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Bank and Rough-Winged Swallow use of the Mississippi River near Monticello, Minnesota

Stephen V. Thrune

BANK AND ROUGH-WINGED SWALLOW USE OF THE MISSISSIPPI RIVER NEAR MONTICELLO, MINNESOTA

by

Stephen V. Thrune

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This thesis submitted by Stephen V. Thrune in partial fulfillment of the requirements for the Degree of Master of Arts at St. Cloud State College is hereby approved by the final evaluation committee.

Alfred J. Hopwood, Chairman

Alfred H. Grewe

Ruben L. Parson

Lowell R. Gillett
Dean, School of Graduate Studies

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A program of field observations was devised to determine the extent of use of the Mississippi River near Monticello, Minnesota, by bank and rough-winged swallows. The study area extended from one mile above a nuclear-powered electricity generating plant to three miles below the plant. Field work was initiated in June, 1971, and terminated in September, 1972. Swallow colonies in river banks were inspected and various parameters were recorded. Birds were observed during nesting and fledging periods to determine behavior. Swallows were mist-netted and banded to determine ranges in hatching and fledging dates and to determine the size of the local breeding swallow community. Band recapture data for 1972 indicated a dispersal of birds banded in 1971 and a marked habitat preference. Post-fledging data indicated a marked preference for foraging over a rapids upstream of the power plant and for perching on transmission wires near this rapids. The normal operation of the power plant did not appreciably alter the usage of the river by bank and rough-winged swallows.

May 1973
Month Year

Approved by Research Committee:

Alfred J. Hopwood, Chairman
Alfred J. Hopwood

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CHAPTER I

INTRODUCTION

Bank and rough-winged swallows[1] are often seen hunting above various water bodies. Canoeists have stopped to marvel at colonies in river banks. Trout fishermen have watched hundreds of swallows swarming over a riffle during an insect emergence. Gravel pit operators have noticed numerous burrows in the vertical gravel banks. Road construction crews have made hundreds of potential homesites for swallows by constructing roads through rolling terrain.

Rapid erratic flight and small delicate size separate bank and rough-winged swallows from most other birds seen by observers. These are the smallest swallows in the United States. Bank swallows nest from Arizona, Texas, Alabama, and Tennessee northward through the Canadian provinces. Rough-winged swallows nest from the lower parts of the Canadian provinces southward through the entire United States. Bank swallows winter in South America; rough-winged swallows winter in Central America (Bent, 1963).

Bank and rough-winged swallows migrate to the northern latitudes in spring. According to migration records kept at St. Cloud State College, the swallows arrive in the St. Cloud area about the end of

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[1]Scientific designations of organisms mentioned in the text are listed in the Appendix.

April. They begin nesting activities two weeks after arrival. Both species nest in holes excavated into banks. Bank swallows use freshly exposed earthen banks, while rough-winged swallows modify existing holes.

Bank and rough-winged swallows normally feed over or near water. These birds eat flying insects only, but because the young are initially fed only soft-bodied insects by their parents, the nesting sites should be near water where emerging soft-bodied insects predominate.

Northern States Power Company has constructed a 545 megawatt power plant 3.5 miles upstream from Monticello, Minnesota. This nuclear-powered electricity generating plant uses water from the Mississippi River to remove the waste heat from power production, and the thermally enriched effluent from the plant is discharged into the river.

I have attempted to determine how bank and rough-winged swallows utilize the river habitat as a total resource and how the power plant affects that resource. The power plant could affect the local swallow populations if the heated effluent caused some change in the benthic insect populations and consequently reduced, decimated, or eliminated their food source.

CHAPTER II

METHODS AND MATERIALS

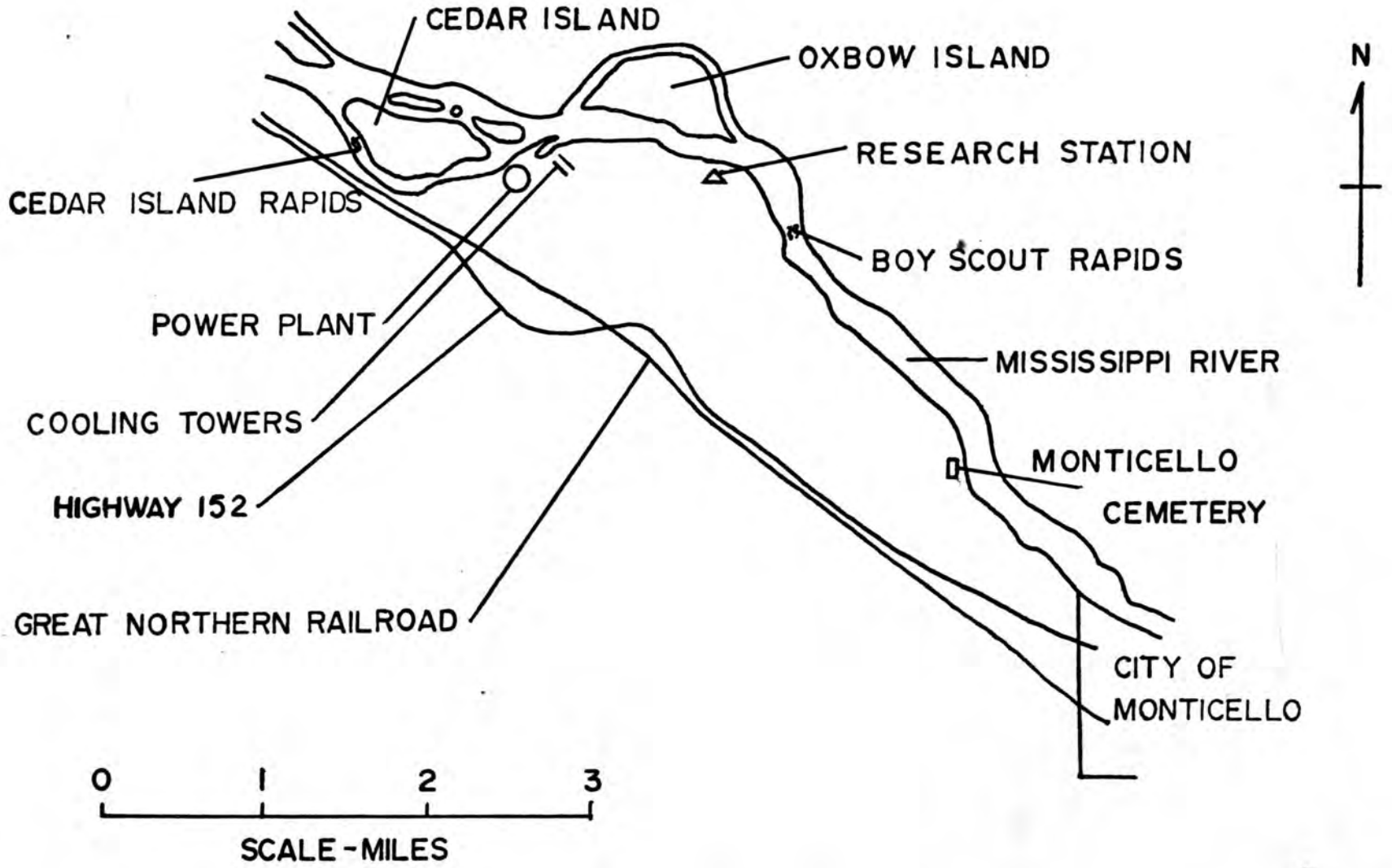
I began the study in June, 1971. It continued through two nesting seasons and was terminated in September of 1972. The study area extended from 1 mi above the plant at the western tip of Cedar Island downstream to 3 mi below the plant at the Monticello Cemetery (Figure 1.) This report is based on observations and measurements collected at several nesting sites in the vicinity of the power plant. I netted swallows to determine hatching and fledging times. I have attempted to estimate the size of the bank and rough-winged swallow community by banding as many birds as possible and by trying to determine the number of active burrows at each colony. I have described bank use by nesting adults and determined burrow dimensions and the substrate necessary for their construction.

