

strip aluminum, number 16 standard wire gauge in thickness, and 125 x 10 millimetres in measurements. Dual numbers are stamped on four times and triple numbers, three times; the legend is stamped in between these numbers. The diameter of the band is adjustable in the field.

The bands remain serviceable from two to five years, according to the wearing propensities of the terrain, and then have to be replaced.

All penguins are footmarked by puncturing the webs according to a pre-arranged plan. Footmarking ensures that, in most cases, the identity of any given penguin is not lost and, in this way, is more efficient than bands. Bands, however, make for more speedy recognition of the bird in the field.

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23 Skibo St., Kew, Dunedin, New Zealand.

(*Ed. note:* by way of comparison, bands furnished by the Fish and Wildlife Service in sizes 5 and 6 are of number 18 gauge, while sizes 7A and 7B are of number 16 and sizes 8 and 9 are of number 14. Widths are 6/16 inches for sizes 5 and 6, 7/16 for sizes 7A and 7B, and 8/16 for sizes 8 and 9. These are in terms of the American Standard Wire Gauge while Mr. Richdale's are in the Imperial Standard Wire Gauge. Number 14 American Gauge is about equal to number 16 Imperial Gauge, number 16 to number 18, and number 18 to number 19.)

THE SOUTH WINDSOR BANK SWALLOW COLONY

By E. ALEXANDER BERGSTROM

This paper represents the preliminary results of the banding of Bank Swallows (*Riparia r. riparia* Linnaeus) at a single colony in South Windsor, Conn., in the seasons of 1945 through 1950. The site is a long-established one, on the east side of the Connecticut River where the river keeps eroding the meadow, and at least half a mile from any house.

METHODS OF STUDY

As several feet of the meadow were generally washed away each winter, it was impossible to put permanent markers in the face of the bank, and impractical to arrange for a precise survey each spring. Using a 50-foot tape, we made rough measurements of the bank, placing numbered wooden stakes at 100-foot intervals each year. Approximate accuracy in placing the stakes at the same spot each year along the half mile of bank occupied by the swallows was obtained by placing stake 11 at a pasture fence running back at right angles to the river.

Having sections marked off made counts feasible, and we soon found that counting all burrows two inches or more deep gave figures perhaps 25% higher than when we tried to eliminate unused burrows by direct observation. The counts by section (Table 1) are admittedly still a little high, and not of uniform accuracy. Most burrows could be reached quite readily, where the river formed giant steps by its successive stages in spring, but occasionally some sections were too steep for easy banding. The variations in counts for each section year by year reflect quite subtle environmental changes, as the bank was not disturbed by man and no part of it was stony or covered with heavy vegetation.

As most of the time available for banding was on weekends and the season hardly more than six weeks long, it was important to us to find ways to trap as many Bank Swallows as possible in that time, consistent with their safety and the accuracy of our records. None of the techniques of daytime trapping seemed very effective, such as the use of a gathering cage, or of an insect net (Dexter, 1942), or digging out nestlings (Stoner, 1936). Where burrows were close together it would have been impossible to restore their entrances after such digging. We found blocking the burrows at night to be much the best procedure. We had poor results when we did so just after dark (Burdick, 1943) as the swallows remained restless. It proved much more satisfactory to finish blocking the burrows by a half hour before dawn, so that daylight was available for the actual banding (Morris, 1942). It was imperative to make as little noise and step as lightly as possible, to avoid startling many birds into nocturnal flight. Only ten to 20 burrows per active bander were blocked with traps, but 75 to 100 more with wads of crumpled newspaper, to be replaced by traps at our convenience. As we did not have a large crew available, this enabled each of us to handle more birds without keeping them fluttering in traps for long periods. We did not consider it wise to make a practice of staying in the colony past mid-morning, particularly when there were young swallows to be fed. Using a mirror to reflect sunlight proved to be the best way to see into the burrows, though it was not possible to see well enough to count eggs, and some burrows were too irregular for the nest chamber to be visible at all.

