1990 Summary Report of the Forster's and Black Tern Breeding Survey of the Minnesota Valley National Wildlife Refuge and Vicinity

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by

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INTRODUCTION

Forster's terns (Sterna forsteri) and black terns (Chlidonias niger) have both traditionally bred in Minnesota. The breeding range of the Forster's tern is primarily in the Northern Great Plains including the western half of Minnesota extending east through the central part of the state to the Twin Cities (Coffin and Pfannmuller, 1988). Black terns breed throughout the state except in the northeastern region and in the southeastern region away from the Mississippi River (Janssen, 1987). Casual observations over the last few years have indicated that both species have been breeding on some of the wetland areas included in and adjacent to the Minnesota Valley National Wildlife Refuge (MVNWR) (Mary Mitchell; Pers. Comm., 1990). The objectives of the 1990 survey were to identify those wetlands currently being used for breeding by either tern species and to conduct nest counts and fledgling counts to estimate productivity.

MATERIALS AND METHODS

The survey area included the wetlands along the Minnesota River between Fort Snelling State Park and the city of Jordan, Minnesota. All of the major wetlands currently owned by the Minnesota Valley National Wildife Refuge were surveyed, as well as wetlands in the vicinity that may be managed by the Refuge in the future. In addition, Gun Club Lake was surveyed as it was speculated that it may offer significant tern habitat for the region. The locations of all surveyed wetlands are identified on maps in Appendix A and a list of named wetlands that were surveyed appears in Table 1.

Table 1. Wetlands surveyed for black and Forster's terns in the Minnesota Valley National Wildlife Refuge and vicinity, 1990.

Gun Club Lake*	Blue Lake
Long Meadow Lake	Rice Lake (Upgrala Unit)
Base Ponds	Little Rice Lake
Hogback Ridge	Grass Lake
Peterson Pond	Chaska Lake
Black Dog Lake	Carver Marsh
Continental Grain	North Louisville Swamp
Rice Lake (Wilkie-Rice Unit)	Johnson Slough
Fisher Lake	South Louisville Swamp

* Owned by Fort Snelling State Park

Most of the wetlands were visited at least twice between the last week of May and the first week of June to determine the presence of either Forster's or black terns (Appendix B). The initial survey visit was conducted from shore using a spotting scope and binoculars. On the second visit, all but the smallest wetlands (Carver Marsh and Little Rice Lake) were surveyed from canoe. All wetlands where terns were observed during the first two preliminary visits were then revisited by canoe at least twice during the rest of June and the first week of July to find and mark nest locations. Colonies were approached by canoe and nest locations were disclosed when adults flew off the nest to defend. Aggressive behavior by adult terns increased as one neared the nest making the nest search process fairly straightforward. Searches were conducted systematically by zigzagging back and forth through the colonies. All nest searches were done by canoe except on Blue Lake where shallow water and emergent vegetation required hip waders to move around the colony.

To minimize the effect of human disturbance on nest abandonment, each human intrusion into a colony was limited to 1/2 an hour. Incubating adults returned quickly to their nests once the human intruder was beyond the edge of the colony and any additional passes through the colony were not conducted until the colony had settled for at least 15 minutes. Nest searches were not conducted on rainy days nor on clear sunny days when temperatures exceeded 85 F.

Each nest was marked with a stake made of common fence lath sequentially numbered with an indelible marking pen (Dunn, 1979). Stakes were placed approximately 2m from the nest site to minimize predator detection. At each nest site the following data were collected: number of eggs, dominant vegetation within 2m of the nest, dominant nesting material, and 3 measurements of water depth adjacent to the nest. Vegetation data were subjective and no attempts were made to quantify cover classes within the vicinity of each nest. However, each wetland was classified in general terms according to Cowardin's (1979) nomenclature (Mitchell; Pers. Comm., 1990) (Appendix C). The measurements of water depth at each nest site were taken at three equidistant points adjacent to the perimeter of each nest. In cases where the nests were on larger platforms of dead vegetation, the three measurements were taken at the edges of the floating platforms at varying distances from the nest center.

After initial nest searches, colonies were searched at least once or twice more to verify that all nests had been located (Appendix B). If no new nests were located after the second nest search it was concluded that all nests had been counted. If additional nests were found upon the second visit, then a third nest search was conducted. The timing of repeated nest searches

was determined by the results of the previous searches. In some cases adult behavior and the finding of numerous 1-egg clutches suggested laying was just beginning and these colonies were given at least a week before being recounted. Colonies that had mostly 2 and 3-egg clutches were usually revisited within 4 days to verify laying was complete.

Hatching and fledging dates were predicted from the literature so that future visits to the colony could be timed accordingly. Hatching success was not measured in this study, so colonies were not visited until a few days after predicted hatch date. The post-hatch visits served to verify the synchronization of the colony hatching dates and provided data to fine-tune the predicted period of fledging dates.

After fledging started, colonies were visited repeatedly to count fledged young. Fledged young were easily distinguished from adults by plumage. Though adults were seen in various stages of molting throughout the fledging period, no fledged young had any visible black plumage, while all molting adults retained at least a patch of black either on their head, breast or back. A few non-breeding black terns that were at least 1 year old (i.e. subadults) were seen throughout the survey and distinguished from 1990 fledged young by behavior rather than plumage. Unlike the 1990 fledglings, subadults were present in late May, always fed independently, exhibited no begging behavior, and had adult-like vocalizations.

Each colony was traversed by canoe and fledged young were counted while in the air or resting on emergent vegetation. Fledged young rarely were all in the air at the same time, but often returned to the same general resting area so that groups of fledged young could be tracked. On a given survey day, counts were repeated until the same fledging count was arrived at three times. Daily counts were repeated during the fledging week until a peak count for the colony was determined.

The amount of effort required for each phase of the survey and the number of times each colony was visited depended on the size of the wetland, ease of movement within the wetland, and the nesting and fledging success (Appendix B).

RESULTS AND DISCUSSION

Black and Forster's terns were noted on several of the wetlands early in the season, but only some of these wetlands were later used for breeding. All wetlands that were later used for nesting had at least 1 species of tern present during the last week of May (Table 1). In two cases (Fisher Lake and Rice

Lake (Wilkie-Rice)), only 1 species of tern was noted in the first visit, but by mid-June both species were nesting. There was an early report from Refuge staff of a large flock of Forster's terns seen on Long Meadow Lake in mid-May, but when it was checked in late May and again in June, there was no evidence of an established breeding colony.

Table 2. Early census summary and identification of breeding colonies of black and Forster's terns, Minnesota Valley National Wildlife Refuge and vicinity, 1990. (BT = Black Tern; FT = Forster's Tern).

MVNWR UNIT Wetland	Census Date	# of Adult Terns Present	Breeding Colony Later Established?
LONG MEADOW LAKE			
East Long Meadow	5/29	1 FT	No
West Long Meadow	5/28	2 FT	No
Bass Ponds	5/29	2 FT	No
Hog Back Ridge	5/29	2 FT	No
BLACK DOG LAKE			
Black Dog Lake	5/30	10 BT	No
WILKIE/RICE			
Continental Grain	5/27	3 BT	No
Rice Lake	5/28	11 BT	Yes (BT & FT)
	6/9	31 BT, 16 FT	
Fisher Lake	5/28	7 FT	Yes (BT & FT)
	6/9	12 FT, 2 BT	
Blue Lake	5/28	4 BT	Yes (BT)
UPGRALA			
Big Rice	5/27	5 BT	No
Grass Lake	5/27	10 BT	Yes (BT)
CHASKA LAKE			
Chaska Lake	5/24	27 BT	No
Carver Marsh	5/24	3 BT	Yes (BT)
Gun Club Lake*	6/14	6 BT, 4FT	Yes (BT)

*Gun Club Lake was not originally to be censused, so the initial visit was not made until mid-June.

Colony Locations

Locations of the 1990 tern colonies within each wetland are indicated on the maps in Appendix D.

Nesting, Hatching and Fledging Phenology

Colony phenology data is summarized in Table 3.