Colony and Burrow Inspection

An average swallow colony in the area could be described as a 4-ft high 50-ft long vertical section of an 80-ft long bank of exposed sandy loam. Swallow burrows were clustered in the vertical section of the bank. Few roots projected from the bank's face and pieces of sod from the former river bank littered the talus slope below the bank.

Because of their locations, it was easiest to approach the colony

Figure 1. Map of the study area near Monticello, Minnesota.


CEDAR ISLAND
OXBOW ISLAND
N
RESEARCH STATION
CEDAR ISLAND RAPIDS
BOY SCOUT RAPIDS
POWER PLANT
MISSISSIPPI RIVER
COOLING TOWERS
MONTICELLO
CEMETERY
HIGHWAY 152
GREAT NORTHERN RAILROAD
CITY OF
MONTICELLO
0
1
2
3
SCALE - MILES

sites by boat. However, in June of 1971 I began close inspection of the colonies on foot. The river at that time was about 2 ft above normal summer level and receding. In 1972 I began inspecting the colonies by boat because the water level was 6 ft above normal. When the water receded to 5 ft above normal, I continued the inspection on foot. At that time I collected soil samples for subsequent mechanical laboratory analysis. The Bouyoucos method (Bouyoucos, 1951) was used to identify the textural class of the soil in each colony.

To inspect the swallow burrows I used a two-cell flashlight and a flat wooden stick 1 in. wide, 0.25 in. thick, and 52 in. long. On cloudy days the flashlight was used to illuminate the burrows. In bright sunshine I used the flashlight's glass face to reflect sunlight into the burrows. I probed the burrows with the stick and recorded various dimensions and observations.

Depth measurements of burrows in 1971 were made after all birds had fledged. Depth measurements of burrows in 1972 were made on 13 June. Nests were found in most of the burrows, indicating that most burrow construction had been completed. No post-fledging depth measurements were made because 11 days after the completion of fledging the river rose 5 ft. The following day it rose another 2 ft and the ensuing current eroded the faces of the colonies, making accurate burrow measurements impossible.

Netting Procedure

Birds were captured with four-shelf black nylon mist nets 42 ft long and 5 ft high with 1.5 in. mesh. Birds were netted as early as

0450 and as late as 2130 Central Daylight Saving Time (CDST). Initially I began netting at 0900 and continued until I had netted each area once, until the wind had increased enough to disrupt the fragile net, or until the temperature had increased and caused the birds to hyperventilate. The netting procedure involved the closely timed use of two mist nets. I set the first net in the first area. Then I left the first area and waited 20 min. I set the second net in a second area. Thirty minutes after leaving the first net I returned to band the captured birds. Then I set the first net at a third area. I returned to band the birds at the second area 30 min after I had left it. I then set the second net in a fourth area. This procedure was continued until all areas were sampled. To avoid prolonged disturbance, I never set the mist nets adjacent to each other in a colony.

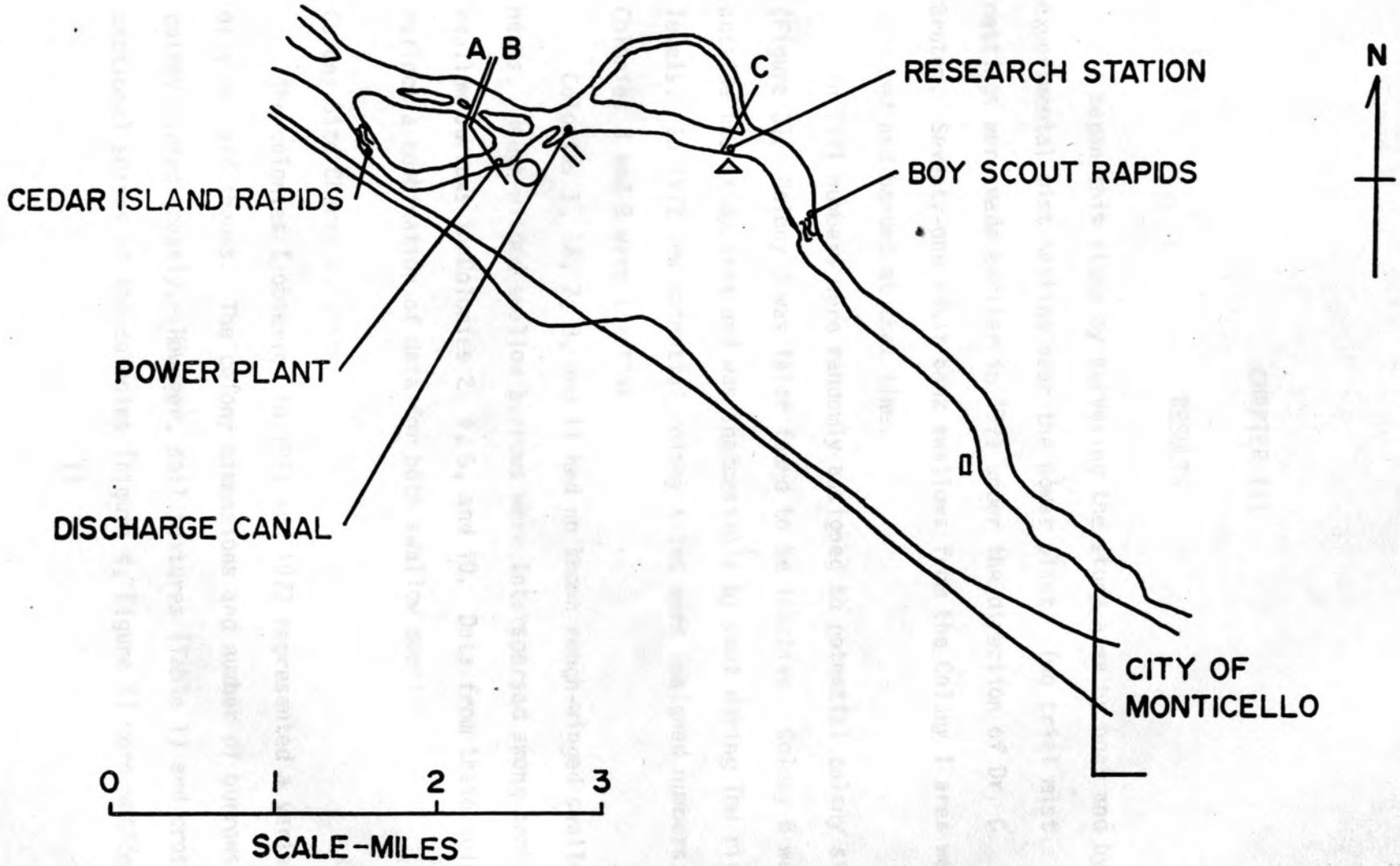
I placed mist nets no farther than 2 ft from burrow entrances during the daylight hours. The tops of the nets were placed below most of the burrows. Birds were able to avoid the nets and enter the burrows, but they became entangled as they left the burrows with their usual downward swoop. When I set the nets before sunrise, however, the tops of the nets were above the highest burrows. At this time the nets were nearly invisible and the swallows were readily caught both entering and leaving burrows. The captured birds were banded and data regarding each bird's age, species, and band number were recorded.

River and Riverbank Use by Swallows

In 1972 after the birds had fledged I made an effort to determine whether swallows prefer certain areas for foraging and perching.

Observations were made at Cedar Island Rapids, the power plant, the mouth of the discharge canal, the research station, and Boy Scout Rapids (Figure 2). At each site I allowed sufficient time for the birds to calm after my approach and then I made a five-minute census. I counted only bank and rough-winged swallows flying downstream past me; purple martins, tree swallows, cliff swallows and barn swallows were not counted. After I censused swallows at all five areas, I traveled by boat from Boy Scout Rapids upstream to Cedar Island Rapids, then back downstream to the research station. This was to determine any specific location preferred by the swallows. The shoreline and the three sets of transmission wires crossing the river were observed for perching swallows each time foraging birds were counted.