Hairnets, as recommended by the Manual for Bird Banders, proved mediocre as traps, taking only one bird at a time and needing constant repairs. The basic idea of cellophane bags fastened over a cardboard tube with a rubber band (Morris, 1942) was excellent, but thin cardboard did not make very good tubes. We were fortunate in obtaining very heavy, rigid cardboard tubes on which paper for billing machines

TABLE I: COUNTS BY SECTIONS OF BANK

Section	1945	1946	1947	1948	1949	1950
South of 1	.....	.....	20	108	21	.....
1-2	.....	50	67	48	14	28
2-3	.....	66	.....	1	42	3*
3-4	82	1	23	.....	3	.....
4-5	60	1	.....	.....	5	.....
5-6	.....	.....	.....	.....	5	.....
6-7	77	.....	3	.....	.....	.....
7-8	93	3	45	.....	.....	.....
8-9	45	.....	.....	.....	.....	.....
9-10	25	20	.....	.....	.....	.....
10-11	52	42	12	.....	.....	26
11-12	.....	54	20	49	22	13
12-13	6	68	52	36	.....	16
13-14	55	68	19	5	.....	28
14-15	40	54	2	1	.....	7
15-16	53	101	.....	.....	92	12
16-17	48	22	.....	.....	63	8
17-18	34	21	54	135	109	44
18-19	82	51	90	53	65	39
19-20	.....	.....	1	68	3	.....
20-21	.....	.....	.....	109	.....	.....
21-22	1	9	8	170	9	.....
22-23	14	52	1	2	38	4
23-24	5	33	47	.....	.....	.....
24-25	26	44	32	.....	5	4
25-26	112	105	102	.....	.....	33
North of 26	.....	1	18	.....	.....	20
Totals	910	866	616	785	496	285

*these three burrows were between stakes 2 and 10.

was rolled; they never collapsed and could be used dozens of times before wearing out. The two-pound cellophane bag (sold for home freezers) will hold up to half a dozen Bank Swallows at a time, and can be reused several times; admittedly it cannot be used at all in the rain, as the seams come apart, but this is hardly a major fault. Traps of this sort can be carried in quantity in a knapsack and can be placed speedily in any burrow that is within reach at all. Each bander can keep 10 to twenty in use, using quiet periods to move a few of the traps which had been in place longest without yielding results. Some burrows may hold no swallows because they had already raised their brood or because they became alarmed in the night and flew out; others may contain brooding females too tenacious to yield to any methods we cared to use. Too intensive an effort to capture all the swallows in one small area is dangerous in theory and was demonstrated by the Stoners to be bad in practice (Stoner, 1936).

Table 2 shows the results of the banding trips, year by year. Using the methods described earlier, each bander normally could average 20 newly banded Bank Swallows per hour of actual banding, after extensive preparations in advance. One reason for the high average was that, in contrast to daytime trapping, we captured both adults or several young birds at once, in a high percentage of cases. Bands were opened in advance and a dozen slipped onto each numbered blanket pin;

TABLE 2: BANK SWALLOWS BANDED AND RECAPTURED

Year	1944	1945	1946	1947	1948	1949	1950
Burrows	835	910	866	616	785	496	285
Adults Banded	309	248	409	410	220	98
Im. Banded	137	.....	23	116	54	.....
Total	446	248	432	526	274	98
Adults Available for Recapture.....	309	557	966	1376	1596
Adult Returns	14	37	72	52	24
Im. Available	137	137	160	276	330
Im. Returns	4	2	3	7	.....

each pin corresponded to one of our mimeographed sheets for keeping records during banding (letterhead size, on clip boards). Band numbers were placed on the sheet in advance with a hand numbering machine; space was provided for the date, bander, band pin number, section of bank, whether the bird was immature, and notes (used largely for return records). The method was helpful in promoting accuracy and the consecutive use of bands. Each burrow was marked with a six-inch garden label showing the numbers of banded birds and the date, mostly for reference later in the season when banding young swallows. Our permanent records were kept on three by five inch cards, one to a bird, using a rubber stamp as much as possible and marking returns and recoveries with colored metal signal tabs.

THE EFFECTS OF HIGH WATER

The Bank Swallow requires a special sort of disturbance community in which to nest, an abrupt bank with a minimum of vegetation. Man-made sites tend to be too hazardous (such as active gravel pits), or short-lived if the bank slumps and becomes covered with vegetation. The best sites along streams are on curves where annual erosion takes place, and the only Bank Swallow colony in the Hartford region known to have been comparable to that at South Windsor was one at Glastonbury which was eliminated 30 years ago when the bank was ripped up to protect the channel.

