2002 BLACK TERN POPULATION SURVEY AND OTHER MARSH BIRD MONITORING ACTIVITIES IN VERMONT

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ABSTRACT

2002 BLACK TERN POPULATION SURVEY AND MARSH BIRD MONITORING ACTIVITIES IN VERMONT

As part of ongoing research into the status of Vermont's marsh birds, a statewide census of the black tern (***Chlidonias niger***) nesting population was undertaken again in the year 2002. The black tern nesting population showed a drop from the high of 100 pairs in 1999 to only 66 pairs found in 2002. Virtually all black tern nesting in Vermont in 2002 was found at Missisquoi National Wildlife Refuge in Swanton with only one pair found at Mud Creek Wildlife Management Area in Alburg. This is cause for concern because all nesting is in one confined area, with no nesting at the south end of Lake Champlain or on Lake Memphremagog as noted in the past.

In addition, the survey of selected marshes in Vermont for other marsh birds (pied-billed grebe, least bittern, American bittern, Virginia rail, sora, common moorhen, and American coot) was continued. Fifteen marsh bird routes situated in emergent marshes within state Wildlife Management Areas, Missisquoi NWR, or in marshes designated as "Important Bird Areas" were surveyed. Virginia rail is still the most common and abundant marsh bird surveyed , followed by the common moorhen, with least bittern, sora, American bittern, pied-billed grebe, and American coot being uncommon and sporadic.

These ongoing activities together have two major objectives: to look at marsh bird population trends within the marshes of Vermont, and to investigate the effect of water level and marsh vegetation changes on marsh bird numbers.

Relationships between various marsh bird nesting patterns are discussed as well as correlations between black tern nesting locations and water level. Recommendations are made for management activities which could benefit the black tern nesting population.

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INTRODUCTION

The black tern (***Chlidonias niger***) is a colonial nesting marsh bird which is currently on the Vermont threatened species list due to its declining numbers. In order to better understand the biology and population status of this species, statewide censuses of the Vermont black tern nesting population have been made for the past 13 years. The black tern is a bird which nests in loose colonies within large emergent marshes, often building its nest on old muskrat lodges and floating debris. Because this nesting habitat is impermanent and the overall marsh vegetation varies each year depending on water level, colony locations vary from year to year. The transitory nature of nesting colony locations makes it important to survey all potential colony sites in Vermont each year.

The Vermont black tern nesting population has been hovering at 50-100 pairs since the start of this study in 1990, probably down from about 300 pairs in the 1970s, although this latter number is not well documented. This apparent decline in numbers has many possible causes, only some of which may be related to nesting activity in Vermont. Because of the marsh nesting behavior of this species, and the fact that the young may leave the nest soon after hatching if disturbed, it is very difficult to get an accurate estimate of nesting success for black terns. This author and others have made various attempts to determine individual nest or colony breeding success with varying degrees of success (Shambaugh 1994a).

In 2002 the entire Vermont black tern breeding population was concentrated in and around the Missisquoi National Wildlife Refuge in Swanton, VT. This situation does not bode well for the future of this species in Vermont. As recently as four years ago terns were also nesting at Little Otter Creek in Ferrisburg and South Bay WMA in Coventry. Fortunately, the MNWR has a wide variety of marsh habitats, and it appears that there is suitable nesting habitat somewhere within the refuge most every year.

In addition to the above black tern census work, the author continued to coordinate volunteer marshbird surveys of selected marshes in Vermont in 2002. As in previous years, the following bird

species were selected for monitoring: pied-billed grebe (***Podilymbus podiceps***), least bittern (***Ixobrychus exilis***), American bittern (***Botaurus lentiginosus***), Virginia rail (***Rallus limicola***), sora (***Porzana carolina***), and common moorhen (***Gallinula chloropus***). These species were selected because they are obligate, emergent marsh-nesting species. They also have limited nesting populations, or there is a limited knowledge of their breeding habitat preferences and abundance in Vermont. In addition, the American coot (***Fulica americana***) was included starting in 1999, because it is part of the monitoring methodology used for this study (McCracken et al. 1995), and several volunteers started reporting it.