Figure 2. Map of the Monticello study area showing five census sites and three sets of transmission wires, A, B, and C.


A
B
C
RESEARCH STATION
N
BOY SCOUT RAPIDS
CEDAR ISLAND RAPIDS
POWER PLANT
DISCHARGE CANAL
CITY OF
MONTICELLO
0
1
2
3
SCALE-MILES

CHAPTER III

RESULTS

I began this study by surveying the study area by boat and by experimental mist netting near the power plant. Two trial mist nettings were made earlier in 1971 under the direction of Dr. C. Bruton. Seventy-one adult bank swallows from the Colony 1 area were captured and banded at that time.

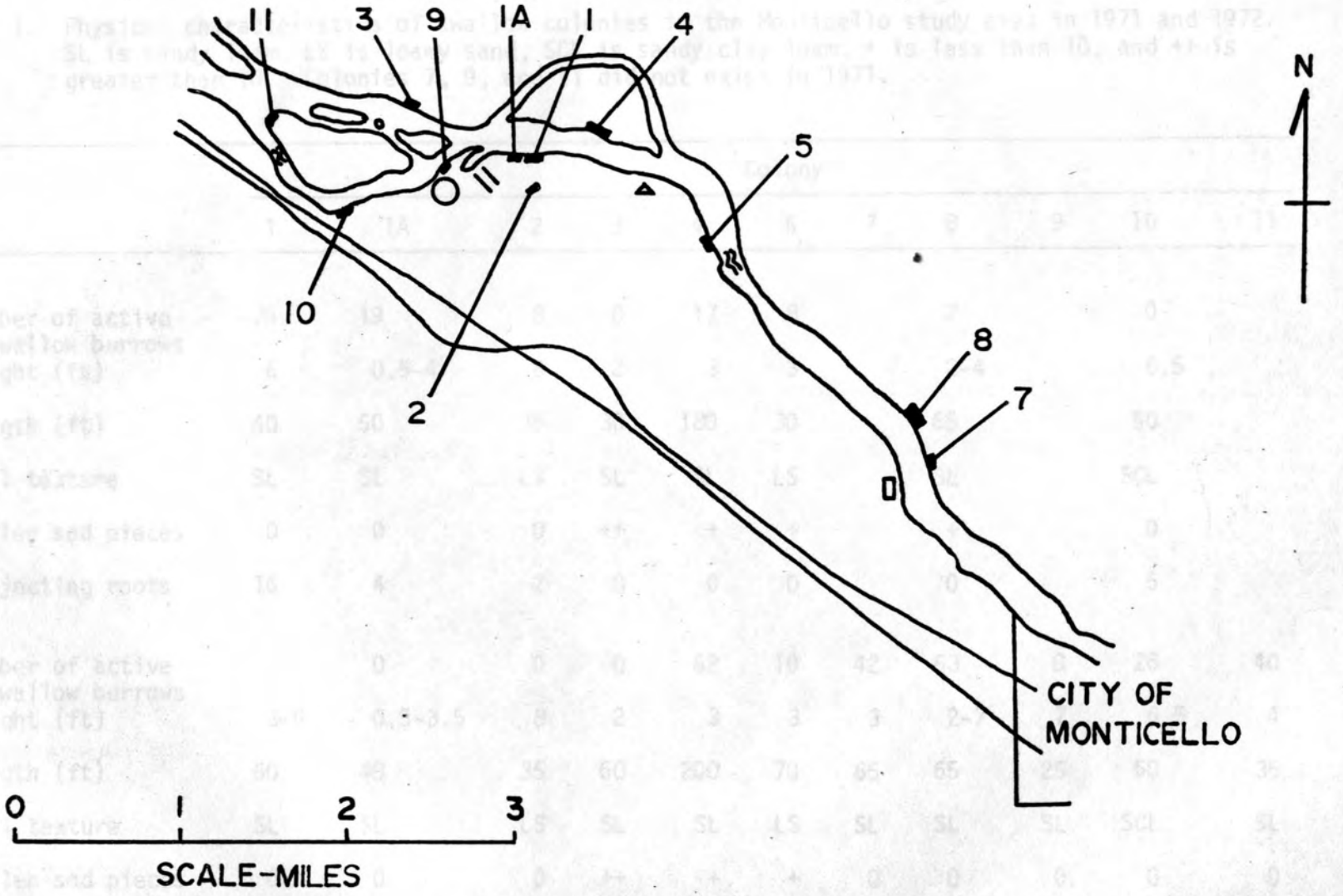
In 1971 numbers were randomly assigned to potential colony sites (Figure 3). Colony 3 was later found to be inactive. Colony 6 was outside the study area and was inaccessible by boat during low river levels. In 1972 new potential colony sites were assigned numbers. Colonies 3 and 9 were inactive.

Colonies 1, 1A, 7, 8, and 11 had no known rough-winged swallow nests. Rough-winged swallow burrows were interspersed among bank swallow burrows in Colonies 2, 4, 5, and 10. Data from these colonies reflect a combination of data for both swallow species.

Colony Site Characteristics

The colonies I observed in 1971 and 1972 represented a variety of sizes and shapes. The colony dimensions and number of burrows per colony varied greatly. However, soil textures (Table 1) and cross-sectional shapes of the colonies (Figure 4, Figure 5) were noticeably

Figure 3. Map of the Monticello study area showing locations of swallow colonies observed in 1971 and 1972.


11
3
9
1A
1
4
5
10
2
8
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6
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CITY OF
MONTICELLO
0
1
2
3
SCALE-MILES

Table 1. Physical characteristics of swallow colonies in the Monticello study area in 1971 and 1972. SL is sandy loam, LS is loamy sand, SCL is sandy clay loam, + is less than 10, and ++ is greater than 10. Colonies 7, 9, and 11 did not exist in 1971.

	Colony										
	1	1A	2	3	4	5	7	8	9	10	11
1971											
Number of active swallow burrows	76	19	8	0	17	8		2		0	
Height (ft)	6	0.5-4	8	2	3	3		2-4		6.5	
Length (ft)	40	50	35	30	180	30		65		50	
Soil texture	SL	SL	LS	SL	SL	LS		SL		SCL	
Fallen sod pieces	0	0	0	++	+	+		+		0	
Projecting roots	16	4	2	0	0	0		0		5	
1972											
Number of active swallow burrows	1	0	0	0	62	10	42	63	0	26	40
Height (ft)	3-6	0.5-3.5	8	2	3	3	3	2-7	7	6.5	4
Length (ft)	60	40	35	60	200	70	65	65	25	50	35
Soil texture	SL	SL	LS	SL	SL	LS	SL	SL	SL	SCL	SL
Fallen sod pieces	0	0	0	++	+	+	0	0	0	0	0
Projecting roots	6	12	2	3	0	0	50	0	0	3	1

Figure 4. Cross-sectional diagrams of Colonies 1, 1A, 2, 3, and 4 in the Monticello study area in mid-June of 1971 and 1972. Lower limit of each drawing is at a common high water mark except for Colony 2 which was 100 yards from the river and above the influence of floodwater. Arrows indicate average nest position, horizontal lines indicate roots projecting from bank face, vertical lines indicate grass, black areas indicate pieces of fallen sod. The absence of an arrow indicates that there were no active burrows.