Table 3. Initial nesting, renesting, hatching, and fledging dates for black and Forster's tern colonies of the Minnesota Valley National Wildlife Refuge and vicinity, 1990. (BT= Black Tern; FT = Forster's Tern)

Colony	Initial Nesting and Renesting Dates	Hatch Dates	Fledging Dates
Black Terns			
Rice Lake (Wilkie-Rice)			
East Side	6/01	6/22*	-
West Side	(6/20)*	-	-
North Side	(6/21)	7/11*	7/31
Fisher Lake	6/20	-	-
Blue Lake	6/18-6/20*	-	-
Grass Lake	6/21*	-	-
Carver Marsh			
NW Side	5/31	6/20*	-
NW & Central Sides	6/14)*	7/4	7/24
Gun Club Lake			
West Side	?< 6/14	-	-
Southwest Side	6/14<?<6/26	7/4<?<-7/16	7/23<?<8/4
Forster's Terns			
Rice Lake (Wilkie-Rice)			
East Side	?< 6/13	-	-
Fisher Lake	6/6*	-	-

* These dates are confirmed. Other dates represent a best approximation based on a 21-day incubation period and a 20-day period to fledging. A "-" indicates no birds were known to hatch or fledge on that wetland.

Black terns initiated nests around May 31, with a second peak of nesting activity occurring around June 20th. It is

speculated that the mid-June nesting activity on Rice Lake[1], Carver Marsh and Gun Club Lake likely represents renesting attempts by terns that lost nests earlier in the season. The time between the loss of the early nests and the mid-June nesting dates was sufficient for terns to physiologically produce a second clutch. However, without marked birds it is not possible to rule out the hypothesis that the mid-June nesting activity was initiated by late-nesters rather than renesters.

Nesting Sites

General observations concerning nest site characteristics were noted during the course of the survey. Black terns nested in loose colonies with most nests at least 3-4m from a conspecific. Adjacent vegetation cover was moderately dense, but generally a nest site could be seen when within 2-3m. The colonies with the heaviest nesting activity (Blue Lake, Rice Lake, Carver Marsh, Gun Club Lake) were dominated by Scirpus spp. stands with intermittent areas of open water (See Appendix B for associated wetland types). Although cattail stands (Typha spp.) were also present in some of these areas, the black terns were never seen nesting right in amongst the cattail stalks. It appeared that homogeneous cattail stands were too dense to serve as suitable nesting habitat.

The vast majority of black tern pairs chose nesting substrate composed of dead bulrush stalks (Scirpus spp.) from the previous year. These stalks could be submerged if pressed downward, but were not completely free-floating and appeared to still be attached underwater. Six pairs of black terns nested on larger mats of mud and compressed vegetation. Only one pair nested on an old, flattened muskrat house and one pair nested on an abandoned Pied-billed Grebe (Podilymbus podiceps) nest. None of the terns nested on floating boards as reported in previous studies (Bergman et al., 1970; Bailey, 1977; Dunn, 1979). The top edges of the black tern nests were normally within 5cm of the water level.

Because few Forster's terns nested during this study, it is unwise to draw too many conclusions about their nest site preferences. On Rice Lake, the birds chose nesting sites within the black tern colony, so general vegetation characteristics are the same as indicated before, i.e. Scirpus stands interspersed with open water areas. The 4 Forster's nests on Fisher Lake, were found in the middle of the lake surrounded primarily by low lying lilypads Nymphaea spp. and only a light cover of Scirpus spp. The Forster's nests on both lakes were much higher off the

[1] Unless specifically stated to the contrary, "Rice Lake" refers to the Rice Lake found in the Wilkie-Rice MVNWR Unit.

water (>15 cm) than the black tern nests, and one of them was built on top of a muskrat house.

Nesting Material

Nesting material used by both Forster's and black terns was usually comprised of dead plant stems and leaves of aquatic emergent vegetation that was common in the area surrounding the nest site. River bulrush (Scirpus latifolia) and Round-stemmed Bulrush (Scirpus spp.) were dominant components of the nests of both the black and Forster's terns (Table 4). Cattail (Typha spp.) stems were the only vegetation components that appeared exclusively in the Forster's tern nests. Since the Typha spp. stems are fairly large diameter, their use by the larger Forster's terns is probably a reflection of the tern's ability to manipulate a wider size-range of nesting materials.

Table 4. Composition and surrounding vegetation of nests[2] by black terns and Forster's terns of the Minnesota Valley National Wildlife Refuge and vicinity, 1990. (BT= black tern, n = 114 nests; FT = Forster's tern, n=7 nests)

Species	% of Nests Composed of Vegetation Component*		% of Nests with Vegetation Component* within 2m	
	BT	FT	BT	FT
River Bulrush (Scirpus fluviatilis)	89	57	82	86
Roundstem Bulrush (Scirpus spp.)	10	28	14	43
Cattail (Typha spp.)	0	14	9	0
Arrowhead (Sagittaria spp.)	0	0	<1	0
White Pond Lily (Nymphaea spp)	0	0	2	5
Duckweed (Lemna spp.)	0	0	18	0
American Lotus (Nelumbo lutea)	0	0	3	0

* Percentages may add up to more than 100% as some nests or nest sites had more than one vegetation component.

[2] A nest was counted as a nest if at least one egg was present.

Water Depths Surrounding Nests

Water depth would be expected to directly influence the amount of suitable nesting habitat available to terns by controlling the amount of substrate exposed. Table 5 summarizes the mean water depths surrounding the nest sites in the current survey. Though the wide standard deviations associated with the means precludes definitive conclusions, the two extreme values may point to a trend. Blue Lake had the shallowest water levels and the greatest number of nesting attempts, while Grass Lake had the deepest water levels and the fewest number of nesting attempts. In general, substrate availability appeared to be limiting on Grass Lake due to high water. Though there were numerous bulrush stands available, none of the previous year's dead stalks were above water. In fact, it was on Grass Lake that a black tern chose an abandoned pied-billed grebe nest with 4 eggs in it as a nesting site, supporting the idea that more traditional nest sites were scarce.

Table 5. Average water depths surrounding nest sites of black terns and Forster's terns in the Minnesota Valley National Wildlife Refuge and vicinity, 1990.

Black Tern Colony	Mean Water Depths (cm) Adjacent to Nest
Rice Lake (Wilkie-Rice)	43 cm (n=70, 32 nests, s.d.=17)
Carver Marsh	65 cm (n=39, 14 nests, s.d.=14)
Blue Lake	32 cm (n=155,54 nests, s.d.= 6)
Grass Lake	72 cm (n=7 , 4 nests, s.d.= 6)
Gun Club Lake	57 cm (n=21 , 8 nests, s.d.=14)
Forster's Tern Colony	
Rice Lake (Wilkie-Rice)	38 cm (n=9, 3 nests, s.d.=24)
Fisher Lake	47 cm (n=8, 3 nests, s.d.= 9)

Nest Counts and Clutch Sizes

A total of 113 black tern nests were found on 6 of the surveyed wetlands of the Minnesota River Valley during the 1990 season (Table 6). Mean clutch sizes from lakes with more than 1 nest ranged from 2.14 -2.42. These values fall within the ranges reported in the literature (2.6 - Goodwin, 1960; 2.6 - Bergman et al., 1970; 2.67 - Platt, 1979; 2.14 - Platt, 1980; 2.25 Cuthbert, 1954).

Only 7 Forster's nests were found on 2 of the surveyed wetlands during the 1990 season (Table 6). Mean clutch sizes of 2.67 and 3.00 are higher than that reported in the literature by Bergman et al.(2.5, 1970), but sample sizes are clearly too small to draw significant conclusions.

Table 6. Colony size, mean clutch size, and nest success for black terns and Forster's terns in the Minnesota Valley National Wildife Refuge and vicinity, 1990.