All of the above activities have two long term objectives: to look at marsh bird population trends within certain major marshes in Vermont, and to investigate the effect of water level and marsh vegetation changes on marsh bird numbers. By investigating marsh bird responses to vegetation changes this research is trying to determine habitat requirements for nongame marsh birds, investigate what habitat is created by the vegetation management undertaken, and determine what effect these management efforts have on nongame marsh bird numbers.

MATERIALS AND METHODS

BLACK TERN CENSUS

Black terns were censussed as in previous years (Shambaugh 1995). Briefly, areas where black terns have historically nested were censussed by canoe during the black tern incubation period, approximately June 1 through June 20. An estimate of nesting pairs was made by counting the number of adults flushed up from the colony while canoeing through it, then dividing by two. This estimate was verified, as much as possible without excessive disturbance, by locating actual nests. All black tern census work was undertaken by the author.

MARSH BIRD CENSUS

The four marsh bird survey routes created in 1996: Charcoal Creek at Missisquoi National Wildlife Refuge in Swanton VT, Mud Creek at Mud Creek Wildlife Management Area (WMA) in Alburg VT, Route 17 at Dead Creek WMA in Addison, VT, and Brilyea at Dead Creek WMA were all surveyed again in 2002 (see Figures 1-4 for site locations). Of the thirteen routes created after 1996, eleven were surveyed during the summer of 2002. These routes, their locations, and year that surveys began are as follows: Long Marsh (1998), Goose Bay (1998), Dead Creek (1998), and Cranberry Pool (1999) at MNWR in Swanton, VT (see Figure 1), Sandbar WMA (1999) in Milton, VT (see Figure 6), Little Otter Creek (1999) in Ferrisburgh, VT (see Figure 7), West Rutland Marsh (2001) in West Rutland, VT (Figure 8), Berlin Pond (1999) in Berlin, VT (Figure 9), Lake Bomoseen (1999) in

Hubbardton, VT (Figure 10), and Herrick's Cove (1999) in Rockingham, VT (Figure 11), and Panton Rd. (2002) in Panton, VT (Figure 12).

These survey routes were set up and surveyed according to the Marsh Bird Monitoring Program protocol developed at the Long Point Bird Observatory, Ontario, Canada (McCraken et al. 1995) with modifications as described previously (Shambaugh 1998). Briefly, a survey route consists of between two and nine stations located at least 200 m apart. Each survey station is semi-permanently marked with either a post pounded into the mud or a metal rod pounded in the ground. Pre-recorded calls of least bittern, Virginia rail, sora, common moorhen, and pied-billed grebe are played at each survey station and responses are recorded for the next five minutes. The number of each species responding within a 100m radius semi-circle centered on the station are reported. This semi-circle is referred to as a survey plot. The American bittern was included in the survey without use of pre-recorded calls because they are loud, distinctive, and reliably detected without the use of a tape.

RESULTS AND DISCUSSION

BLACK TERN CENSUS

Based on the results of the 2002 black tern census, it is estimated that there were 66 black tern pairs nesting in Vermont in 2002 (see Table 1). Unfortunately, the area in Vermont where black terns nest continues to become more restricted each year. No terns were documented nesting in the southern half of Lake Champlain or on Lake Memphremagog for the third year in a row. Mud Creek Wildlife Management Area in Alburg was, as recently as 1995, one of the major nesting areas in Vermont for this species. In 2002 there appeared to be only one pair nesting there. This leaves the Missisquoi N.W.R. as the only significant nesting area in Vermont in 2002. Fortunately, the Missisquoi NWR is the largest wetland complex in Vermont, with large amounts of a wide variety of wetland habitats and it continues to support a healthy population of black terns, with major concentrations in 2002 at Long Marsh, Cranberry Pool, and Charcoal Creek North.