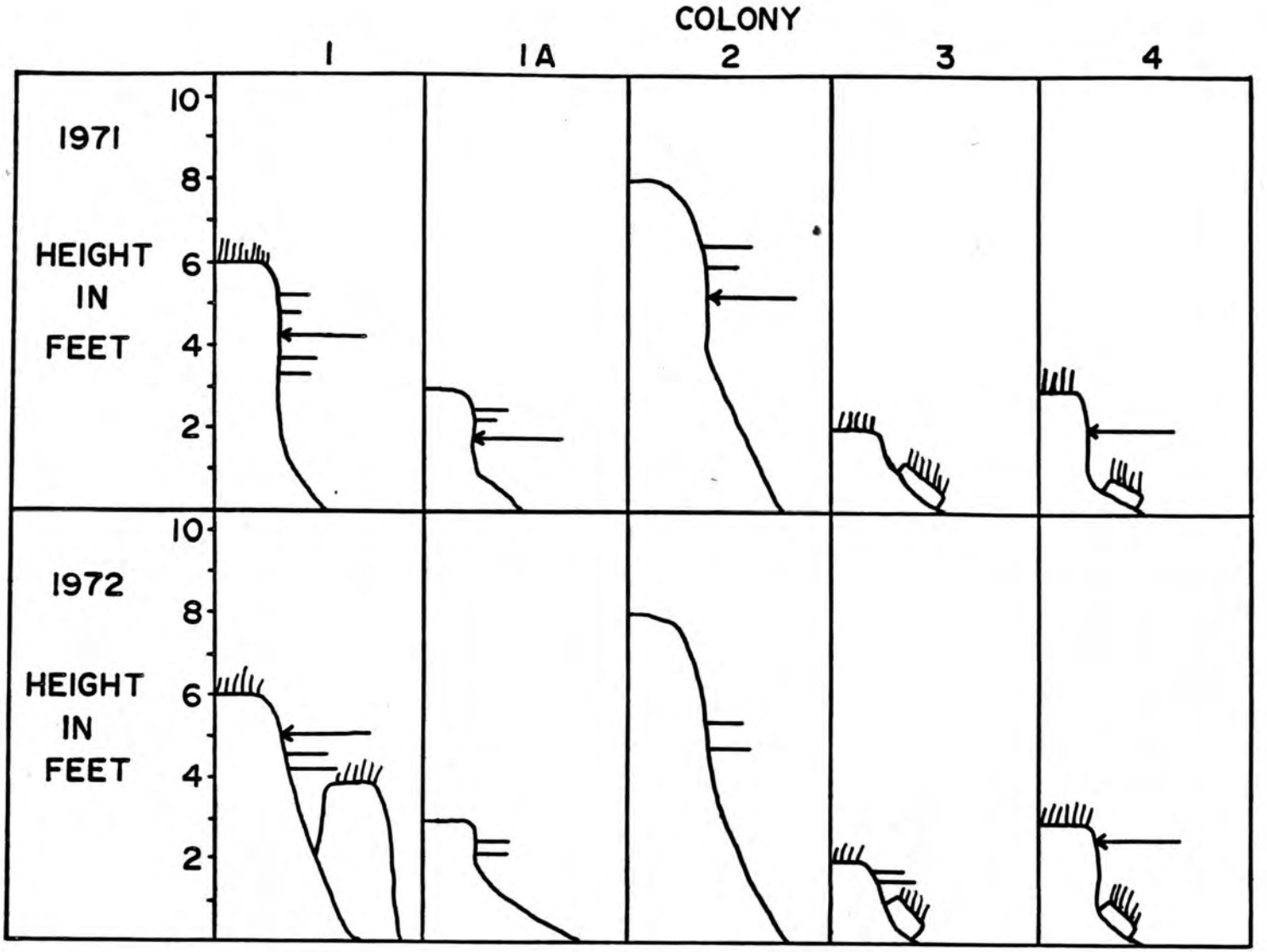
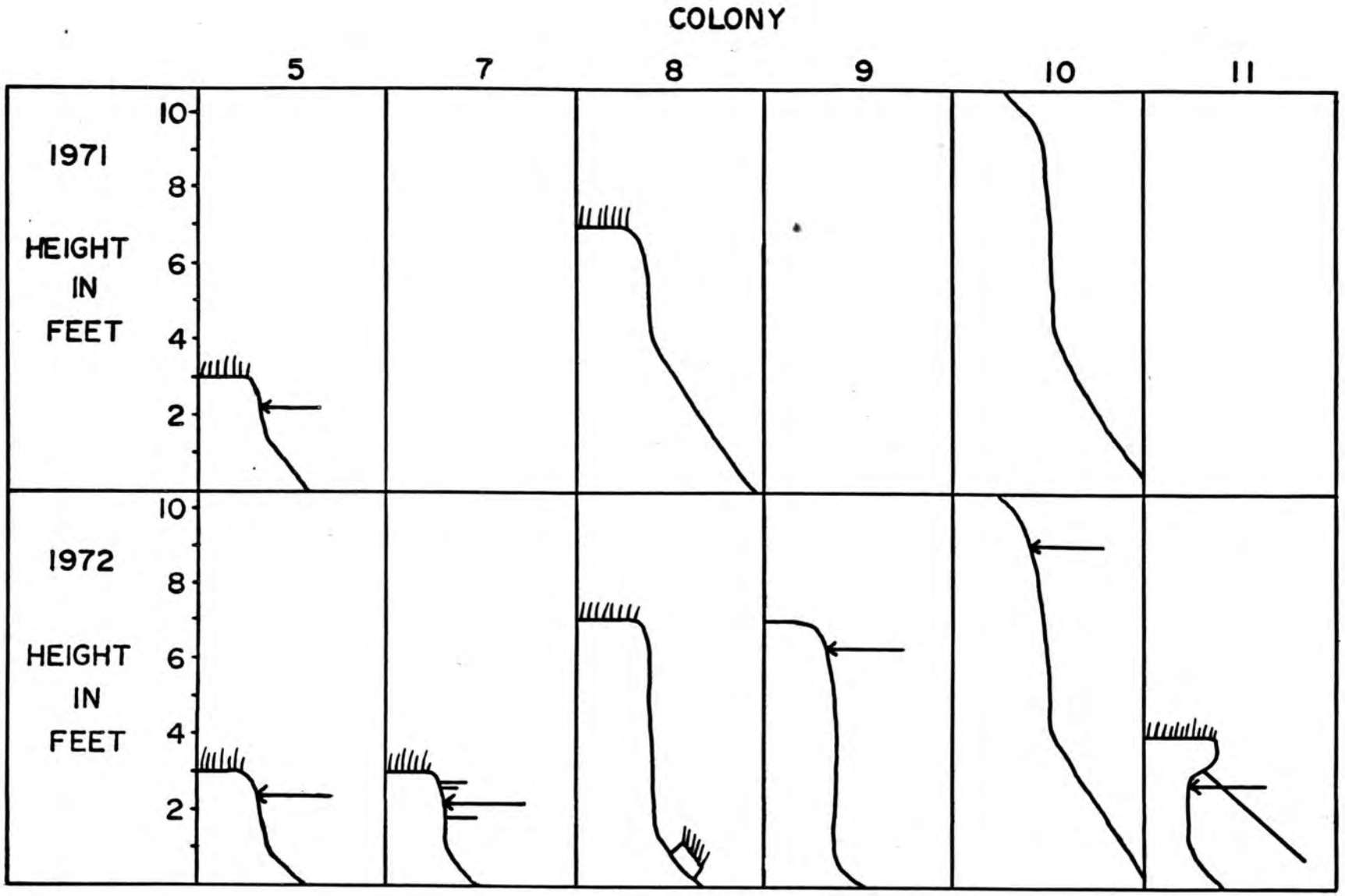

COLONY
1
1A
2
3
4
1971
1972
HEIGHT IN FEET
10
8
6
4
2

Figure 5. Cross-sectional diagrams of Colonies 5, 7, 8, 9, 10, and 11 in the Monticello study area in mid-June of 1971 and 1972. Lower limit of each drawing is at a common high water mark. Arrows indicate average nest position, horizontal lines indicate roots projecting from bank face, vertical lines indicate grass, black areas indicate pieces of fallen sod. The absence of an arrow indicates no active burrows except for Colony 8 where no burrow measurements were made. Colonies 7, 9, and 11 did not exist in 1971.