We could not measure the precise river height at South Windsor, but found that a bank-full stage occurred when the river height at Hartford was about 20 feet. While it appears that there is generally a foot or two difference in actual height over that five-mile distance, we used the Hartford figures since we were interested primarily in relative heights in different seasons. Zero on the Hartford gage is .55 feet below mean sea level at Saybrook on Long Island Sound, 51.8 miles down-stream; the range of recorded heights is from 37.56 feet to just under one foot. It happened that the official flood stage, 16 feet, is also the point at which direct flooding of Bank Swallow burrows at South Windsor will begin. Stages of ten feet or more may cause the collapse of sections of bank, depending mostly on the length of time the river remains at that height, and the strength and direction of the wind.

While the Bank Swallow is dependent on some annual erosion at such sites, one of the major limitations on the population is high water in nesting season. The most striking of the specific examples at South Windsor was the season of 1897, with river stages of just over 20 feet

on June 12 and July 16, so that the raising of any young would have been impossible. No year since 1897 has involved such severe conditions, and while there are some records of river height back to 1639, those in earlier centuries are fragmentary. We do know of ten other years when the Connecticut reached flood stage once during the swallows' nesting season, but it is likely that some young were raised in each year, particularly since some of the flood stages were very early or late in the season. Failure to raise any young, or a marked reduction in the number raised, would impose a very severe strain on a colony of a species as short-lived as the Bank Swallow, and recovery to former numbers would be slow at best.

No flood stages occurred during the six seasons of our banding at the colony, but on two occasions, the river rose to just below flood stage, with some disruption of the nesting season. A crest of 14.6 feet on May 29, 1946, washed away or shortened many burrows, and caused some movement of birds (referred to later in this paper). A count of burrows made three days before the crest was actually exceeded that July, but many sections of bank showed marked fluctuation: for example, section 3-4 dropped from 55 burrows to one, and 15-16 from 185 to 101. In 1947 the river reached 15.8 feet on June 6, with obvious erosion of burrows, and a drop in estimated burrows from 785 on May 25 to 608 on June 13. It is likely that at least some of the swallows renested; we did not make a July count that year.

THE EFFECTS OF COLD RAIN

Heavy mortality of fledglings of many species of swallows and swifts has been observed in periods of very cold, rainy weather in the nesting season, due to the disappearance of aeroplankton (see for example, Koskimies, 1950). In the seasons which we observed, 1945 started cool and wet but improved in June, still being considered a poor year for swallows in New England generally (this and the following comments depend in part on the Records of New England Birds). The 1946 and 1947 seasons were generally quite favorable in temperature and rainfall, in sharp contrast to 1948, which was a poor season for nesting landbirds throughout New England, and for swallows in particular. May at Boston was the worst on record for rain, cloudiness and low temperatures, and June had the lowest average temperature since 1919. Hartford weather was similar, showing for example an excess of 4.71 inches of rainfall for June. Seasons of high water and heavy rainfall at South Windsor do not necessarily coincide, because of the watershed of more than 10,000 square miles above the colony. While the 1949 season was an exceptionally warm and dry one, swallows of several species were reported as scarce in several parts of New England. The 1950 season was also warm and generally favorable for landbirds, though with quite a bit of rain at Hartford.

REASONS FOR POPULATION CHANGES

We are unable to offer any precise explanation for the recent decrease in the sizes of the South Windsor Bank Swallow colony. It appears that the effects of human interference and predation were slight. While the

six seasons involved were those in which the general use of DDT insecticides expanded greatly, no wholesale spraying of the area near the colony is known, and there was no apparent dearth of aerial insects. As the bank itself stayed in favorable condition for the swallows, I am inclined to ascribe the drop in population primarily to the bad weather of June 1948, and secondarily to the erosion by high water during the 1945 and 1947 seasons. The drop in 1950 as compared to 1949 is puzzling, but might be laid to high mortality rates due to loss of vigor in June 1948. Furthermore, it is likely that the number of young raised in June 1948 was below normal; this was my impression at the time, although no exact count was feasible, and a substantial number of young did survive to flying age.

MOVEMENTS WITHIN THE COLONY

Only occasionally is it possible to record the nest sites of individual birds in successive years with even approximate accuracy. This usually involves either endless hours of observation, as for the Interpont Song Sparrows (Nice, 1937), or limited parts of a colony, such as the study quadrats laid out on Tern Island, Chatham (Austin, 1947). The South Windsor Bank Swallow colony was an easy one in which to make such records, as the entrances to the burrows were in what amounted to a single dimension, a thin line not over four feet up and down and half a mile long.