Colony	Number of Nests	Number of Eggs	Mean Clutch Size	Number Successful Nests*	% Successful Nests
Black Terns					
Rice Lake (Wilkie-Rice)	32	74	2.31	7	22
Fisher Lake	1	2	2.00	0	0
Blue Lake	54	133	2.42	0	0
Grass Lake	4	9	2.25	0	0
Carver Marsh	14	30	2.14	3	21
Gun Club Lake	8	18	2.25	5	63
TOTAL	113	266	2.33	15	13
Forster's Terns					
Rice Lake (Wilkie-Rice)	3	8	2.67	0	0
Fisher Lake	4	12	3.00	1?	25
TOTAL	7	20	2.86	0	14

* A nest was defined as successful if at least 1 egg was known to have hatched.

Nesting Success
Black Terns

Measuring hatching success was not included as part of the current study. However, because of the large number of nests that were lost before hatch, more time was available for revisiting individual nests. Though the precise number of hatched young/nest could not be determined, an adult's defensive behavior could be used to indicate whether a particular pair had young in the nest vicinity even if the young remained hidden. Nesting success rates are summarized in Table 6.

Overall, the nesting success of the black terns in the 1990 season was quite low. The majority of nesting attempts failed completely with nests and/or eggs disappearing before hatch. The Gun Club Lake colony had the highest nesting success (63%), while the other successful colonies were much lower with only 21-22% nest success. These latter success rates fall in the low range of previously reported nest success rates (39%, 19% (Dunn, 1979); and 34% (Bailey, 1977).

Though it cannot be stated definitively what caused the nest failures, heavy storms with high winds and rains were likely the major causes for nest loss and abandonment at Blue Lake and contributing factors at Rice Lake and Carver Marsh. Destruction of nests by storms has been a major factor in other black tern studies (Bergman et al, 1970; Dunn, 1979). Locally, June of 1990 was the wettest month on modern record. Several storms occurred between June 13 and June 27, and 5 of them had 32-40 mph peak winds. On July 8 there was also a severe thunderstorm with peak winds of 39 mph (WCCO Weather Report, 1990). The June storms coincided with the end of the incubation period for the east colony on Rice Lake and the northwest colony on Carver Marsh. On both lakes, nests that previously held incubated eggs were found empty and abandoned with evidence of water damage. The damaged nests were still above water level, suggesting that egg loss was due to wind and wave action rather than an overall rise in lake level.

On Blue Lake, the entire colony was abandoned sometime between June 23 and July 14. The storms on June 27th, 28th or July 8 likely caused the colony failure. Most nests located on July 14 were either waterlogged or completely submerged. Only 1 pair of the original 53 was still present on the lake. Gun Club Lake nests successfully weathered the storms that apparently wiped out the Blue Lake Colony. Though a simple explanation is not apparent, different lake morphologies and watershed characteristics likely create varying wave action and water level changes in response to precipitation and wind.

Predation may also have been a contributing factor to the low nest success, particularly on Rice Lake and possibly on

Carver Marsh. Single eggs, as well as entire clutches, did disappear from complete clutches throughout the incubation period. Direct evidence of predation was observed three times on Rice Lake. Twice, a pierced egg was found within 1m of an active nest that had previously had a complete clutch. The piercing appeared to have been caused by a rather slender avian beak, perhaps a Red-winged Blackbird (Agelaius phoeniceus) or Yellow-headed Blackbird (Xanthocephalus xanthocephalus).

Another predated egg was neatly cut away on the large end and had its contents removed. The result was reminiscent of an egg predation by a raccoon (Procyon lotor) though conclusive evidence is lacking.

Other possible predators that were frequently seen on the breeding lakes were Black-crowned Night Herons (Nycticorax nycticorax), Green-backed Herons (Butorides striatus) and Great Blue Herons (Ardea herodias). Black-crowned Night Herons were particularly abundant on Rice Lake and may have been nesting in the marsh on the north and west sides of the lake. Black terns consistently mobbed the night herons whenever one flew near the colony indicating the terns considered them a threat.

Nesting Success

Forster's Terns

At most, only one pair of Forster's terns hatched young successfully. All other nests were found abandoned with no eggs. Three of the four Fisher Lake nests were clearly flooded out as nests were found completely submerged after the June storms. The three nests on Rice Lake were abandoned during the same period that the black terns abandoned. Though its possible the Forster's terns were also flooded out by wave and wind action, there was no telltale evidence that these larger, higher nests had been storm-damaged. This strengthens the hypothesis that predators may be implicated in the Rice Lake colony failures of both tern species.

Reproductive Success

As a consequence of the low nesting success in 1990, overall reproductive success for both species was also quite low. No Forster's terns fledged and black tern fledging success is summarized in Table 7.

Table 7. Fledging success for black terns for the Minnesota Valley National Wildlife Refuge and vicinity, 1990.

Colony	# Fledged Young/ Total # of Eggs	# Fledged Young/ Total # of Nests	# Fledged Young/ Successful Nests
Gun Club Lake	.39 (7/18)	.86 (7/8)	1.4 (7/5)
Rice Lake (Wilkie-Rice)	.17 (13/74)	.41 (13/32)	2.1 (13/6)
Carver Marsh	.06 (2/30)	.14 (2/14)	1.0 (2/2)
TOTAL	.15 (22/142)	.40 (22/54)	1.7 (22/13)

Because black tern young are able to fly off the natal wetland soon after fledging, few studies have attempted to count fledged young. Those studies that do report some form of fledging success usually report it in terms of number of fledged young/number of successfully hatched young. Bailey (1977) reported a fledging success rate of 11.5% of 26 hatched young that were penned, but it is not possible from his reported results to determine the number of fledged young per egg, per nesting attempt, or per successful nest. Since the current survey did not count hatched young per se, data are not comparable with Bailey's figures.

Mossman (1980) did estimate .78 fledged young/successful nest, which falls below the range of values calculated from this study (1.0-2.1) (Table 7). Mossman's figure was calculated from the ratio of fledged young/# of adults seen in the air after fledging but before migration has occurred. He assumed that each adult seen represented 1 adult of a successfully nesting pair, and that adults and young were equally conspicuous. I calculated ratios in a similar manner for the Rice Lake terns, and the values ranged from 1 (10/10) to 3.25 (13/4), compared to Mossman's ratio of .39. Ratios for Gun Club Lake ranged between 0 (1/0) to .7 (7/5), and Carver Marsh ratios ranged between .3 (2/7) to .5 (1/2). The total number of fledged young was so small on all three of these lakes that it is difficult to draw confident conclusions. However, ratios between fledged young/adults on Rice Lake, the colony with the largest number of fledged young, ranged so widely from time to time that there seems to be no evidence to support the assumption that only one adult is usually present with a fledged young. The reproductive success of the current study was arrived at more directly and is probably more reliable than one based on fledged young/adult ration. Reproductive success values from the current survey might be best used as baseline data to compare with future

surveys that use the same methodology.

A final summary of the tern survey appears in Table 8. These final counts for breeding pairs are conservative as they filter out any double-counting of possible renesters. It was assumed that renesters required at least 8 days before laying another clutch (Bailey, 1977).

Table 8. Final summary of 1990 breeding tern survey for the Minnesota Valley National Wildlife Refuge and vicinity.

Black Terns

Colony	# Breeding Adults	# of Fledged Young	# of Subadults*	TOTAL
Rice Lake (Wilkie-Rice)	50	13	1	64
Fisher Lake	2	0	0	2
Blue Lake	108	0	0	108
Grass Lake	8	0	1	9
Carver Marsh	22	2	0	24
Gun Club Lake	10	7	1	18
TOTAL	200	22	3	225

Forster's Terns

Rice Lake (Wilkie-Rice)	6	0	0	6
Fisher Lake	6	0	0	6
TOTAL	12	0	0	12

* Immature plumaged birds at least 1 year old.

Management Recommendations

Based on the results of the current survey the major limiting factors for black tern reproductive success appears to be 1) nest loss due to storms, 2) lack of suitable nesting habitat and possibly 3) nest predation. On managed wetlands where water levels can be controlled artificially, the water should be kept low enough to expose nesting substrate from May through July. Water levels were sufficiently low to encourage nesting when the Scirpus spp. root masses were just at water level or protruding 1-2 cm above the water. Lowering high water levels on Grass and Fisher lakes might substantially increase the number of black tern nests that may be established early in the season. Lack of suitable nesting sites on these lakes appeared to discourage all but a handful of birds from initiating nests, even though 15-20 adult terns were regularly seen feeding on these wetlands. It is possible that these wetlands provide valuable feeding habitat for breeding terns from nearby wetlands, however this speculation was not confirmed since individual birds were not distinguishable.

