AN INVESTIGATION OF BLACK TERN (*Chlidonias niger*) REPRODUCTIVE SUCCESS IN VERMONT, 1993.

NOVEMBER 12, 1993

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ACKNOWLEDGMENTS

This project would not have been possible without the support of the Vermont Nongame and Natural Heritage Program, the Vermont Nongame Wildlife Fund, and the USFWS Endangered Species Office. I would also like to thank the Mad River Canoe Co. of Waitsfield Vt for their generous donation of the use of a Malecite canoe for the field season. Special thanks also to all those who helped me put up and remove the observation tower, and to Lisa McCurdy at Missisquoi N.W.R. for all her help putting out and retrieving the nesting platforms. Finally, funding from the Vermont Audubon Council made it possible to buy the materials to build the nest platforms.

INTRODUCTION

The black tern (Chlidonias niger) is a colonial nesting marsh bird which has been declining significantly in numbers throughout its range, and in particular in the Northeast. In Vermont the population has apparently declined by about 50% since the 1970's. For the past three years (1990 - 1992) the Vermont black tern population has been censused, and there was concern that reproductive success was extremely low in 1992 (Shambaugh 1992). In particular, the Mud Creek Wildlife Management Area (W.M.A.) in Alburg, VT (see Figure 1) had the largest nesting population in 1992, with an estimated 60 eggs produced at 24 nests. From these only about ten fledgelings were produced (approximately 0.4 fledgelings/pair, or 17% of eggs survived to fledge). At 0.4 fledgelings/pair it would take five years for a given pair to reproduce itself. Based on banding records, the longest lived black tern appears to be eight years (Novak 1992). It seems therefore that there was extremely low reproductive success at Mud Creek in 1992. Whether this was due to factors specific to Mud Creek in 1992 or is evidence of a more widespread problem is unknown.

Several investigators have gathered information on reproductive output as part of larger studies on black terns during the past 20 years. However, the term reproductive success with respect to the black tern has not been well defined. Black tern chicks are semi-precocial and can therefore leave the nest long before fledging. This makes the determination of fledging success for individual nests quite difficult. Most investigators have therefore discussed reproductive success only in the context of hatching success. This has been defined generally as a nest where at least one egg hatches, which means that one could have 100% hatching success while only having a single egg from each nest hatch (black terns generally lay three eggs). Using the above definition Dunn (1979) found 39% and 19% success in 1975 and 1976 in Ontario. Firstencel (1987) found 60% and 43% in 1983 and 1984 in New York, and Bailey (1977) found 34% hatching success in Wisconsin in 1977. More recently, Mazzochi and Muller (1993) found an overall 32% success at three areas in New York in 1992. In general then, about 40% of black tern eggs apparently hatch.

Two of the above investigators went on to determine fledging success as well. Firstencel (1987) reported a

fledging success of 21% in 1984 while Bailey (1977) found 12% in 1977. The mean fledging success for both studies can be calculated at 15%. This number is not extremely low, until one looks at their definitions. Both authors report the numbers of **hatchlings** which survive to fledge. Therefore their fledging success does not reflect the already low hatching success documented during their studies. Utilizing the data in Table 3 of Firstencel (1987) one can calculate a true fledging success (defined as percent of eggs laid which survive to fledge) of 6% overall for both years of the study. Bailey (1977) observed 38 nests with an average of 2.9 eggs per nest which equals approximately 110 eggs laid. Of these, only 3 were documented as having survived to fledge. If interpreted correctly, this translates to only a 3% fledging success. Based on these data it is clear that the recruitment from these colonies was extremely low, at between 0.1 and 0.2 fledgelings/pair. For comparison, the common tern (Sterna hirundo) which is an endangered species in Vermont, produced approximately 0.7 fledgelings/pair in 1991 on Lake Champlain (Vermont Institute of Natural Science, 1991). This was considered to be good success considering the intense predation pressures.

Novak (1990) estimated fledging success (as percent of eggs laid which survived to fledge) at three colonies in New York in 1989 at 13%, 26%, and 20%. These estimates were based on egg and fledgeling counts for colonies as a whole without attempting to follow individual nests as the previous authors did. It is therefore possible that the detailed behavioral observations attempted by both Bailey and Firstencel had an adverse impact on fledging success of the nests they observed.