COLONY
5
7
8
9
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11
1971
HEIGHT
IN
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10
8
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2
1972
HEIGHT
IN
FEET
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8
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4
2

similar. The tremendous spring ice flow in 1972 caused an above-normal attrition of banks, especially downstream of the power plant where the river narrows into one channel 500 ft to 700 ft wide (McConville, 1971). The soil loss from bank faces ranged from 6 in. to 3 ft in this area. Some of the colonies were lengthened, and several new colony sites were created (Table 1). The cross-sectional shapes changed somewhat in that Colonies 5 and 8 lost much loose, previously fallen soil, thus exposing more vertical surface area (Figure 5). Height and length values in Table 1 represent swallow colony measurements, not bank measurements. The heights given are the distances from the tops of the colonies to a common water line. For example, Colony 10 was a 6.5-ft high colony in a 20-ft high bank. Exposed banks ranged from 0 to 30 ft longer and from 0 to 13.5 ft higher than the swallow colonies within them. Colony 1A had sweet clover plants leaning over the edge of the bank; the other colonies had no overhanging plants.

Nesting Behavior of Bank Swallows

In 1971 burrowing and nest-building activities had nearly ceased before this project was started. Most swallows were incubating their eggs. The first young birds were observed on 13 June.

In 1972 I first observed the swallows on 23 April. The majority of the population had arrived by 3 May. I first observed excavation scratches on 30 April, and by 15 May most burrows had been started. When a pair of swallows had chosen a burrow site, they repeatedly returned to this site and landed on the face of the bank. Often they

hovered less than 2 ft in front of this site and one or both birds flew in to cling to the bank. About 20 sec after landing, the clinging bird appeared to flutter and lose its balance. Its head was bent down, low enough to be out of sight from behind, as the bird pecked at the bank. As this excavation began, the bird grasped the bank with its feet and braced with its tail. After a brief period of digging, both birds flew away. They returned shortly and repeated the fluttering behavior. During the early stages of excavation, the excavating adults spent only about 10% of the time at their burrow sites. The rest of the time they flew in a twittering mass above and in front of the colonies.

When a burrow was deep enough for a bird to stand in, the roof of the burrow showed deep arced gouges and the floor showed fine scratches. Often an excavating bird paused to defend the burrow. The area defended was as far as the bird could reach above and to the side as he was clinging to the bank or standing on the lip of the burrow.

When the burrow was deep enough to accomodate both birds, they often occupied it simultaneously. Often the floor was covered with loose dirt. At this time burrow defense ceased. At this stage of excavation the birds spent at least 50% of the time in their burrows. Hunting for food, courtship flights, and the previously mentioned twittering flights consumed the rest of their time.

Tunnels were excavated horizontally and roughly perpendicular to the face of the bank. They were often bent, perhaps around obstruc-

tions. Depth (Table 2, Table 3) varied from 10 to 52 in. A few burrows were constructed as much as 60 degrees left or right of the perpendicular plane through the face of the colony.

The nest chamber was a 4- to 6-in. wide lateral extension of the burrow. Its floor was no higher than the floor of the tunnel but was occassionally 0.5 in. lower. The nest occupied most of the nest chamber. It was constructed of small twigs and grasses and was usually lined with soft duck or domestic fowl feathers before the eggs were laid. The feather lining was replenished when the young birds hatched.

Eggs were laid soon after the nest was finished. I found that clutches ranged from three to six white eggs, usually four or five. One egg was laid each day, and incubation began after the last egg of the clutch was laid. The eggs hatched in approximately 14 days. Usually all the young of one clutch hatched on the same day, although the overall hatching period spanned 3 weeks.

When the young were from three to five days old they "cheeped" almost constantly. Thereafter they were quiet except when the parent birds brought food. The nestlings crouched low when I peered into the burrows. At two weeks of age they often left their nests and approached the burrow entrances. When a light was directed at them they shuffled back into the nest chambers. Birds ready to fledge would often charge toward a light directed into their burrows.

A few days before the peak in fledging I observed adult swallows entering their burrows every 1.5 min. They remained in the burrows

Table 2. Average measurements of swallow burrows in swallow colonies in the Monticello study area in 1971.

Parameters (in.)	Colony					Average
	1	1A	2	4	5	
Height	1.2	1.0	1.5	1.5	1.3	1.3
Width	2.2	2.1	2.4	2.3	1.9	2.2
Depth	17.5	14.7	14.7	20.3	14.5	16.3
Distance from top of bank	20.7	13.5	19.7	11.9	10.5	15.3

Table 3. Average measurements of swallow burrows in swallow colonies in the Monticello study area in 1972.

Parameters (in.)	Colony					Average
	1	4	5	10	11	
Depth	19.0	20.4	20.5	15.9	15.6	18.3
Distance from top of bank	11.0	6.3	7.1	13.2	14.7	10.5

for 10 to 12 sec. When these adults were captured leaving their nests they often carried fecal sacs. When they were captured trying to enter their burrows, they often dropped mouthfuls of soft-bodied insects. These insects were usually lacewings, midges, and mayflies.

The young birds fledged in 18 to 21 days. I found that they were capable of flight at least one day before they normally fledged. Fledglings flew nearly as well as adults, though at first they flew somewhat slower than adults and required rest after less than a minute's flight. The young birds were strong enough, however, to take off from a flat surface without the usual downward swoop used by birds leaving their burrows.

The fledging period ended nine days earlier in 1972 than in 1971. It spanned 22 days, rising to a peak on 3 July and ending on 12 July 1972. During this time, many birds were pursued in flight by two or three others. I assume these especially vociferous birds were fledglings following their parents. Adult bank swallows left the study area about one week after their young had fledged. By this time the fledglings seemed to be fully independent. Less than one week after all birds had fledged, I observed the construction of many pseudo-burrows throughout the colonies. These were excavated by immature birds in a manner similar to that of adults digging nest burrows. The pseudo-burrows were at most 1.5 in. deep and were immediately abandoned. By 1 August 1972 most swallows had left the study area.

Banding

I started banding on 12 June 1971 and continued through 20 July.

Subsequent nettings yielded no birds. I concentrated netting and banding pressure on Colonies 1 and 1A, the more populated swallow colonies nearest the power plant (Table 4). I banded the first immature bank swallows on 1 July and the last ones on 20 July. The number of immature swallows captured reached a peak near 14 July and dropped rapidly thereafter. I captured some of these young birds by prodding them out of their burrows. I banded them and returned them to their burrows. In 1972 I banded birds from 20 June through 12 July. Attempts made after 12 July yielded no birds. I concentrated on Colonies 4 and 5, and the majority of swallows banded were from these colonies (Table 5). The total number of birds banded would have greatly increased if Colonies 7 and 8 had received the same pressure as Colonies 4 and 5. I banded the first immature bank swallow on 21 June and the last ones on 12 July. A peak in the number of immature swallows banded was reached near 6 July. I captured all young birds as they flew into or out of their burrows; I did not prod any birds out of burrows in 1972. Often I captured what seemed to be an entire family of young birds closely grouped in the net near a burrow.

Recaptures

In 1971 I recaptured many swallows which had been banded previously that year (Table 6). In 1972 I recaptured birds banded in 1971 as well as in 1972; all had been banded in this study. Table 6 lists recaptures in 1971 and 1972. Some birds were captured and counted more than once. Table 7 lists the number of birds banded in

Table 4. Number of swallows banded at each swallow colony in the Monticello study area in 1971.

	Colony								Total
	1	1A	2	4	5	7	8	10	
Adult bank swallows	132	24	6	4	7	0	0	0	173
Immature bank swallows	89	8	1	1	0	0	0	0	99
Adult rough-winged swallows	1	0	4	1	1	0	0	0	7
Immature rough-winged swallows	1	0	4	0	0	0	0	0	5
Total swallows	223	32	15	6	8	0	0	0	284

Table 5. Number of swallows banded at each swallow colony in the Monticello study area in 1972.

	Colony								Total
	1	1A	2	4	5	7	8	10	
Adult bank swallows	1	0	0	93	12	11	26	1	144
Immature bank swallows	0	0	0	96	3	0	0	0	99
Adult rough-winged swallows	0	0	0	3	2	0	0	0	5
Immature rough-winged swallows	0	0	0	1	1	0	0	0	2
Total swallows	1	0	0	193	18	11	26	1	250

Table 6. Number of times banded swallows were caught in mist nets at each swallow colony in the Monticello study area in 1971 and 1972.