Water level fluctuations were again a problem for black terns in 2002. A major rain storm swept through the area of Missisquoi NWR in mid-June, causing the Lake Champlain lake level to rise over one foot in the week from June 11 to June 17. The Missisquoi River flooded over its banks into Cranberry Pool during this storm (Dave Frisque pers. comm.), apparently causing the destruction of black tern nests in the pool. On June 1 there were an estimated 14 pairs nesting in Cranberry Pool. By June 20, when young should have been present, new two and three egg nests were found. Apparently most of the pre-June 11 nesting activity within Cranberry Pool was unsuccessful due to flooding, but it occurred early enough for the terns to attempt to re-nest. Adults and nestlings were still present in Cranberry Pool on July 6, so this nesting area was used successfully even though the first nests were destroyed by rising water.

The other major nesting areas in 2002, Charcoal Creek North and Long Marsh, were also exposed to rising waters from this storm event. These marshes are on the edge of Lake Champlain so they would have seen a gradual rise in water as the lake as a whole rose, unlike Cranberry Pool which likely saw a rapid flood as the Missisquoi River flooded its banks into the pool. Fortunately, the nests in these lakeside marshes were mostly on floating mats of vegetation and debris. As far as I was able to determine virtually all of the nests rose with the rising water and the adults continued to incubate the

eggs. *Only one egg from* a swamped nest was found during a visit on June 14. As can be seen in Figure 13, many of these nests were constructed on floating, dead burreed stems from the previous year. This nest substrate rises and falls with the changing water levels so in that respect it is an ideal nest site. The major drawback to a nest such as this is that it would be very susceptible to wave action from the wind or a boat wake. The nature of these marshes is such that there is generally not a lot of fast boat activity, but these nests are so precarious, and this species has such limited nesting in Vermont, that I believe these areas should be posted to prohibit boat use from June 1 through July 15. Figure 14 depicts the areas on Missisquoi NWR where I would recommend posting. Many of these areas are already posted for other reasons, it may just require a slight change in timing or location to include black tern protection.

Figure 15 graphs the Vermont black tern population numbers for the past 13 years. It can be seen that there is a large fluctuation in the number of black tern nesting pairs in Vermont, from a low of 44 in 1996 to a high of 100 in 1999. It also appears as though there may be an approximate seven year cycle of number of nesting pairs in Vermont, with maxima in 1992 and 1999 and minima in 1996 and 2001. The cause for this possible cycle is unknown, but it appears to at least partially be related to fluctuating lake levels (see below). If this trend continues in 2003 then there should be about 84 nesting pairs in Vermont in 2003 (see Figure 15).

Based on data from 1990-2001, it appears that there is a relationship between Lake Champlain lake levels, and the amount and location of black tern nesting in Vermont. The lake level value utilized is the mean of the daily lake level, as measured in Burlington, for the period May 15 - May 31. This is the time when black terns will be scouting out wetlands searching for suitable nesting habitat. There appears to be a negative relationship between lake levels and the number of black terns nesting in Vermont (see Fig. 16). Using the relationship between overall Vermont tern numbers and lake level based on pre-2002 data (see Shambaugh 2001 and Figure 16), and the 2002 mean water depth of 98.12 feet, it is possible to predict a 2002 Vermont black tern nesting population of 69 pairs. This compares quite well with the actual, observed estimate of 66 pairs. The logical extension of this is that it should be possible to predict on June 1st the approximate number of nesting pairs in Vermont in 2003 based on the May mean lake level. This negative relationship indicates that, contrary to previous thinking by this author, it may be that nesting habitat is limited in Vermont, at least during above average lake level years. Certainly if the lake level remains very high into June, then those marshes on the border of Lake Champlain such as Charcoal Creek, Long Marsh, Goose Bay, etc. probably will not have very much emergent vegetation until later than normal. Because the nesting season for black terns in Vermont is so short, and starts so late, any delay in emergence of suitable nest vegetation and habitat could cause terns to abandon nesting for the year. Flocks of apparent non-nesting adults have been observed on several occasions in June. Both times these were especially noticeable were high water years (1996 and 2000).