In an attempt to gather accurate information on black tern recruitment in Vermont it was decided to concentrate on Mud Creek W.M.A. Not only did this colony have apparent reproductive problems in 1992, it was also the largest colony in the state, and afforded better potential visibility than other sites in Vermont. Mud Creek W.M.A. is a large cattail marsh with a central body of open water (see Figure 2). At the north end of the open water is a large pool approximately 1-4 ft. deep where most nesting occurred in 1992.
This pool has very little vegetation in it early in the nesting season (May-June), with reeds and wildrice becoming more common gradually during the summer as water levels drop and vegetation grows. The relatively sparse vegetation at this site made it quite likely that a estimate of recruitment could be made without undue disturbance if some sort of an observation tower were erected.

In addition, an experiment was attempted to determine if black terns could be encouraged to nest in a particular area. Eleven artificial nest platforms of two designs were put out at the Goose Bay colony site within Missisquoi National Wildlife Refuge (N.W.R.) (see Figure 1). The intent was to

determine if black terns would utilize these platforms, which design they might prefer, and if the number of nesting pairs at this site might be increased by increasing available nesting sites.

MATERIALS AND METHODS

1993 was a year of record high water in the Champlain Valley, with Lake Champlain cresting at approximately 102 feet (about 2.5 feet above average crest) on May 2. Therefore, starting in early May, visits were made to Mud Creek W.M.A. to determine if black terns would return and utilize the area for nesting in 1993. Searches for black terns, nests, and nestlings were made by canoe (Mad River Canoe Kevlar Malecite model with center seat for solo canoeing) as described by Shambaugh (1992). When nests were located they were photographed and marked with 10 ft. by 1/2 in. by 1/2 in. posts located within 10 ft. of the nest. These posts made it possible to follow the fate of individual nests, as well as to observe activity at individual nests from a distance. It was hypothesized that due to the relatively sparse vegetation at this site if an observer could get to an elevation of 10 -15 ft. above water level, observations could be made of many nests without excessively stressing the birds. Unfortunately, because of the size of the marsh there are no trees in the vicinity of the nesting area. Therefore, on June 6 an observation tower was erected on the eastern edge of the pool to facilitate observations (see Figure 2). Because Mud Cr. W.M.A. is a waterfowl hunting area, whatever tower was used would have to be removed prior to hunting season. It was therefore decided not to construct anything on site. The choice was made to utilize a 12 ft. tripod with swivel seat on top marketed as a deer hunting stand supplied by the Vermont Dept. of Fish and Wildlife (Sentinel Tower cat. no. HD-40413-012 Cabela's Inc., Sidney, NE). The legs are in segments with one leg serving as a ladder, and they are made of aircraft aluminum so the whole unit weighs only 47 lb. It was decided to locate the tower in a spot where the water was about four ft. deep and the mud bottom extended down an unknown distance. In order to keep the legs from sinking into the mud, a set of feet were made out of plywood (approx. 2 ft. by 2 ft.) with a box of "2 x 4"s in the center to keep the leg from slipping off. These feet were attached to each leg above water level with clothesline in such a way that they could be removed and left behind if they got stuck in the mud. Two of the legs were also tied to 12 ft. "2 x 4"s sunk about five ft. into the mud. In this way the whole structure was "floating" on top of the mud, but was anchored so it could not blow over. The tower itself has a platform on top on which one can stand

plus a seat which rotates 360 degrees. This made it ideal for observing the entire wetland, even looking over and to a certain extent down into the cattails. Because the water was about 4 ft. deep where the tower was erected the effective height at eye level while sitting in the seat was approximately 10 ft. Even with the ability to disassemble the legs it took four people and two canoes to get the tower to the proper location and erect it. Observations were made using 7 x 50 binoculars (Swift Inc model No. 789), and a 15 - 60x spotting scope (Swift Inc. model no. 841). Nests, nestlings, and fledgelings were identified and tracked by determining the compass bearing and distance from the tower.