	Colony								Total
	1	1A	2	4	5	7	8	10	
Adult bank swallows	198	39	5	100	23	3	21	0	389
Banded and recaptured in 1971	198	39	5	3	6	0	0	0	251
Banded 1971, recaptured 1972	0	0	0	12	3	0	6	0	21
Banded and recaptured in 1972	0	0	0	85	14	3	15	0	117
Immature bank swallows	4	0	0	12	2	1	0	1	20
Banded and recaptured in 1971	4	0	0	0	0	0	0	0	4
Banded 1971, recaptured 1972	0	0	0	3	2	1	0	1	7
Banded and recaptured in 1972	0	0	0	9	0	0	0	0	9
Adult rough-winged swallows	0	0	7	8	3	0	0	0	18
Banded and recaptured in 1971	0	0	7	1	0	0	0	0	8
Banded 1971, recaptured 1972	0	0	0	4	0	0	0	0	4
Banded and recaptured in 1972	0	0	0	3	3	0	0	0	6
Immature rough-winged swallows	0	0	0	0	1	0	0	0	1
Banded and recaptured in 1971	0	0	0	0	0	0	0	0	0
Banded 1971, recaptured 1972	0	0	0	0	0	0	0	0	0
Banded and recaptured in 1972	0	0	0	0	1	0	0	0	1
Totals									
Encounters in each colony	202	39	12	120	29	4	21	1	428
Banded and recaptured in 1971	202	39	12	4	6	0	0	0	263
Banded 1971, recaptured 1972	0	0	0	19	5	1	6	1	32
Banded and recaptured in 1972	0	0	0	97	18	3	15	0	133

Table 7. Number of swallows banded in 1971 and subsequently recaptured in 1972 in the Monticello study area.

	Bank swallows		Rough-winged swallows		Total
	Adult	Immature	Adult	Immature	
Banded in 1971	173	99	7	5	284
Recaptured in 1972	13	5	1	0	19
Percent recaptured	7.5	5.1	14.3	0	6.7

Table 8. Recapture locations of swallows banded in 1971 and recaptured in 1972 in the Monticello study area.

Number of swallows	Banded			Recaptured
	Age	Species	Colony	Colony
5	adult	bank swallow	1	4
1	adult	bank swallow	1	5
2	adult	bank swallow	1	8
2	adult	bank swallow	1A	8
2	adult	bank swallow	2	4
1	adult	bank swallow	4	5
1	adult	rough-winged swallow	4	4
2	immature	bank swallow	1	4
1	immature	bank swallow	1	7
1	immature	bank swallow	1	10
1	immature	bank swallow	2	5

1971 that were recaptured in 1972. Table 8 lists 1972 recapture locations of swallows banded in 1971.

River Use by Foraging Swallows

The swallows ate mostly insects with aquatic larvae, however, I believe they ate windblown terrestrial forms when available. I observed swallows feeding low over the river during emergences of mayflies and caddisflies. In fog, both swallow species hunted within 2 ft of the water's surface. On cool mornings, after the fog over the river had dissipated, fog still remained in the discharge canal and over the thermal plume in the river. Some birds continued to hunt low in this fog.

Rough-winged swallows preferred to forage within 20 ft of the river's surface near the banks. Bank swallows preferred to hunt at the same height over the middle of the river, but they also foraged above the flood plain area and sometimes hunted high above the river, often rising out of sight.

In 1972 I made an effort to determine whether swallows preferred any certain locations within the study area for foraging. At five sites I routinely censused swallows flying past me (Table 9). These sites were selected because they were easily accessible by land and water and because the distance between them reduced any duplication in counting. Under ideal conditions I was able to see swallows up to 200 yards away.

Riverbank Use by Perching Swallows

In 1971 I observed up to 60 bank and rough-winged swallows

Table 9. Use of the Mississippi River in the Monticello study area by foraging bank and rough-winged swallows in 1972. Each value indicates the number of swallows flying past an imaginary line perpendicular to the river's channel.

Census site	Date											Total
	July				August				September			
	14	20	21	28	2	11	14	31	9	15	22	
Cedar Island Rapids	236	72	33	0	2	75	0	0	0	0	0	418
Power Plant Site	17	0	6	61	17	0	2	21	0	0	3	127
Discharge Canal	5	0	3	0	0	0	0	12	0	0	0	20
Research Station	0	0	0	1	1	0	0	9	0	0	0	11
Boy Scout Rapids	21	17	0	0	1	0	4	2	0	0	33	78
Total	279	89	42	62	21	75	6	44	0	0	36	654

Table 10. Use of the transmission wires crossing the Mississippi River in the Monticello study area by perching bank and rough-winged swallows in 1972. Each value indicates the number of swallows observed perching on the transmission wires.

Census site	Date											Total
	July				August				September			
	14	20	21	28	2	11	14	31	9	15	22	
Transmission wires A	140	0	26	12	0	0	3	0	0	0	375	556
Transmission wires B	0	0	0	0	0	0	0	0	0	0	0	0
Transmission wires C	0	0	0	0	0	0	0	0	0	0	0	0
Total	140	0	26	12	0	0	3	0	0	0	375	556

perched in several dead oak trees near Colony 4. No birds perched on the transmission wires or at any other location in the study area.

In 1972 I observed the three sets of transmission wires in the study area to see how often swallows used them as perches (Table 10). I limited routine observation of transmission wires A and B to the portions of the wires south of Cedar Island because the north side of Cedar Island was inaccessible by boat at normal water level. Table 10 lists the number of swallows observed perched on each of the three sets of transmission wires. Birds perching momentarily were not counted.

The swallows used several other perches along the river during mid-July. Flocks of from 10 to 35 swallows perched on transmission wires A immediately north of Cedar Island, in dead oak trees on the northeast side of Cedar Island, and in a living oak tree on the east side of Cedar Island. Four rough-winged swallows perched near Colony 4 in the same trees used by perching swallows in 1971.

Behavior Toward Hawks

I found the behavior of swallows toward hawks to vary depending upon the hawk species. In 1971 a pair of red-tailed hawks frequently foraged over the study area. The swallows harassed these hawks when they flew over the colonies. The lower the hawks flew, the greater the degree of harassment. The swallows pursued them until the hawks rose above the swallows or until the swallows disappeared from sight. A rough-legged hawk in the study area was seldom harassed by the swallows. Kestrels that occassionally passed through the area were

sometimes pursued for a short distance by two or three swallows. None of these raptors were ever observed attacking or harassing the swallows.

Predators and Parasites

Predators had a limited influence on the swallow populations in this study area. I observed a garter snake with three bulges in its body leave one burrow and enter another when the young swallows were about one week old. A hawk, believed to be a sharp-shinned hawk, attacked, killed, and abandoned a rough-winged swallow entangled in a mist net. Several nest chambers were opened from above. These openings were typical of those made by striped skunks. A badger, identified by its claw marks and tunnel construction, dug into one bank and destroyed about a dozen relatively low swallow burrows. Higher burrows were unmolested because the badger was apparently unable to climb the vertical bank. A mouse and a chipmunk were suspected predators. I observed them on separate occassions running into and out of swallow burrows.

Parasites were common among the swallows. I found lice crawling on my arms as I banded swallows, an insect larva in the nasal passage of one nestling bank swallow, and fleas in many of the recently active burrows.

CHAPTER IV

DISCUSSION

Colony Sites

The Mississippi River at Monticello is an erosional river; material is eroded rather than deposited. The tremendous hydraulic forces coupled with high current velocity and large water volume in spring are sufficient to erode bank surfaces fairly regularly. Steep banks are exposed readily and rapidly when trees on the river bank are undermined and fall away. I believe most of the colony sites in the study area were created by the toppling of trees poorly anchored in the sandy soil. The spring ice flow had enough force to tear through sod and expose the sandy soil to the current. The floodwater current then attacked these areas and created lengthy exposed banks. In 1972 Colony 1 increased in length by 20 ft (Table 1). Apparently chunks of ice hammered the bank hard enough to dislodge a 3-ft deep piece of soil from the downstream edge of the already existing colony. The slope of the colony decreased and a 10-ft wide piece of bank slid part way down the bank's face (Figure 4). Colony 4 also increased in length by 20 ft (Table 1). This colony was lengthened when the turbulent water eroded the soil under the bank and tore away the sod.