The mean Lake Champlain lake level over the last 13 years, for the second half of May, is about 98 feet, and using this as a cutoff it appears possible to observe trends between black tern nesting location and dry vs. wet years. At Cranberry Pool (see Figure 17), an impounded wetland, when Lake Champlain is above average level there is a mean of 19% of the state's nesting population using this marsh. This compares with a mean of only 7% when Lake Champlain is dryer than normal. The Charcoal Creek South marsh on the other hand is a lakeside colony and it demonstrates an opposite trend (see Figure 18). On average, 16% of the Vermont nesting population will use this colony site on a dry year as compared with only 3% on a wet year. Therefore, generally speaking, if the lake level is above average in May then the terns will most likely be in Cranberry Pool in significant numbers, while if the lake level is below average they will be at Charcoal Creek South in significant numbers. This can be explained in the following way. If the lake level is above average then the water is too deep at Charcoal

Creek South for proper nesting habitat to be available. Cranberry Pool, being an impoundment, maintains possible nesting habitat over a much wider range of lake levels so it acts as a refugia when the lake level is so high that other sites (such as Charcoal Creek South) aren't available. Based on this hypothesized relationship, it is especially important to make sure that Cranberry Pool retains water during wetter than normal years. If a drawdown is necessary it should be timed to coincide with a normal or slightly dry year. The converse of this is that it is especially important to make sure that Charcoal Creek South is protected during drier than normal years, when it is likely to attract a significant amount of nesting activity.

Because of the declining black tern population in Vermont I have been attempting to develop ideas to improve the prospects for this species. I believe that the limiting factor for the successful nesting of this species in Vermont is the availability of suitable nest substrate when the birds are preparing to nest, and the continued suitability throughout the nesting season. Some marshes have vegetation but it is too dense or not dense enough, others have the 'correct' vegetation structure but the timing of vegetation emergence is not suitable, or no nest substrate is available even though the vegetation is suitable, or the water level drops too much during the nesting season and the nests are left exposed to predators.

As noted previously, I had thought that there was a large amount of apparently suitable nesting habitat in Vermont as a whole, so the limiting factor for this species must be nest failure or problems outside of the breeding season or outside Vermont. But, black terns have only a very limited time frame and search area in which to find a suitable nest site in Vermont. Suitable vegetation generally doesn't emerge until about June 1 on a typical year, and black terns leave Vermont about mid-August, so there is only a window of about 80 days to produce a brood of chicks. The process of laying eggs (four or more days), incubating (about 21 days), raising the young to fledging (about 21 days), and the building of fledgling strength and skills prior to migration (about two weeks) takes about 60 days, so there is very little leeway in the timing of a successful brood. If a tern pair is not incubating by about June 20, at the latest, then they will not be able to raise a successful brood. Therefore, the period from about June 1 through June 20 is a critical period for this species in Vermont. If suitable nest habitat is not found during this three week period, then nesting will not be successful.

I believe the process an adult black tern will go through upon returning in the spring is as follows: The bird will return to the area where it was born or nested previously, and if suitable nesting substrate is present and/or other terns are hanging around, then it will stay. If no other terns are present and/or no suitable substrate is available then the bird will expand its search area to surrounding marshes. Whether the bird would be searching primarily for other terns or for suitable nest substrate is unknown. Because these are social animals, the presence of other terns is certainly important. At some point though, if no nest site is found, the urge to nest will be lost and the bird will abandon the search, and start to flock with other non-nesters. These non-nesting flocks have been observed sporadically in Vermont, as noted above. This hypothesized search strategy is why I believe that it is such a problem that black terns are no longer nesting at the south end of Lake Champlain or Lake Memphremagog. Until or unless the black tern population expands greatly in the northern end of Lake Champlain, these birds are not likely to re-colonize other areas far from Missisquoi NWR. If the Missisquoi NWR area becomes saturated with nesting black terns, then there would be pressure to expand, but otherwise they will continue to search out existing colonies near where they have nested previously. The goal at this point therefore should be to increase the number of successful black tern nesting pairs within and around the Missisquoi NWR and Mud Creek WMA.