Two designs of artificial nest platform were constructed. Six solid 16 in. by 16 in. platforms were built from "2 x 6" planks, and five 32 in. x 32 in. frames were built out of "2 x 4's" with a wire mesh platform on top (see Figure 3). These platforms were made from designs supplied to Lisa McCurdy at Missisquoi N.W.R. by Ian Drew of Montezuma N.W.R. (Drew, 1993).

As a separate independent estimate of recruitment from the Missisquoi population, observations were made of black tern adult/fledgeling ratios at the mouth of Dead Creek (Missisquoi N.W.R.). This is a staging area for terns and gulls after they have left the nesting area but before they migrate. Observations were made using the spotting scope and binoculars while sitting in a canoe a short distance away. Due to the constant comings and goings at this site, and because of the difficulties in differentiating molting adults from fledgelings, repeated counts were made on two separate days.

RESULTS AND DISCUSSION

MUD CREEK

Mud Creek W.M.A. was created in the 1950's when a water control structure (dam) was built at a spot near Route 78. Because of the high water levels throughout the Champlain Basin in 1993, this dam was topped by approximately 2 ft. of water on May 2, and the marsh was directly connected to the lake throughout May and into June. Because of these elevated water levels, there was very little nesting substrate available within the pool where black terns had nested previously. The vast majority of the 24 nests found in 1992 were within the main pool; in 1993 no terns nested in that area. The only nests found were located in small bays off the main pool where nesting substrate was available. The major nesting area in 1993 was apparently a series of small pools northeast of the north end of the open water. These pools were not accessible by me and not directly visible, but it was possible to observe black terns flying to and from the

area continuously. These pools are also clearly visible on aerial photographs of the area taken in 1992 (see Figure 2). Because of the inaccessibility of these areas, an accurate count of nests was not possible in 1993. A maximum count of 31 adults on June 6 was obtained, but based on prior experience this probably underestimates the number of nesting birds present. Therefore, calculations will be based on an estimate of 20 pairs with a probable range of 16 - 24 total pairs.

There were five nests which I was able to follow from egg laying through fledging and therefore their fate is known. Below is a brief description of each:

NEST 1A: Found on 6/4/93 at western edge of north pool with 2 eggs present. On 6/12 there was no sign of nest, eggs, or young. Probably lost to predation.

NEST 1: Found 6/4 with 3 eggs present at the northeast corner of the north pool. No activity observed after mid June, no sign of nest on 6/29. Probably lost to predation.

NEST 4: Found 6/16 at western edge of north pool with 3 eggs present. Fledged 3 young.

NEST 5: Found 6/16 at western edge of north pool (about 50 ft. from nest 4) with 3 eggs present. Had lost 1 egg by 6/29 (maybe it rolled into the water?). Fledged 2 young.

NEST 7: Found 3 egg nest at far south end of marsh near the railroad tracks on 6/16. Nest empty on 6/29 with a nestling feather found near the nest. Probably lost to predation.

In addition, there was one nest where the fate was unknown, but it may have fledged up to 3 young. This was NEST 6 which was located about 20 ft. from nest 7 at the south end of the marsh. It contained 3 eggs on 6/16, and 3 nestlings on 7/4. On 7/11 I could not locate them, but there were still adults in the area acting somewhat defensively. It is possible that the young had moved far from the nest toward open water and therefore that up to three fledged.

From the above data it can be seen that five nests produced 14 eggs (average = 2.8 per nest). Of these, five were known to fledge (36% fledging success or 1.0 fledgelings per pair). Eight of fourteen eggs were lost to predation (57%), and one egg was lost to unknown causes but probably rolled into the water (7%). Two of the five nests (40%) successfully produced fledgelings. In addition, nest 6 may have produced up to 3 fledgelings. It is also possible that some of the pairs reported above as being unsuccessful could have re-nested successfully. The major source of mortality appears to be predation during the incubation phase. Also, there is a tendency for either all of the eggs from a nest to survive or none.

