive to any given year based on each mortality estimate, against the actual number we recaptured. From these tests we found that the 0.546 survival rate best fit our long-term recapture data. Overall, a 45% mortality of both adults and juveniles appears to represent mortality for our populations.

The problem with determining a differential mortality for adults and juveniles must be resolved in the first year after banding. Table 5 shows a tremendous decrease in the survival of both adults and juveniles the first year after banding. Twenty-seven percent (425) of the 1564 adults banded through 1982 are recaptured at some time, whereas, only 16% (382) of the 2470 juveniles banded through 1982 are ever recaptured. So 11% more adults survived than juveniles through their first year suggesting a higher first year juvenile mortality. However, of those swallows that are

TABLE 5
SURVIVAL TABLE BASED ON A COMPOSITE OF ALL ADULT COHORTS AND ALL JUVENILE COHORTS

Age (years)	Adults		Juveniles	
	Pop. size[a]	Survival rate[b]	Pop. size[a]	Survival rate[b]
0–1	1564	0.272	2470	0.155
1–2	425	0.416	382	0.421
2–3	177	0.446	161	0.373
3–4	79	0.620	60	0.600
4–5	49	0.531	36	0.639
5–6	26	0.231	23	0.609
6–7	6	0.500	14	0.786
7–8	3	0.667	11	0.455
8–9	2	1.000	5	0.800
9–10	—	—	4	1.000

[a] Summation of all numbers in each age class from Tables 3 and 4, respectively, excluding age 0–1 in 1983 since no recaptures have been made from that year.
[b] Population size of second age class/population size of first age class, i.e., 425/1564 = 0.272.

subsequently recaptured the mortality decreases to approximately 35% for adults and juveniles alike. This suggests a high mortality or dispersal after the initial banding, but once they are recaptured they are likely to be recaptured again in successive years.

We attempted to use Jolly's (1965) method to estimate survivorship based on recapture data. Lack of consistency in our banding effort resulted in low numbers of recaptures in some years which caused the calculated estimates to be untenable. Many of our recaptures were not caught each year and were seen only once or twice in the 9 years of study. Four of our six 9-year-old birds were recaptured for the first time in 1982 or 1983. Nine years is the longevity record for Cliff Swallows (M. K. Klimkiewicz, pers. comm.). This gap in recapture time caused problems when we attempted to use the Jolly method.

In general, our mortality estimates did not vary greatly from Mayhew's (1958). An average of 45% annual mortality for adult and juvenile Cliff Swallows was estimated from our data as opposed to 50% for Mayhew. Samuel's (1971) estimate of 65% first year juvenile mortality was lower than our estimated 84% mortality. However, we also had a high first year adult adult mortality of 73%. These high percentages could represent dispersal, as well as mortality. Cliff Swallows are spreading rapidly southward in Texas and many of these "missing" birds could be pioneering new colonies.

SUMMARY

We used 9 years of banding data to study movement patterns and to estimate mortality of Cliff Swallows (*Hirundo pyrrhonota*). Adult swallows averaged a 79% return rate to their breeding "colony," but not necessarily to their breeding culvert. Young swallows averaged a 74% return rate to their breeding "colony." No significant difference was found between the rate of return of either sex. Using Downing's (1980) survival tables, we calculated a 45% annual mortality for both adults and juveniles. Juvenile first year mortality was 11% higher than adult mortality. Six 9-year-old swallows were captured during the study, tying the existing longevity record.

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DEPT. WILDLIFE AND FISHERIES SCIENCES, TEXAS A&M UNIV., COLLEGE STATION, TEXAS 77843. ACCEPTED 29 FEB. 1984.