On Blue Lake, Rice Lake and Carver Marsh floating nesting platforms that could rise easily with changing water levels and withstand wave action might be used as a management tool. However, since 1990 appears to have been an unusual storm year, it would be wise to monitor these colonies at least 2 more years before embarking on a management program that might be unnecessary in the long run.

In general, it would be valuable to understand more precisely how the amount and rates of rainfall correlate with rises in water levels on each wetland. Some watersheds may be fairly responsive to precipitation recharge. By keeping such a wetland artificially low early in the season, terns may choose it for nesting only to be later flooded out by natural precipitation. This may have been the case on Blue Lake, where artificially low lake levels attracted large numbers of nesting black terns, but later rainfall flooded the entire colony. Because black terns nest so close to water level, controlling water levels throughout a nesting season may require more precision than is possible. However, if water levels could be lowered slightly after nest establishment, then later flooding from natural precipitation might be prevented.

So few Forster's terns nested in the Minnesota River Valley that any management suggestions would be unsupported with data. However, since this species is already at the far eastern edge of its range, I would not suggest managing any of the wetlands specifically for the Forster's terns unless the management activity also benefits another threatened species that lies more within the central part of its range.

Future Survey Recommendations

If a future nest and fledgling survey is conducted, I suggest the survey be planned to last from the 3rd week in May through August 14th. The 1990 survey did not plan for any survey work between the third week of June and first two weeks of July and it was expected that all necessary survey work could be completed by the 3rd-4th week of July. However, late nesters and/or renesters established nests throughout June which meant many young did not fledge until the last week of July. Fledging counts needed to continue for 7-10 days after the start of fledging, thereby requiring survey work through the first week of August. Survey support that includes all of June and July is necessary to allow for the unpredictable effects weather and predation may have on nest establishment and renesting.

Though it would be useful to abbreviate the survey process so that a rough estimate of reproductive success could be obtained each year, tern nesting behavior and selection of habitat make that difficult. Without nest counts, visits to the colonies could provide only the crudest estimates of productivity. As was the case with the fledged young/adult ratios, ratios of flying adults/# of nests are equally unreliable and difficult to interpret. However, if one assumes that fledged young remain on the natal lake at least a week before dispersing, a quick handle on relative productivity between lakes may be obtained by conducting a fledgling count 2-3 times during the week of fledging. Peak counts could be used as a rough estimate of relative reproductive success, though there would be no way of relating that to the number of nesting attempts. If such a survey is conducted, then fledglings should be counted from a canoe out in the colony. By moving through the colony, fledged birds fly up and can be more easily counted. Fledgling counts made only from shore are likely to be grossly underestimated.

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APPENDIX A

WETLANDS SURVEYED IN THE 1990 BREEDING TERN SORVEY FOR THE MINNESOTA VALLEY NATIONAL WILDLIFE REFUGE AND VICINITY

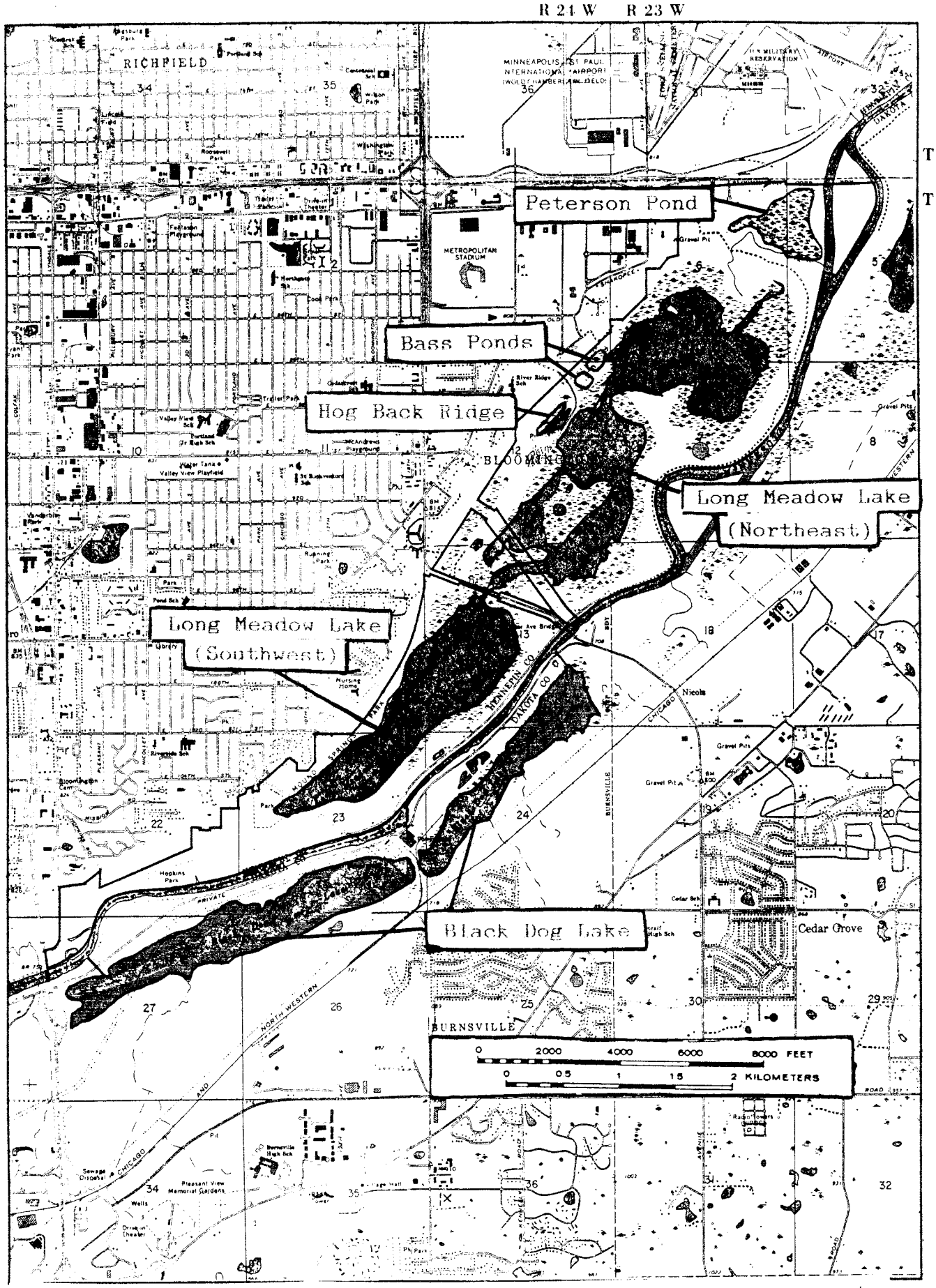


Figure 1. Wetlands surveyed for the 1980 breeding bern survey in the Minnesota Valley National Wildlife Refuge and vicinity. (Northeast and southwest arms of Long Meadow Lake, Bass ponds, Peterson Pond, Hog Back Ridge, and Black Dog Lake.)