A second method used to determine recruitment was to estimate the total number of fledgelings produced at the Mud Creek colony. This was made possible by the observation that

fledgelings from the entire marsh congregated with adults at the pool at the north end of the marsh once they were able to fly. Reasons for this might be: an abundance of perches with good visibility, large amounts of open water make for a good practice flight area, abundant food, and the fact that black terns are gregarious. Because of the excellent visibility from the observation tower, and the relatively sparse vegetation present, it was possible to estimate total productivity from the colony by counting fledgelings. An estimated 24 young successfully fledged from the Mud Creek colony in 1993 based on these observations. This is approximately 1.2 young per pair (range = 1.0 -1.5).

A third estimate of fledging success was obtained by observing the ratio of adults to fledgelings congregating on driftwood at the mouth of Dead Creek on Missisquoi N.W.R. in Swanton, VT. This is a staging area for black terns of the Missisquoi population prior to migration. Because there is such a large concentration of terns in a small area (the highest count for 1993 was 89 black terns) it is possible to get a reasonably accurate count. On 7/25/93 and 8/3/93, repeated attempts were made to determine the ratio of adults to young. On 7/25 the counts resulted in estimates of 1.1 - 2.1 young per pair, while on 8/3 the range was 0.8 -1.2 The value of 2.1 young/pair was obtained on the first count at this site and is most probably an overestimate of young produced due to the difficulty in differentiating fledgelings from winter plumage adults. Therefore the 8/3 results are deemed more reliable. The validity of this technique is unknown though because I don't know if adults or young might be preferentially congregating there.

The three (partially) independent estimates of reproductive success obtained (1.0, 1.0 - 1.5, and 0.8 - 1.2 young per pair) all indicate that approximately one fledgeling per pair was produced in the area studied. This is substantially more young produced at Mud Creek in 1993 than my very rough estimate of 5-10 young/24 nests in 1992 (0.2 -0.4 young per pair). Possible reasons for this include:

1) 1992 production was underestimated. This is quite possible but it is not likely that twenty or more fledged.
2) Random variation. Either 1992 was a bad year or 1993 a good year. There is no way to determine this.
3) Due to high water and minimal nesting substrate at the north pool the black terns were forced to override their colonial instinct and nest in the relatively more dispersed pools northeast of the main pool. Because the nests are less localized, predation pressure would be decreased, and since predation appears to be the major source of mortality, more young would fledge. In 1992, when the terns were nesting primarily in the north pool, nests were found on virtually every potential nest site in the pool. It would certainly be easy under these

circumstances for a predator to develop a search image for black tern nests and decimate the population. The only way to determine if this hypothesis is correct is to repeat the study in a year when the terns are nesting colonially in the main pool.

A fledging success of about one young per pair is evidence of a fairly healthy breeding population, at least for 1993. At this rate it would take two years for a given pair to reproduce itself. This does not indicate a rapidly expanding or declining population, but indicates no immediate cause for concern. It is also certainly better than the results observed by Firstencel, Bailey, etc. Again this may be due to the more dispersed nesting at Mud Creek this year, or the above investigators may have caused added mortality due to their presence, or some other unknown cause.

ARTIFICIAL NEST PLATFORMS

Goose Bay colony on Missisquoi Bay had an estimated six nests in 1993. Of these I was able to locate five, two on natural substrate, two on small platforms, and one on a large platform. The fate of all of these nests is unknown because the vegetation had grown up to such an extent that the colony was totally inaccessible by the time young should have fledged.

The fact that three of five nests found were on platforms demonstrates the feasibility of using artificial platforms as nesting substrate for black terns in Vermont. On the other hand, there were 13 nesting pairs at Goose Bay in 1992 and only six in 1993. The reason for the decline is unknown. There was apparently no shortage of breeding age adults in the area (see discussion of the Charcoal Creek North colony site below). It would appear therefore that we were not able to attract terns to this colony site because of the plentiful nesting platforms. The reason for this is unknown.

One difficulty found with the platforms was in the securing of nesting material onto them. Hay, dead grass, and reeds were secured to each platform with twine to cover the top as much as possible. This was intended to both make the platforms appear more natural and to give the birds nesting material. Upon later visits this material had disappeared from some of the platforms. This may have been due to poor attachment, wave action, or muskrats who were observed to use some platforms as feeding platforms.