Factors affecting the ability of a pair to nest successfully are:

1) suitable nest substrate available when looking to build a nest.

Nest site requirements for black terns are quite specific and temporally variable. This species nests in emergent marshes on floating mats of emergent vegetation, floating debris, floating muskrat feeding platforms, old muskrat lodges, or patches of exposed mud. In a "normal" year, little of this habitat is available prior to mid to late May because the water is too deep and/or the emergent vegetation has not grown sufficiently. So although the birds are attempting to find nest sites as early as May 15, in Vermont that habitat is often not available until June, except maybe in low water years.

2)continued suitability throughout the nesting cycle.

Although suitable nest substrate may be available in a particular marsh in early June, that marsh may dry up, or the lake level drop or rise during incubation. In this situation, terns would nest but not successfully because the habitat has disappeared.

3)presence of other terns (a psychological need).

Because black terns are a loosely colonial species they prefer to nest in the vicinity of other terns. This is not a requirement though because terns have been observed to nest in relative isolation.

4)predation.

Again, because this species is semi-colonial, if the water level drops or a predator develops a search image for black tern nests, then whole colonies can be lost to predation.

5)acts of nature: weather, water level changes etc.

Rain storms and droughts leading to major fluctuations in water levels can cause nests to become flooded or left on dry ground. Strong winds causing large waves are also a significant potential source of nest loss.

In order to optimize the above factors the following management activities could/should be undertaken:

A) Lower the water level within impoundments (Mud Creek and Cranberry Pool) as quickly as possible in the spring to a level where emergent vegetation will grow early in the spring. For instance, at Cranberry Pool if the target is 97.5', it would benefit black terns if that could be accomplished as early as possible before June 1. At Mud Creek the water depth in the main open water is too deep for early emergent growth, so dropping the level by one to two feet during May, if lake levels permit, should encourage earlier emergent growth. This will necessitate active beaver management to prevent their damming near the outlet.

B) Along with A above it is also necessary to do whatever is possible to maintain a constant water level within Mud Creek and Cranberry Pool during the egg phase, approximately June 1 through July 1. If the water level rises too much nests will become swamped as at Cranberry Pool in 2002, if the water drops then nests will be susceptible to predators such as raccoons, as in 2000 in Cranberry Pool.

C) Decrease the amount of vegetation at those areas where the vegetation is very dense, such as cattails at Mud Creek, in order to open up more water for emergent vegetation (burreed, bulrush, etc.). This can be accomplished using the 'cookie cutter' as in 1996, herbicides, explosives, fire, etc. Unfortunately, none of these are very politically palatable or practical.

D) Decrease predation. It might be possible to decrease mammalian predation within restricted areas such as Cranberry Pool by trapping out the raccoons. This would probably not be a long term solution, but it might help to build up the tern population if racoon trapping were undertaken around

Cranberry Pool and Big Marsh slough for a few years. Of course this wouldn't help control avian predation, but most documented black tern predation has been due to racoons.

E) Minimize human disturbance within nesting marshes. As mentioned above, areas where black terns are nesting should be posted so anglers, recreational boaters, etc. do not disturb nesting birds. This is probably only necessary at those areas marked on Figure 14, few people enter the interior of Mud Creek during the nesting season and that is currently the only other nesting area in Vermont besides Missisquoi NWR.