HENNEPIN & SCOTT COUNTIES, MINNESOTA

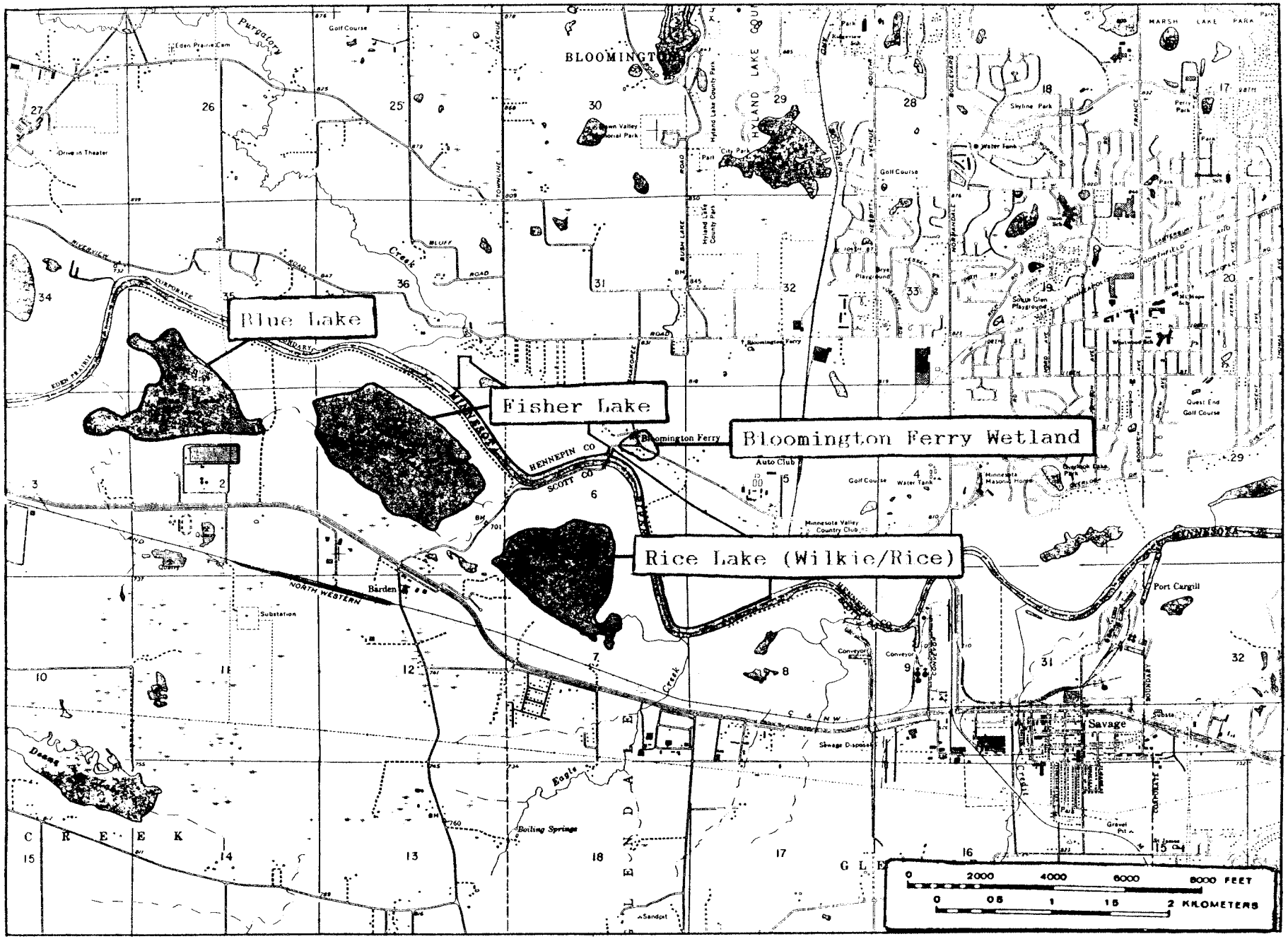


Figure 2. Wetlands surveyed for the 1990 breeding tern survey in the Minnesota Valley National Wildlife Refuge and vicinity. (Bloomington Ferry Wetland, Blue Lake, Fisher Lake and Rice Lake)

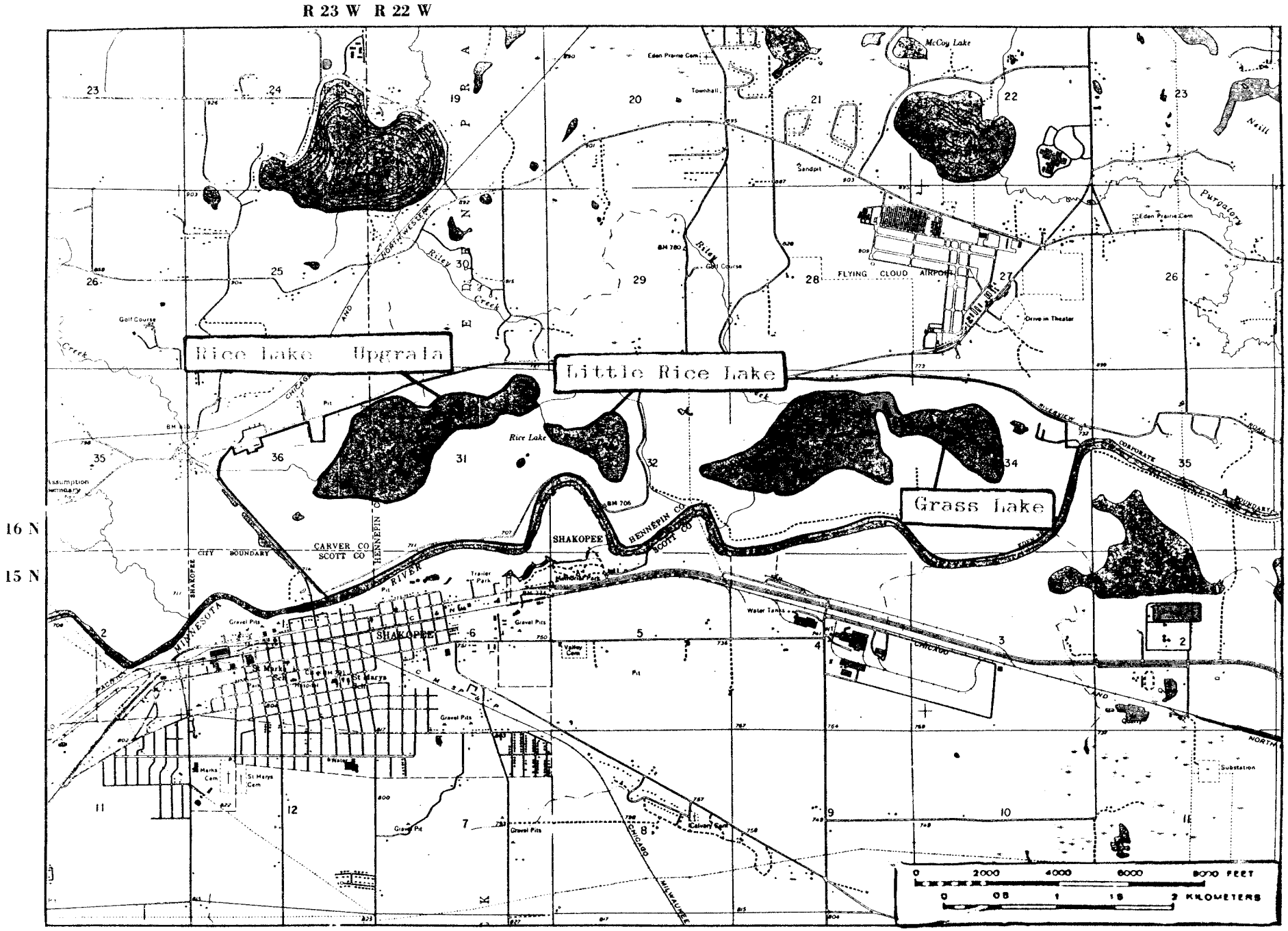


Figure 3. Wetlands surveyed for the 1990 breeding tern survey in the Minnesota Valley National Wildlife Refuge and vicinity. (Rice Lake (also called Big Rice or Rice Lake of MVNWR Upgrala Unit), Little Rice Lake and Grass Lake).