Another problem observed with the designs utilized was the fact that fresh wood is very light colored. The platforms were very conspicuous from water level until the vegetation grew up around them. This could have made them more prone to disturbance by humans as well as more prone to predation. In addition, the platforms were probably very conspicuous from the air, especially with a black bird and

nest in the middle. This could have made them more susceptible to predation from aerial predators. The platforms will be left outdoors this winter to weather before re-use next year.

NESTING AT OTHER COLONY SITES

As mentioned above, the Goose Bay colony had six nesting pairs in 1993, down from 13 in 1992. Estimated breeding populations at some other colony sites are listed in Table 1. For general locations of these sites see Figure 1, for detailed locations see Shambaugh (1992). These are mostly estimates based on brief visits by myself or volunteer helpers, so the accuracy of these counts is not as great as in previous years. It can be seen however that there is an apparent decline in nesting pairs at virtually all sites. Part of this is probably due to the less thorough census this year, but I believe it is at least partially due to the high water levels in the spring. As can be seen in Table 1, Big Marsh Slough had a nesting population of about 15 pairs in 1993 as compared to none in 1991 or 1992. Another observation which indicates altered or disrupted breeding habits is the observation on 7/13 of 25 - 30 adults congregated on two exposed mats at the Charcoal Creek North colony site. This is the peak of the nesting season for black terns and most pairs should have had eggs or nestlings. Nearby within the same marsh there were approximately 15 pairs nesting normally. These congregations are highly unusual during the nesting season; the only similar thing I have seen is the congregations at the staging area at Dead Creek on Missisquoi Bay. It was too early for staging however, and all of the terns were in full breeding plumage with no fledgelings present so it is not likely that it was normal staging. The logical interpretation is that they were non-breeding adults.

CONCLUSIONS AND RECOMMENDATIONS

Considering the unusual water levels, the limited resources, and the fact that this was a first attempt at using an observation tower to observe breeding black terns, I believe that the estimate of about one fledgeling per breeding pair is a good approximation of the actual reproductive success of black terns in the North Lake Champlain population in 1993. Because of the uncertainties in such a study and the odd behaviors observed, I believe that this study should be repeated either in 1994 or in the near future when there is a more normal water regime.

Black tern colony sizes appeared to have decreased from previous years, but hopefully this is a temporary setback due to the high water. If censuses in future years indicate this is not the case then the need to repeat or expand this study

becomes more urgent.

Artificial nest platforms have been demonstrated to be useable as black tern nest sites during this study and elsewhere. Minor logistical problems this year may have decreased their usefulness, but these can be corrected for 1994. Could it be that these light colored platforms stood out enough that the birds were disturbed and so they nested elsewhere in 1993? This would explain the decrease in nesting population here from thirteen to six pairs.

Whether this technique proves to be a useful management tool remains to be seen, although the fact that more were not utilized in a year when large non-breeding populations existed indicates that improvements could be made. Refuge personnel have shown interest in the possible use of this technique to entice terns to nest in more protected or suitable habitat, as well as the possibility of expanding the breeding population. Whether these platforms will prove useful for these purposes remains to be seen.

The overall question of what constitutes optimum nesting habitat and what management techniques can be used to reach that goal has not been addressed adequately in Vermont or elsewhere to date. Until more is known about limiting factors on black tern nesting I believe it is premature to assess management options. Therefore the next logical step in black tern research is a detailed analysis of nesting habitat with the goal of creating a set of management objectives.