We had wondered whether the colony was made up of several smaller ones or whether it was homogeneous. There were occasional distances of hundreds of feet along the bank with no burrows, and it seemed possible that groups of swallows from other sites had from time to time moved to this particularly favorable one, due to human interference with their previous sites or due to heavy losses at the South Windsor colony from some June flood. It has been demonstrated with respect to the Common Tern (Austin, 1951) that group adherence functions during the entire life of that species, and tends to coalesce terns into progressively larger units in which reproductive success is greater; it is effective even when site tenacity ceases to function because of ecological or other environmental changes. However, it would seem that group adherence would be a much less important trait of the Bank Swallow because its normal life span is so brief compared to terns. While group adherence in terns seems to originate with family groups, I do not know that it has been possible to demonstrate survival of the group after the death of all its original members, though such survival seems possible in theory, at least in long-lived species.

All of our data indicate that the South Windsor Bank Swallows formed a single colony, with no permanent subdivisions. As in other Bank Swallow banding (for example, Stoner, 1937), we found a strong tendency for adults to return to the same spot where they had nested in previous years. Out of a group of 162 returns of swallows banded as adults, where the section of bank was recorded in consecutive years, 24 were in the same section and 35 in the next, the numbers grading off rather evenly to a single adult which moved 20 sections. 11 out of 162 moved more than ten sections. Comparable data were available on only

12 swallows banded as young, and while a number of them were found in or near the same section as they had been banded in, greater average movement than for adults was apparent. One moved ten sections, one moved 15 sections, two moved 16 sections and one moved 24 sections.

Since it has been shown that site tenacity in Common Terns is particularly strong in older birds, which thus play an important part in keeping the colony at the same site (Austin, 1945), it seemed possible that older Bank Swallows play a similar part. While we reviewed data on 25 swallows which returned at least twice, no conclusive results could be shown, due in my opinion to minor annual changes in the various parts of the bank. While there were no gross changes in the bank, the varying distribution of burrows year by year seems to have been caused by relatively minor differences in vegetation, steepness and heaviness of soil. While only three out of the 15 birds which were captured three successive years were in the same sections each year, it was noteworthy that they were in sections which remained consistently desirable for the swallows (as shown by substantial counts each year). 46-50201, which was banded as an adult in section 15-16 in 1946, was taken the next three years in section 17-18. On the other hand, the only other bird taken in four different years, 46-50210, was in a different section each year, between stakes 14 and 23.

We were unable to find any instances of movement to a different part of the bank, in successive years, by groups of swallows, nor did we find any decided drift toward one end of the colony or the other.

Data on movements during a single season are less numerous. In 1946 three adult swallows were banded in late May at South Windsor and retaken (after the May 29 high water) by Mr. G. H. Parks at the Fishfry St. colony, some three miles south along the river. None of the sections of bank from which these three came suffered any net loss of burrows. Of four birds taken as repeats on June 1, two were in the sections where banded, one was in the next section and one had moved 12 sections; the latter birds also had new mates. In the six seasons, 59 out of 70 repeat records were in the same section where banded. Trapping at the very beginning or end of the season is more likely to reveal movement to a different section, though July repeats as a whole were predominantly in the original section.

MOVEMENTS OUTSIDE THE COLONY

While we have 215 return records within the colony, there are but seven recoveries (by the current definition, at a distance of a mile or more). In addition to the birds referred to in the previous paragraph, three adults banded in 1945 were taken at Fishfry St. in 1946, and an adult banded in 1950 was found dead within a month in Windsor, across the river. One bird taken at South Windsor in 1950 had been banded at Fishfry St. in a previous year.

It is not surprising that no recoveries farther away from the colony have been noted, considering the difficulty of capturing the species away from the nesting site, and the limited number of persons banding the species at all. A rough estimate was made as of late October 1950, using our complete figures and complete figures for the Stoners' work

(kindly supplied by Mrs. Stoner), but otherwise using the return cards at the Patuxent Research Refuge, to the extent that they had been sorted and punched (thus omitting the 1949 and 1950 nesting seasons, and probably 1948 as well). Of about 713 return and recovery records for the Bank Swallow in North America, only seven show movement of more than 15 miles or so from the nesting site, even though the species is in no sense sedentary. They are given below; two (marked with an asterisk) appeared in *Bird-Banding* a number of years ago.