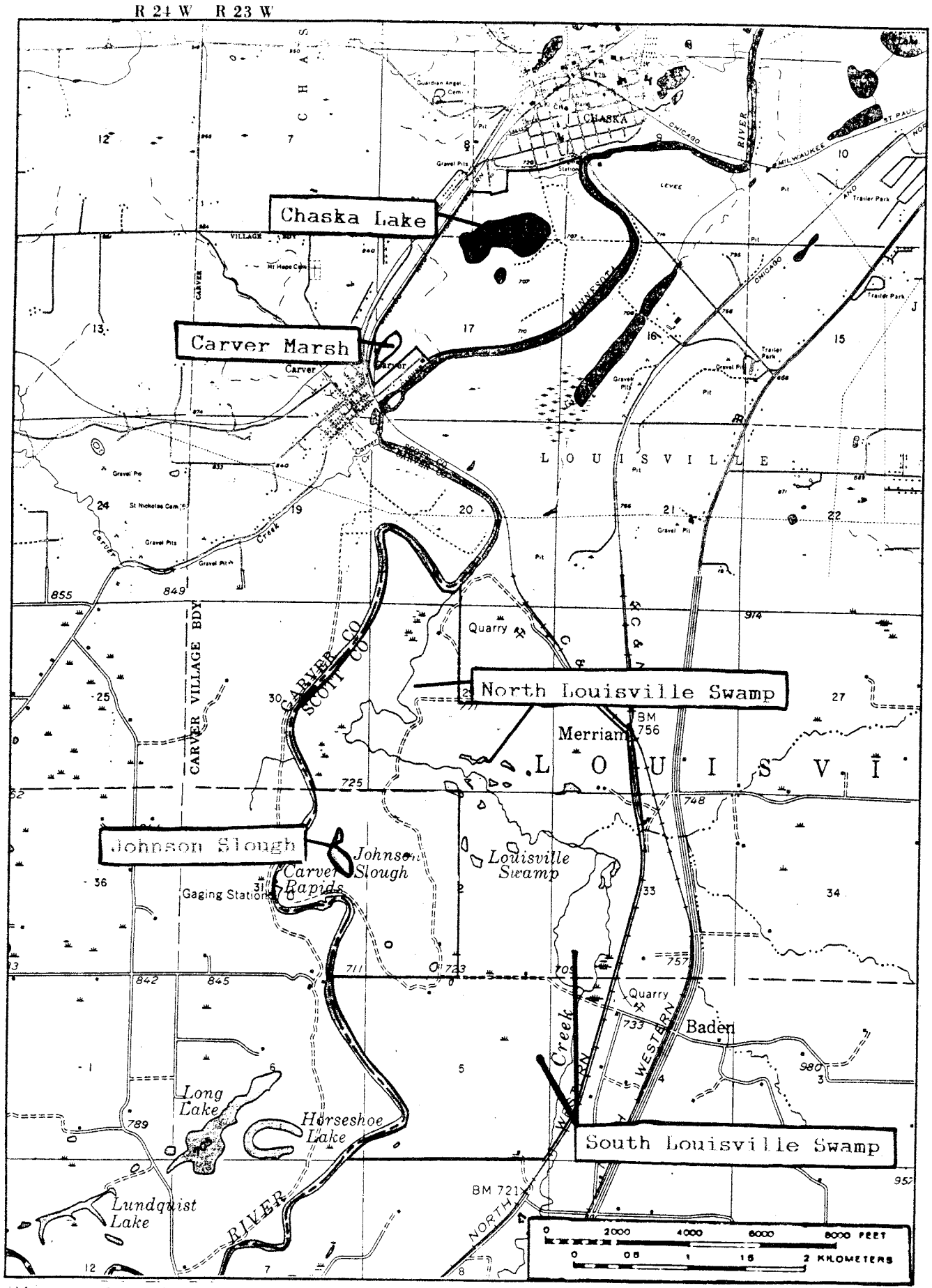
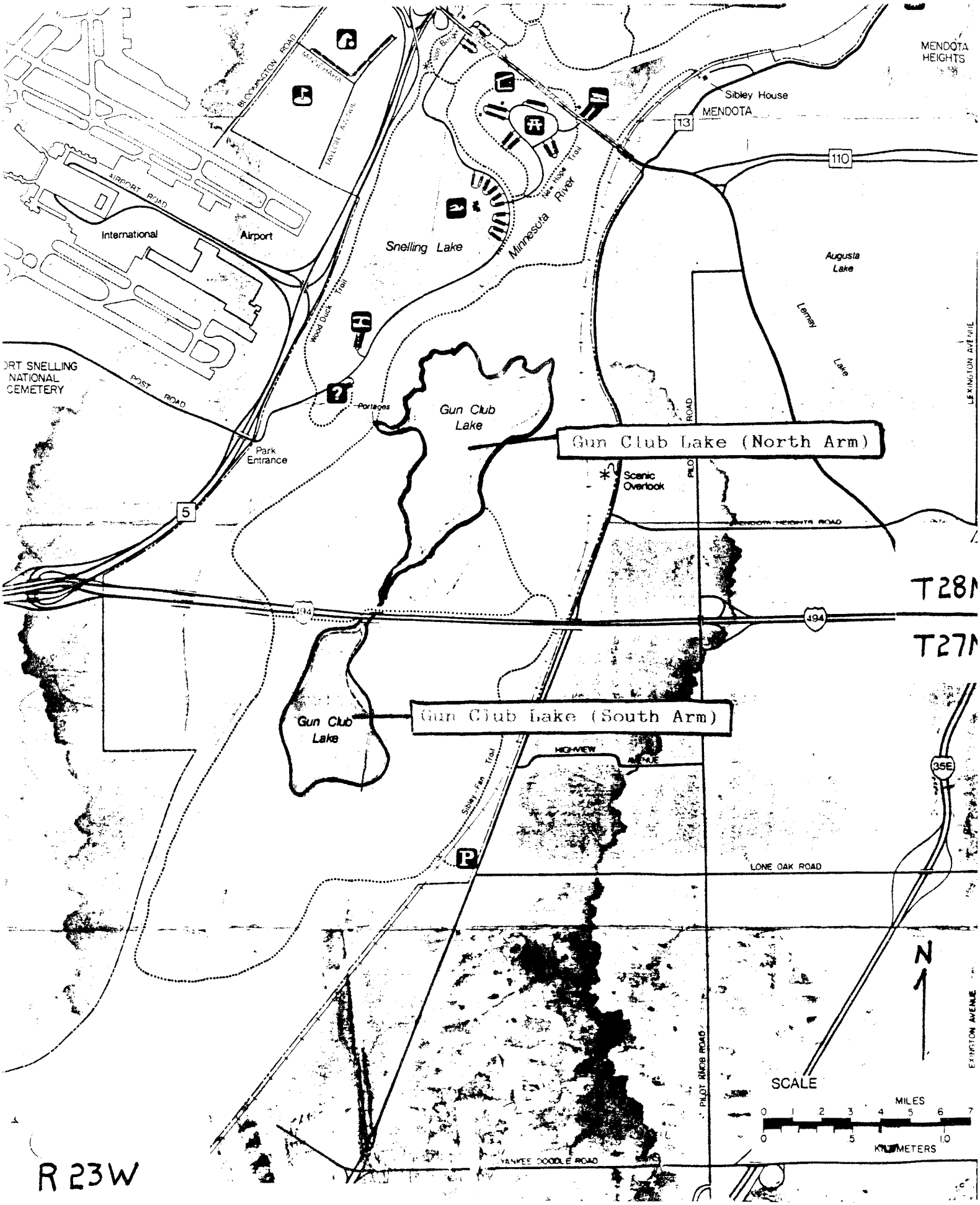


Figure 4. Wetlands surveyed for the 1990 breeding bird survey in the Minnesota Valley National Wildlife Refuge and vicinity. (Chaska Lake, Carver Marsh, North Louisville Swamp, South Louisville Swamp and Johnson Slough.