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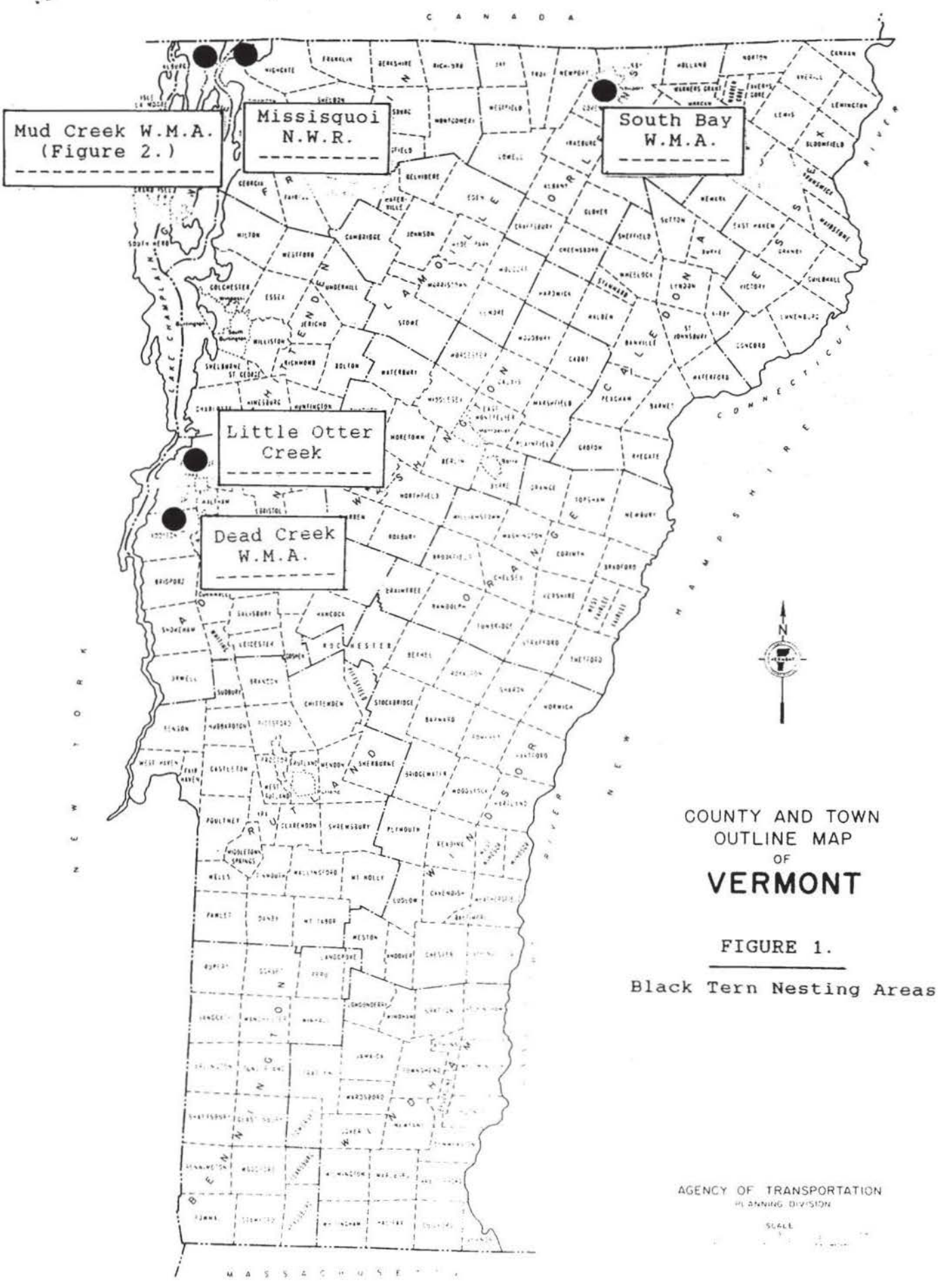

FIGURE 1.