- *C30270, banded at Clear Lake, Ind., June 12, 1932, by Prof. J. W. Stack, was found in house (probably dead), June 1936 at Rio Maranon, near Iquitos, Peru (on a tributary of the Amazon).
- *H68930, banded at Ephraim, Wisc., June 8, 1933, by Harold C. Wilson, was found dead at Manistique, Mich., June 30, 1934.
- L40257, banded at Indianapolis, Ind., July 4, 1933, by S. E. Perkins, III, was found injured (later died) at Delong, Ind., about 90 miles north-northwest, on July 14, 1933.
- 139-27559, banded at Palos Park, Ill., by George Kent on July 16, 1939, was found at La Tempestad, Iquitos, Peru, on January 6, 1940.
- 39-94378, banded at Oneida Lake, New York, by Dayton and Lillian C. Stoner on May 22, 1940, was found dead at College Station, Texas, on May 7, 1941, by W. B. Taylor.
- 40-21157, banded at Waukeska, Wisc., by V. C. Rossman on May 25, 1940, was killed at Westerville, Ohio, on September 7, 1942.
- 42-63192, banded at Komoka, Ontario, by William Morris on July 2, 1942, was found dead at Holland, Mich., on September 3, 1946.

The Peruvian recoveries are from the same general area as the first South American records for the Chimney Swift (Lincoln, 1944). It is interesting to note that of 30 returns or recoveries of Bank Swallows (Sand Martins) banded in Great Britain, three show movement: young birds found dead in the same year during their migration along the west coast of France (Loire Inferieure and Vendee) (Leach, 1949).

OVERALL RETURNS AND RECOVERIES

Table 3 summarizes the returns and recoveries for all swallow banding in North America and Great Britain. The British data are from Thomson (1949); the North American data are from the Patuxent files in October, 1950, except for the Stoner and South Windsor data. No birds banded at South Windsor in 1950 were included, but the Patuxent total of swallows banded probably includes some on which there had been no time for returns (because of the substantial number of birds reported for a fiscal year later than the actual fiscal year in which they were banded). It is believed that all the totals are of reports rather than individuals, counting certain swallows several times if reported in several different years.

The comparison between varying return ratios indicated for the Bank Swallow is instructive. The work done by the Stoners and ourselves pulls the North American ratio up to a point well above that for Great Britain, but the remaining North American returns and recoveries show a ratio exactly the same as the British, .6%. It does not appear that these differing ratios are indicative of different mortality rates or any sort of regional difference between different populations

TABLE 3: OVERALL RETURNS AND RECOVERIES

Species	Years	Banded	No.	%
European Swallow	1909-47	48,934	436	.9
House Martin	"	13,248	84	.6
Sand Martin	"	5,201	30	.6
Tree Swallow	1924-49	18,627	1743	9.3
Bank Swallow—N. America.....	"	29,040	713	2.4
Bank Swallow—Stoners	1923-	7,500	296	3.9
Bank Swallow—S. Windsor.....	1945-	1,926	221	11.5
Rough-winged Swallow	1924-49	1,107	6	.5
Barn Swallow	"	37,416	844	2.3
Cliff Swallow	"	7,602	70	.9
Violet-green Swallow	"	652	24	3.7

of the species. Part of the explanation lies in the smaller proportion of birds banded as young in the South Windsor totals, but the primary explanation is that at South Windsor it has been possible to carry on banding in a single colony more intensively and for more consecutive years than in most other Bank Swallow banding projects. Fluctuations in the size of the South Windsor colony, in the number of swallows banded there each year and in the opportunities to retake swallows banded in previous years have made it impossible as yet to work out mortality rates from these data.

The very high return ratio for Tree Swallows is impressive, and may well be the highest for any passerine species banded in substantial numbers. As compared to the Barn Swallow, adult Tree Swallows are easier to capture, and a substantial part of the banding has been done in long-term, intensive projects (for example, see Low, 1934).

EXTREME OLD AGE IN BANK SWALLOWS

While our banding at South Windsor has not gone on for long enough to show any very old swallows, two birds banded as adults have been known to reach at least five years of age. The Patuxent files contain at least 13 other individuals of that age, with the record still held by 35-59216, banded as an adult and retaken at an age of at least seven years (Stoner, 1942). As this is close to the maximum age recorded for the Song Sparrow and other small passerines, it is unlikely that future banding will reveal any individual Bank Swallow very much older.

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SUMMARY

Some results of six years of banding Bank Swallows at South Windsor, Conn., are described. Birds were taken by blocking the

burrows before dawn. Occasional periods of cold rain or floods during the nesting season are important limitations on the size of the colony. While there was a tendency for swallows to return to the same part of the bank in following years, there was some movement to other parts. Return and recovery records for this and the other swallows found in North America and Great Britain are summarized.

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