MENDOTA HEIGHTS
Sibley House
MENDOTA
13
110
BLOOMINGTON ROAD
TAILLON AVENUE
AIRPORT ROAD
International
Airport
Snelling Lake
Minnesota River
Nature Trail
Augusta Lake
Lemay Lake
LEXINGTON AVENUE
Wood Duck Trail
ORT SNELLING NATIONAL CEMETERY
POST ROAD
Portages
Gun Club Lake
Gun Club Lake (North Arm)
PILOT KNOB ROAD
Park Entrance
Scenic Overlook
MENDOTA HEIGHTS ROAD
5
494
T28N
T27N
Gun Club Lake
Gun Club Lake (South Arm)
HIGHVIEW AVENUE
35E
Sibley Fen Trail
LONE OAK ROAD
N
SCALE
MILES
0 1 2 3 4 5 6 7
0 5 10
KILOMETERS
YANKEE DOODLE ROAD
R 23W

APPENDIX B

NUMBER OF PERSON-HOURS* AND COLONY VISITS REQUIRED AT EACH WETLAND FOR EACH PHASE OF THE 1990 TERN SURVEY OF THE MINNESOTA VALLEY NATIONAL WILDLIFE REFUGE AND VICINITY.

MVNWR UNIT Wetland	Preliminary Surveys (~5/24-6/11)		Nest Searches (~6/12-7/13)		Fledgling Surveys (~7/14-8/5)		TOTAL EFFORT	
	Person Hours	# of Visits	Person hours	# of Visits	Person Hours	# of Visits	PERSON HOURS	# OF VISITS
LONG MEADOW LAKE								
East Long Meadow	5	2	0	0	3	1	8	3
West Long Meadow	6	2	0	0	3	1	9	3
Bass Ponds (All)	2	2	0	0	2	1	4	3
Hog Back Ridge	1	2	0	0	1	1	2	3
Peterson Pond	1	2	0	0	1	1	2	3
BLACK DOG LAKE								
Black Dog Lake	5	3	0	0	2	2	7	5
WILKIE/RICE								
Continental Grain	4	2	0	0	3	1	7	3
Rice Lake	9	3	20	4	15	4	44	11
Fisher Lake	9	3	11	3	6	2	26	8
Blue Lake	3	2	16	3	4	2	23	7
UPPSALA								
Big Rice	5	2	2	1	2	1	9	4
Little Rice	2	2	0	0	1	1	3	3
Grass Lake	3	1	13	3	8	2	24	6
BLOOMINGTON FERRY								
Bloomington Ferry	2	1	0	0	1	1	3	2
CHASKA LAKE								
Chaska Lake	4	2	0	0	3	2	7	4
Carver Marsh	2	1	8	3	6	3	16	6
LOUISVILLE SWAMP								
N. Louisville Swamp	7	2	0	0	2	2	9	4
S. Louisville Swamp	2	1	0	0	1	1	3	2
Johnston Slough	1	1	0	0	1	1	2	2
Port Cargill Lake	3	1	8	2	7	3	18	6
TOTAL EFFORT	73	33	78	19	74	33	225	85

* 1 person-hour = 1 hour of survey effort by one person. Times refer only to time spent at the colonies and all times have been rounded to the nearest hour.

APPENDIX C

CLASSIFICATION OF WETLANDS SURVEYED
IN THE 1990 BREEDING TERN SURVEY OF
THE MINNESOTA VALLEY NATIONAL WILDLIFE REFUGE
AND VICINITY

MVNWR UNIT Wetland	Primary Classification	Secondary Classification
LONG MEADOW LAKE		
East Long Meadow	PAB4*	PEM1
West Long Meadow	PAB4	PEM1
Big Bass Pond	PUB	PEM1
Little Bass Ponds	PAB5	PEM1
Hog Back Ridge	PEM1	PAB5
Peterson Pond	PEM2	
BLACK DOG LAKE		
Black Dog Lake	PUB	
WILKIE/RICE		
Continental Grain	PUB	PF05 & PEM1
Rice Lake	PEM1	PAB4
Fisher Lake	PAB4	PEM1
Blue Lake	PAB5	PEM1
UPGRALA		
Big Rice	PEM2	
Little Rice	PUB	
Grass Lake	PAB4	PEM1
BLOOMINGTON FERRY		
Bloomington Ferry	PEM1	
CHASKA LAKE		
Chaska Lake	PUB	
Carver Marsh	PEM1	
LOUISVILLE SWAMP		
N. Louisville Swamp	PEM1	PF01
S. Louisville Swamp	PEM1	PF01
Johnson Slough	PAB5	PEM1 & PSS1
Gun Club Lake	PUB	PF05 & PEM1

*PAB4 - Palustrine, aquatic bed, rooted vascular
PAB5 - Palustrine, aquatic bed, floating vascular
PF01 - Palustrine, forested, broad-leaved deciduous
PF05 - Palustrine, forested, dead
PSS1 - Palustrine, scrub shrub, broad-leaved deciduous
PEM1 - Palustrine, emergent, persistent
PEM2 - Palustrine, emergent, non-persistent
PUB - Palustrine, unconsolidated bottom

* Wetlands were classified by Mitchell (Pers. Comm., 1990) using nomenclature developed by Cowardin (1979).

APPENDIX D

TERN COLONY LOCATIONS WITHIN EACH WETLAND
OF THE MINNESOTA VALLEY NATIONAL
WILDLIFE REFUGE AND VICINITY, 1990

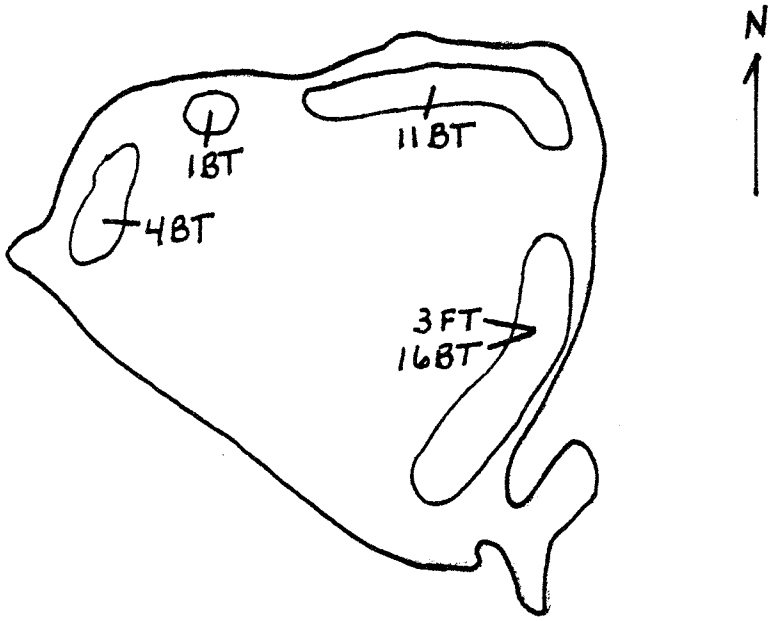


Figure 6. Rice Lake (Wilkie Rice Unit) breeding tern colony locations, 1990. (BT= Black tern nesting pairs; FT= Forster's tern nesting pairs)

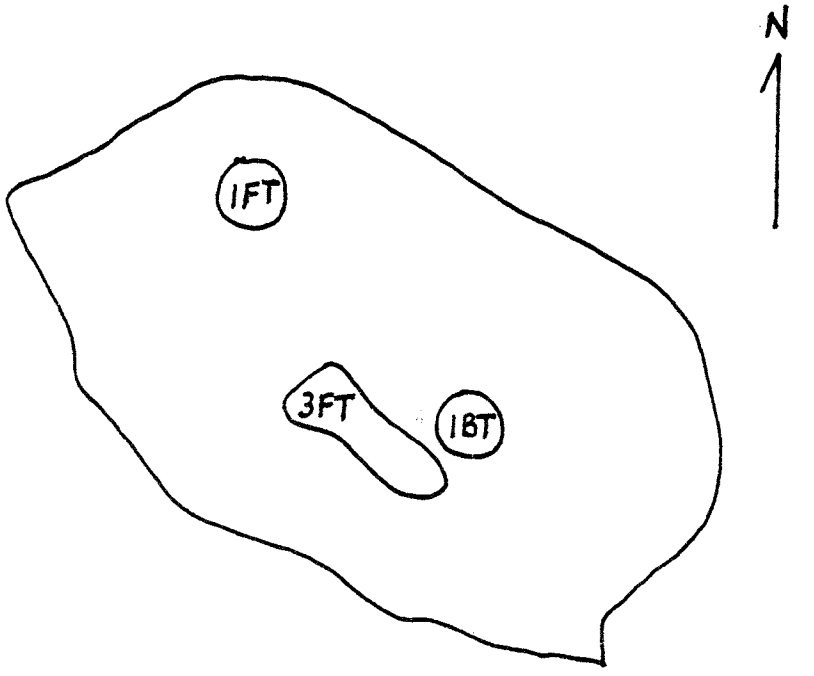


Figure 7. Fisher Lake breeding tern colony locations, 1990. (BT= Black tern nesting pairs; FT= Forster's tern nesting pairs)