Black Tern Nesting Areas

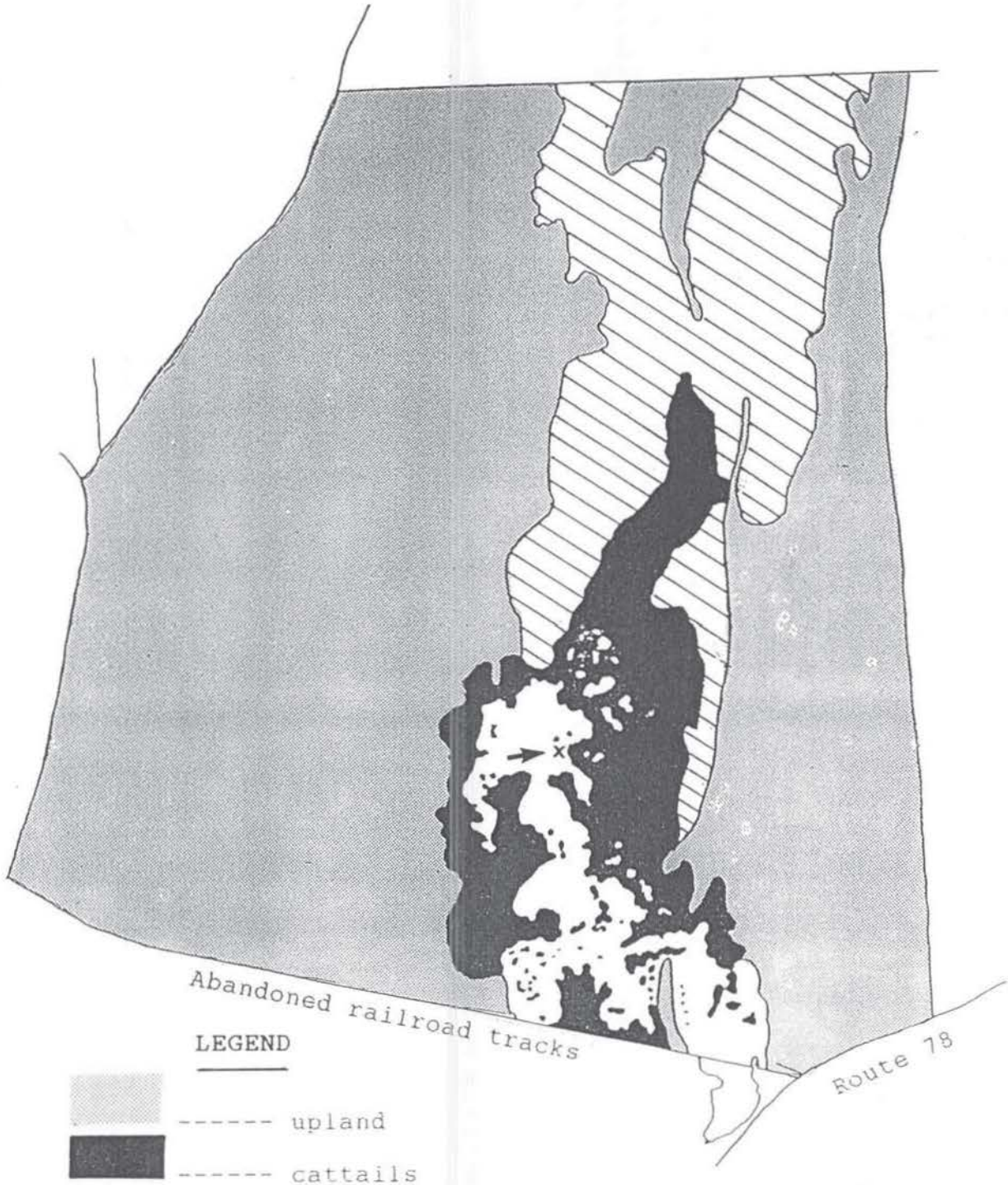

FIGURE 2.

MUD CREEK WILDLIFE MANAGEMENT AREA
(from National Aerial Photo Program
photo 4191-76 4/27/92).
scale approx. one in. = 1800 ft.