Bank swallows do not readily accept every exposed river bank.

They prefer a bank with a nearly vertical slope at least 2.5 ft high. The amount of talus slope or fallen sod below does not seem to matter. Figures 4 and 5 show the contour variations of swallow colony sites. The measurements of Colonies 3 and 4 suggest that the bank in Colony 3 lacked enough vertical surface whereas the 3-ft high bank in Colony 4 was sufficient to attract swallows (Table 1). Roots projecting from a bank do not seem to deter the swallows unless the roots are close together and hinder their hovering in front of burrows. Colony locations are not dictated by direction of exposure. Colony 1 had very little direct sunlight on it while Colony 4 was sunlit most of the day and was exposed to the heat of the afternoon sun. The other colonies were between these extremes.

Bank swallows prefer to nest in sandy loam, which is a soil containing 0 to 45% silt, 0 to 20% clay and the rest sand. In banks containing two soil textures the sandy loam is utilized first and the other soil, usually sand, is utilized later. The bank at Colony 10, however, was a silty clay loam (40 to 70% silt, 30 to 40% clay, the rest sand) with several 1-in. horizontal layers of sand. The slope above the colony was sand. Most of the swallow burrows were excavated into the sand layers but several were excavated into the sand slope above the clay. The birds started 24 burrows in the silty clay loam but none was completed.

Floods responsible for creating nesting habitat along the river are also responsible for eliminating habitat. Floodwaters may erode the face of a bank and leave it as a gradual slope, thereby rendering it unsuitable for nesting. In 1969 Carlson (1971) found a colony of

75 bank swallow burrows 100 yards downstream from the plant intake. There was no evidence of this colony in 1971. It had apparently eroded away as was occurring in Colony 1A. In 1971 Colony 1A was 50 ft long and from 0.5 to 4 ft high. In 1972 it was 40 ft long and from 0.5 to 3.5 ft high (Table 1). Soil fell from the face of the bank along the entire length of the colony. The 0.5-ft high vertical section on the upstream end of the colony assumed the rounded shape of the rest of the bank and was thus unsuitable for swallow burrows. The vertical face of the rest of the colony was shortened by 0.5 ft due to the accumulation of fallen soil. Floodwaters can also eliminate burrows of the previous year by filling them with sediment or by softening the bank enough so that it settles, collapsing the burrows. In some cases bank faces were eroded away leaving short burrows and exposed nest chambers.

Rain can affect swallow colonization and production. River bank faces often crumbled after a downpour. After one hard rainfall in 1971 several burrows, nests, and nestlings were eliminated from Colony 1 in this way. At Colony 4 several burrows were nearly eliminated when rains splashed the sand layer out from under them. During one rain the sand from the slope above Colony 10 trickled down the face of the colony and filled in all but two burrows. In August there were no traces of any swallow burrows having been there.

The bank swallow community in the study area is highly motile. I believe the birds are opportunistic, choosing the most desireable locations for nesting. Bank swallows prefer tall, freshly-exposed vertical banks. These locations have higher burrow densities than other less

preferred banks. For example, the Colony 1 bank in 1971 was obviously very desireable and the Colony 8 bank was less so (Table 1). After the 1972 spring floodwater altered the bank faces, Colony 1 became undesireable and Colony 8 was more preferred. Colony 4 changed little from 1971 to 1972, yet the number of active burrows increased from 17 to 62. Since the physical characteristics did not change, the increase in active burrows may be explained by an increase in the total swallow community in the study area.

Community Size Estimate

In 1971 I observed 130 active swallow burrows, thus there were at least 260 breeding swallows in the study area. These 130 active burrows produced an average of 4.5 young, yielding 585 swallows. There were at least 845 swallows in the study area after fledging. In 1972 there were 244 active swallow burrows or an increase of 228 adult swallows over 1971. Twenty-four of the 244 active burrows were destroyed by rain, and at least 18 were destroyed by predators. The remaining 202 active burrows produced an estimated 909 swallows, an increase of 324 young birds over 1971. The estimated 1972 post-fledging community size was 1,397 swallows.

I believe the 87% increase in breeding pairs in 1972 was due to an increased amount of acceptable nesting habitat in the study area. Not only did Colonies 4 and 8 increase in number of active burrows, but the newly-created Colonies 7 and 11 were well populated.

Nesting Behavior

During this study I observed the swallow community in the study

area. Qualitative rather than detailed observations were made. Some data were accumulated on rough-winged swallows which made up only a small part of the swallow community. More information was collected on bank swallows, the major group in the area.

The bank swallows arriving earliest in the study area prefer to renovate existing burrows rather than excavate new ones. Renovation activities are indicated by windrows of loose soil beneath old burrows. Swallows that arrive later construct new burrows. In 1972 most colony sites were inundated when the swallows arrived. Initiation of excavation was delayed by the high water level. As the water receded, the swallows began excavating in the exposed banks. All burrows started were at least 1 ft above the existing water level. Pseudo-burrows excavated by fledglings were located between and below the old nest burrows. Those constructed below the nest burrows were often at the top of the talus slope below the colony.

Petersen (1955) and Stoner (1936) stated that bank swallow nests are lined with soft domestic fowl or wild duck feathers after incubation has begun. I found nests lined with soft feathers before eggs were laid. They were usually from wild mallards, wood ducks, and teal, although some nests contained only domestic fowl feathers. The latter were most likely secured from along highway 152, a route used by market haulers.

Fledging, as used in this paper, is when a young bird leaves the nest burrow. Immature swallows prodded out of nest burrows can, in fact, fly several days before they are due to fledge. Beyer (1938) indicates that young swallows can fly when they are 16 days old, at

least 2 days before they naturally fledge.

Early in the 1972 breeding season, several nests were destroyed. I believe that many of the displaced swallows renested or attempted to do so. For example, the burrows at Colony 10 were eliminated during a rainstorm. Several days later the swallows excavated in Colony 10, and again their burrows were destroyed by rain and sand. Soon after this two pairs attempted to excavate at Colony 9, but they did not complete the burrows. Stoner (1936) stated that bank swallows may rear a second brood. However, it may be that the birds he saw nesting late were still trying to raise their first brood. Nearly all bank swallows had left the study area a week after the fledging period ended, thus the raising of a second brood was improbable.

Rough-winged swallows do not excavate their own burrows (Lunk, 1955). Rather, they inhabit burrows abandoned by bank swallows and kingfishers. Rough-winged swallows fledge about the same time as bank swallows, but they do not excavate pseudo-burrows. Since its bill is not as well adapted for digging as is that of the bank swallow (Gaunt, 1965), the rough-winged swallow may be physically unable to excavate.

Banding

Mist-netting was initiated on 12 June 1971 when this project was started. According to my calculations most birds were incubating or were just completing clutches at that time. Birds were encountered 547 times in mist nets; 284 swallows were encountered for the first time and banded (Table 4); banded birds were encountered 263 times (Table 6). Some banded birds were recaptured more than once.

Stoner (1936) stated that during the later stages of excavation the swallows are exceptionally sensitive to disturbance and may abandon their burrows. Therefore, in 1972 I started netting and banding when I was certain most birds had started incubating. Birds were encountered 415 times; 250 were encountered for the first time and were banded (Table 5); birds banded previously in 1972 were encountered 133 times; birds banded in 1971 were encountered 32 times (Table 6). Some banded birds were recaptured more than once.