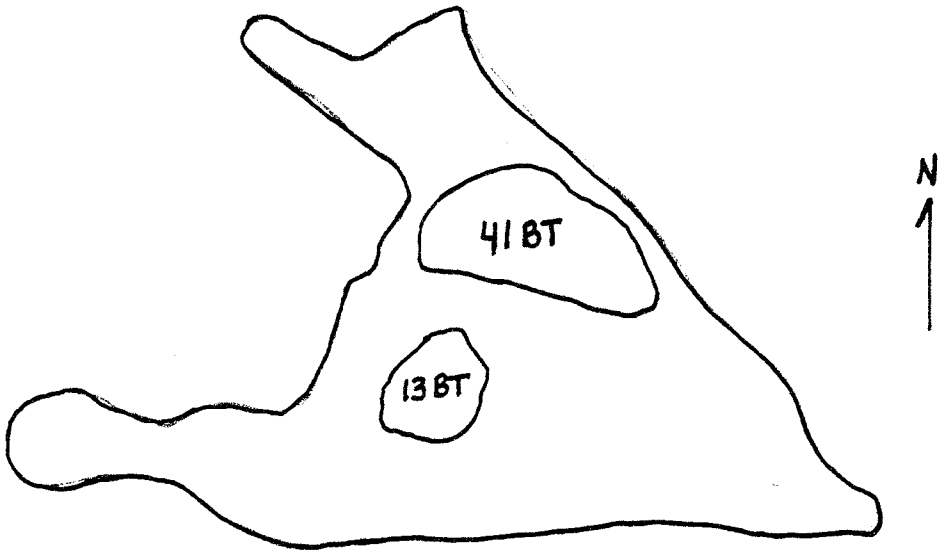


Figure 8. Blue Lake breeding tern colony lncations, 1990. (BT= Black tern nesting pairs; FT= Forster's tern nesting pairs)

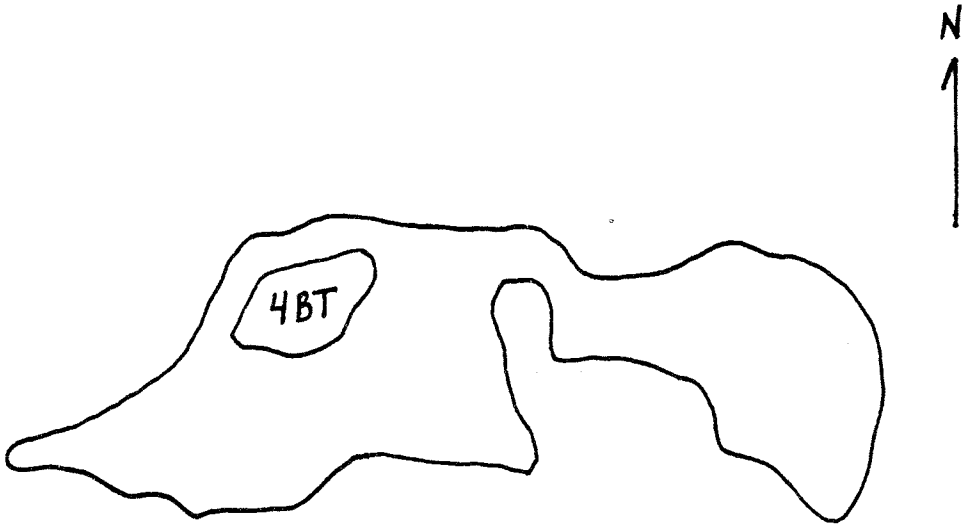


Figure 9. Grass Lake breeding tern colony locations, 1990. (BT= Black tern nesting pairs; FT= Forster's tern nesting pairs)

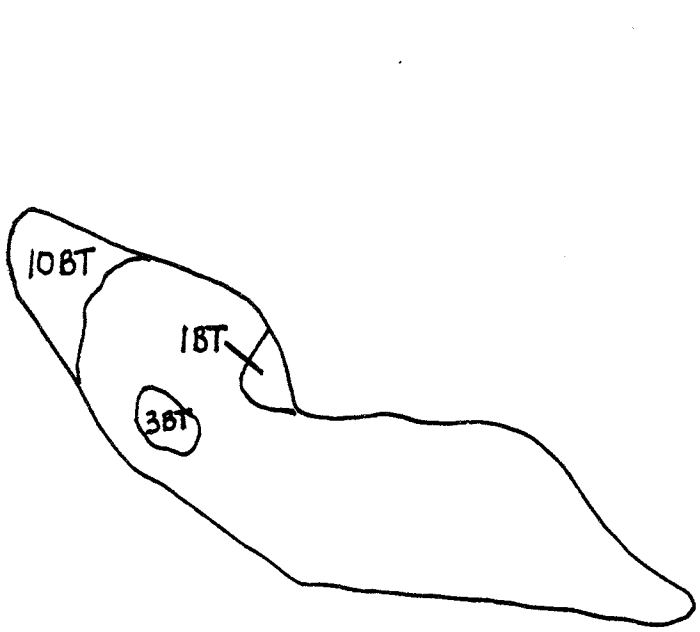


Figure 10. Carver Marsh breeding tern colony locations, 1990. (BT= Black tern nesting pairs; FT= Forster's tern nesting pairs)

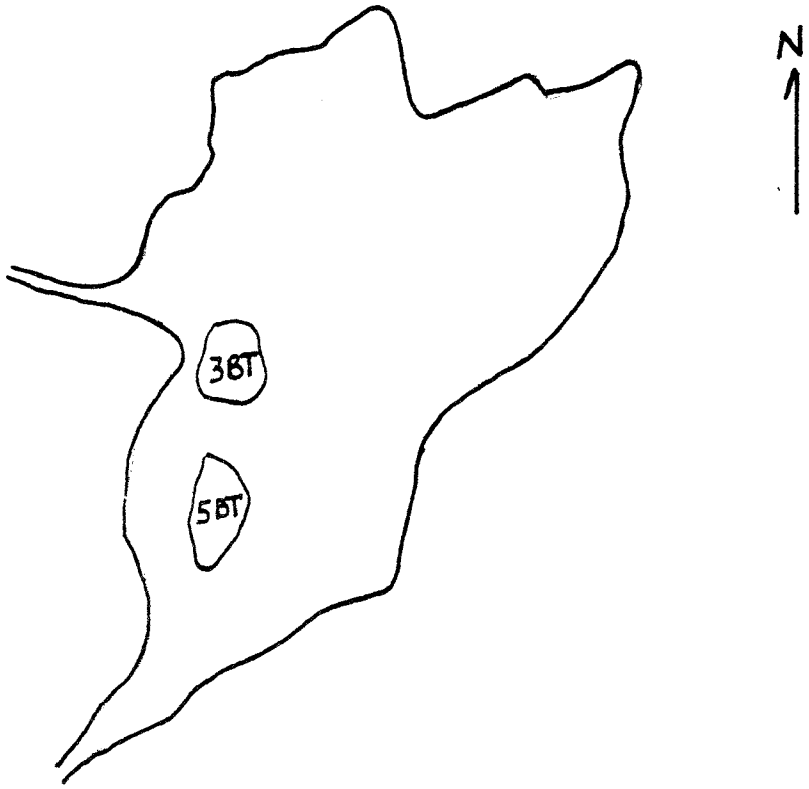


Figure 11. Gun Club Lake breeding tern colony locations, 1990. (BT= Black tern nesting pairs; FT= Forster's tern nesting pairs)