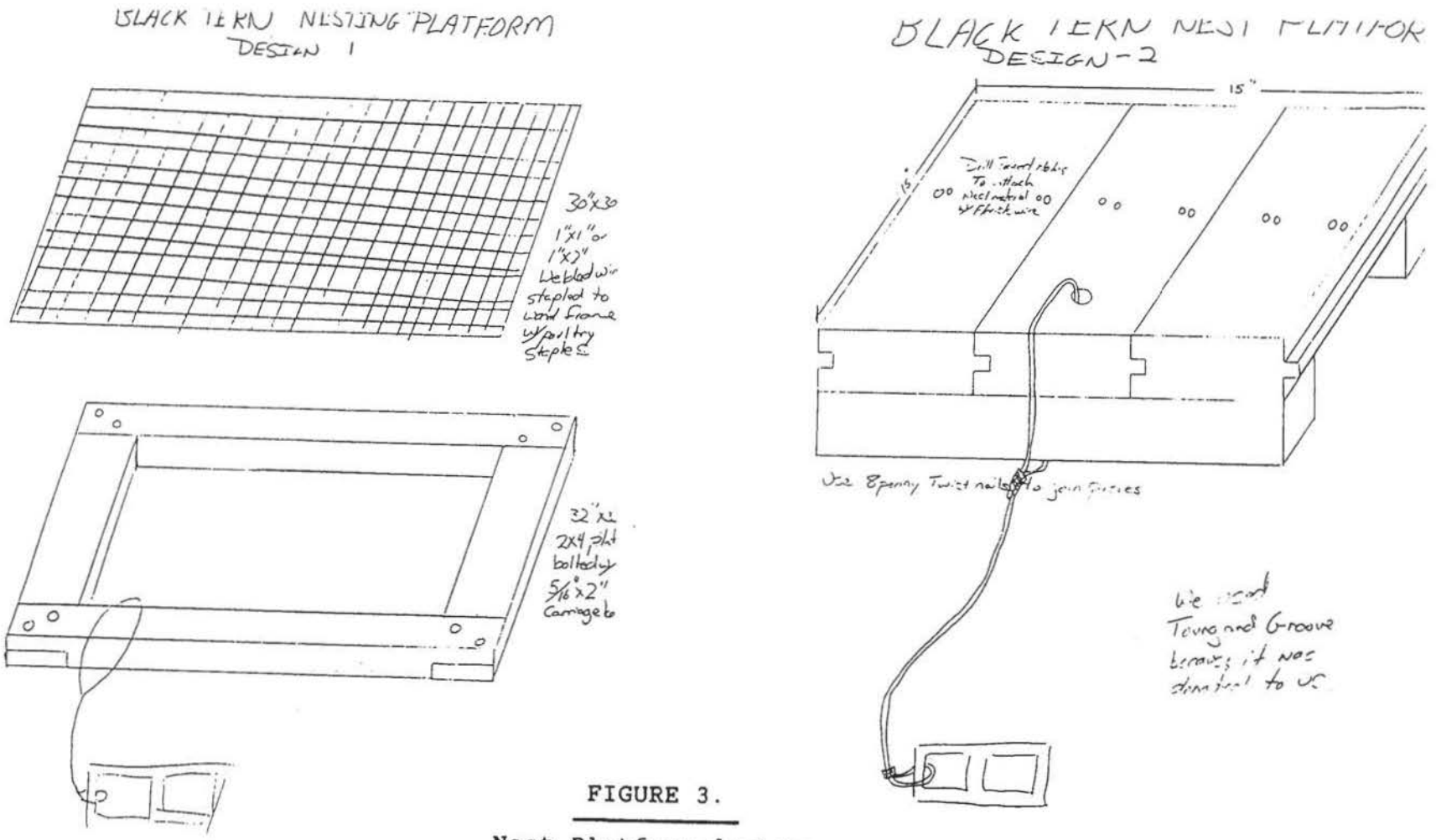

FIGURE 3.

Nest Platform designs
(from Drew, 1993)

TABLE 1.

BLACK TERN COLONY SIZES AND LOCATIONS

COLONY	POPULATION	NUMBER OF BREEDING PAIRS			
		1990	1991	1992	1993
CHARCOAL CR. N.	MISSISQUOI	15	24	22	15*
CHARCOAL CR. S.	MISSISQUOI	5	13	11 (2*)	
CRANBERRY POOL	MISSISQUOI	17	6	5	5
BIG MARSH	MISSISQUOI	UNK.	0	0	15
GOOSE BAY	MISSISQUOI	UNK.	UNK.	13	6
MUD CR. WMA	MISSISQUOI	UNK.	7	24	20*
SOUTH BAY	MEMPHREMAGOG	4	4	4	UNK.
PANTON RD. N.	DEAD CREEK	1	2	1	2*
PANTON RD. S.	DEAD CREEK	0	4	3	UNK.
ROUTE 17 N.	DEAD CREEK	6	0	0	UNK.
ROUTE 17 S.	DEAD CREEK	5	0	0	UNK.
WEST RD.	DEAD CREEK	0	2	4	UNK.
LITTLE OTTER CR.	DEAD CREEK	6	9	8	UNK.
TOTAL		59	71	95	UNK.

UNK. = unknown

* = estimated