I netted birds no more than three times a week to avoid undue stress that could have caused them to abandon their nests. Swallows avoided the nets if they were used more frequently. I saw at least one family of six swallows avoid the net. One by one, the members of the family flew out of the burrow, stopped several inches short of the net, hovered, and flew up over the net.

Netting success, which here refers to the percent of birds banded in a colony, varied according to the number of birds in the colony, the proximity of the burrows to each other, and the netting pressure exerted. Because of the mechanisms involved, netting at widely spaced burrows was time consuming. Furthermore, it appears that where the nests were close together and the population per area was larger, the alarm calls generated by the trapped and flying birds attracted birds from nearby colonies. They, too, were vulnerable to capture when they dive-bombed the net.

Netting success was sometimes reduced in a colony with a high burrow density when the net sagged from the weight of many birds. Swallows could freely enter and leave their burrows over the sagged

net. The set mist net was so frail that normal daytime breezes could disrupt it by blowing the bag to one end or by stretching the entire net taut. The best time to net was the calm of the morning.

Recaptures

Eighteen of the 272 bank swallows banded in 1971 were recaptured in 1972; 13 of these were banded as adults and five were banded as immature birds. This was a 7.5% return for adults, a 5.1% return for immatures (Table 7), and a 6.6% overall return. Stoner (1937) reported his average returns over 10 years to be 5.2% for adults, 1.4% for birds banded as immatures, and 2.8% overall.

One of the 12 rough-winged swallows banded in 1971 was recaptured in 1972. It had been banded as an adult. The return percentages for rough-winged swallows were 14.3% for adults and 8.3% overall.

Eighteen of the 19 birds recovered in 1972 were captured in locations other than where they were banded. Twelve of these birds were banded at Colony 1, and if Colony 1 had remained unchanged in 1972 many of these birds would have been recovered there. Since that colony changed, however, the birds moved to other colony sites (Table 8). Stoner (1937) stated that adult bank swallows are likely to return to the colony where they nested the previous year, and a greater number return to the general region in which they nested previously. He also stated that bank swallows banded as immatures do not often return to the general area where they hatched and that even fewer return to the colony location. I found no immature swallows that had returned to the colony where they hatched.

Use of the River

A few rough-winged swallows fly as early as first light (about 0450 CDST), whereas bank swallows are not seen until one-half hour later. Both species are active throughout the day. A few bank swallows fly near the end of twilight.

Before the young birds fledge, the adult swallows forage throughout the study area, but after fledging, it appears that most birds forage near Cedar Island Rapids (Table 9). Nemanick (1973) states that more insect larvae are found in rapids areas of the river than in the calm areas. When these insects emerge as adults the swallows congregate at the rapids to prey upon them. At Monticello a substantial portion of the diet of both young and adult swallows appears to be caddisflies, mayflies, and midges, since these insects are the most abundant.

Bank and rough-winged swallows prefer transmission wires A over transmission wires B and C for perching (Table 10). The census result for 14 July includes mostly bank swallows, but thereafter the results include mostly rough-winged swallows. I believe transmission wires A are preferred perching sites because they are low over a shallow rapids. During an insect emergence, swallows often hawk insects from the wires.

Predators and Parasites

The buteos and falcons in the study area were not antagonistic toward the swallows. The one accipiter observed attacked and killed a rough-winged swallow helplessly entangled in a mist net. Although

other swallow predators such as snakes, skunks, badgers, mice, and chipmunks inhabited the study area, they had only a minor influence on the total swallow production. Insect parasites were prevalent and fleas and lice especially parasitized the swallows.

Effects of the Power Plant

The construction and presence of the power plant in the study area has affected the swallow community in several ways:

1) Several colony sites have been created. One site is located in a pile of topsoil near the power plant. Other sites resulted from the digging of the discharge canal and the disturbance of the soil during construction of the water intake structure.
2) The perching behavior of the swallows in the study area has been altered by the construction of transmission lines. One set of transmission wires crossing the river near the plant is used extensively by perching swallows.
3) To date there have been only minor changes in the composition of the benthic insect community in the vicinity of the power plant (Nemanick, 1973). Barring any major changes in operational procedure, the plant should have little effect on the food of the birds.
4) Fishermen using the new access roads to reach the river disturb the swallows. Birds do not enter their burrows when a person is within 100 yards of the colony. Several times I encountered fishermen along the bank near the plant. Their

presence could have easily discouraged excavation and nesting at Colonies 1, 1A, and 9.

5) Disturbances caused by the power plant may cause some birds to disregard potential colony sites and others to abandon their excavations. The operational noises from the power plant do not appear to bother the swallows along the river if the plant is in operation when they arrive in spring. However, if the plant is not running when they arrive, but becomes operational after they have started excavating, the new noises may be enough of a disturbance to cause swallows excavating near the power plant to abandon their efforts. According to Stoner (1936), the birds are most sensitive to disturbances at this time. Colony 2 was not used in 1972 because it was shrouded by intense fog from the cooling towers as well as disturbed by frequent noise and the presence of workmen at the towers. Colonies 1 and 1A were not affected by the fog, but the presence of workmen at the cooling towers may have discouraged some excavating activities there. With the decrease in construction activities at the plant site in 1972 more swallows colonized the study area. Continued decrease should produce a further increase in swallow use of the river.

CHAPTER V

SUMMARY

This study was initiated to determine bank and rough-winged swallow use of the Mississippi River near Monticello, Minnesota. The study area extended from 1 mi upstream of a 545 MW nuclear-powered electricity generating plant downstream to 3 mi below the plant. A program of field observation and systematic mist-netting and banding was followed to determine behavior and hatching and fledging times of swallows. Locations of swallows banded in 1971 and recaptured as breeding adults in 1972 indicated a general shift in nesting locations away from the power plant. The number of nesting pairs increased in every swallow colony except the three colonies nearest to the plant's cooling towers. Cooling tower repairs during their excavation cycle most likely discouraged the birds from nesting there. The swallow community in the study area increased in size from 1971 to 1972 due to increased nesting habitat and decreased construction activity at the plant site. Post-fledging data indicated a marked preference for foraging over a rapids upstream of the power plant, and for perching on one set of transmission wires near this rapids. The swallows foraged mostly in the vicinity of the river where mayflies, caddisflies, and midges were plentiful. Several

examples of predation were evident, and parasites were common throughout the study area; neither had a major effect on swallow production. Normal operation of the power plant did not extensively alter the swallows' use of the river.

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APPENDIX

Appendix. Common names and scientific designations of organisms mentioned in the text.

Common name	Scientific designation
Oak	*Quercus* sp.
Sweet clover	*Melilotus* sp.
Mayflies	Ephemeroptera
Lice	Mallophaga
Lacewings	Neuroptera: Chrysopidae
Caddisflies	Trichoptera
Midges	Diptera: Chironomini
Fleas	Siphonaptera
Garter snake	*Thamnophis sirtalis* (Linnaeus)
Mallard	*Anas platyrhynchos* Linnaeus
Teal	*Anas carolinensis* (Gmelin)
Wood duck	*Aix sponsa* (Linnaeus)
Sharp-shinned hawk	*Accipiter velox* (Wilson)
Red-tailed hawk	*Buteo jamaicensis* (Gmelin)
Rough-legged hawk	*Buteo lagopus* (Gmelin)
Kestrel	*Falco sparverius* Linnaeus
Purple martin	*Progne subis subis* (Linnaeus)
Cliff swallow	*Petrochelidon albifrons albifrons* (Rafinesque)
Barn swallow	*Hirundo erythrogaster* Boddaert
Tree swallow	*Iridoprocne bicolor* (Vieillot)
Bank swallow	*Riparia riparia riparia* (Linnaeus)
Rough-winged swallow	*Stelgidopteryx ruficollis serripennis* (Audubon)

Common name	Scientific designation
Domestic fowls, chicken	Gallus domesticus
turkey	Meleagris gallopavo Vieillot
Chipmunk	Tamias striatus Linnaeus
Mouse	Peromyscus sp.
Badger	Taxidea taxus Schreber
Striped skunk	Mephitis mephitis (Schreber)