F) Add perching locations for adults and fledgelings. By putting posts scattered within prospective marshes it will encourage terns to stay around the marsh even before nesting substrate is available. They would also provide loafing areas for the adults during the egg and nestling phases and for the young after fledging. Also downed snags or floating logs, boards, etc. scattered within nesting marshes would provide nestlings and fledgelings a place to loaf and rest. Posts were pounded into the mud around Cranberry Pool in 2002 to encourage black tern use and they were used extensively.

G) Create/improve nesting substrate or supplement it with artificial nest platforms. Artificial nest platforms (floating, anchored rafts) have been used in Vermont and elsewhere in order to either encourage terns to nest in particular marshes or add extra nest substrate which isn't susceptible to water level fluctuations. This experiment has met with mixed success, some researchers thought it improved productivity, while others thought it led to increased predation. In Vermont, platforms were put out in several marshes in the early 1990's and for five years at South Bay WMA on Lake Memphremagog, but the tern population still dwindled away to nothing during this period. The platforms were often used for nesting, but whether young fledged successfully is unknown. So the platforms may have been of some marginal help at South Bay, or they may have sped up the elimination of this colony by attracting terns to nest at spots where they wouldn't nest successfully. The drawback to the platform design used was that the materials were not all biodegradable so it was necessary to try to retrieve them after the nesting season. Vegetation is very tall and dense in these marshes by September making this difficult. An alternative design was attempted in 2002 in Cranberry Pool. Hay bales were staked in place using 4' wooden garden stakes within the marsh. This initial attempt was aimed primarily at seeing if these would stay afloat and staked in place through the nesting season, no attempt was made to add nesting material to make them more attractive to terns. Of the 13 bales put out in May, one disintegrated immediately, four could not be relocated six weeks later, three did not rise or fall with the changing water levels, leaving five which seemed to have functioned adequately. As mentioned above, no nest substrate such as dead burreed stalks were put on the bales so although terns were observed to perch on bales, they weren't used for nesting. Black terns are not known to carry nesting material from long distances, they generally will only pull together debris from the immediate area of the nest. Debris such as in Figure 13 generally accumulates upwind of emergent or woody (buttonbush) vegetation patches, and this debris is the preferred nesting substrate of black terns in Vermont when it is available (see Shambaugh 1994b).

MARSH BIRD SURVEYS

Fifteen marsh bird routes were surveyed in 2002 with a total of 83 stations. South Bay WMA was not surveyed in 2002, but a new marsh route was added on Dead Creek, just north of Dead Creek WMA in Panton, VT (see Figure 12). The marsh bird monitoring routes investigated are situated in emergent marshes within state Wildlife Management Areas, Missisquoi NWR, or in marshes designated as "Important Bird Areas"(IBAs) by Audubon Vermont. IBAs are areas selected by a scientific panel as

being especially important for the continued well-being of Vermonts birds. Summary data for the mean number of each species per station are listed in Table 2 for the Vermont Wildlife Management Areas, Table 3 for Missisquoi National Wildlife Refuge, and Table 4 for Vermont Important Bird Areas. Unfortunately, the results from two surveys within Missisquoi NWR; Goose Bay and Cranberry Pool are not useable due to problems with the data collection.

Several general observations can be made from these data. First, as in previous years, it is clear that the Virginia rail is the most common and abundant marsh bird detected by this survey. The common moorhen is also quite common, but the other species are only found sporadically. One interesting observation is apparent when looking at Table 3. That is, at Long Marsh, Goose Bay and Cranberry Pool there is a negative relationship between Virginia Rail densities and Common Moorhen and Pied-billed Grebe densities. When there are many rails there tend to be few moorhens and grebes. This is somewhat expected since rails prefer dense vegetation while moorhens and grebes prefer to be able to swim.

Table 5 lists the trends of marsh bird numbers within the three original Wildlife Management Area survey routes: Brilyea and Route 17 within Dead Creek WMA and Mud Creek WMA. The number listed is a sum of the maximum number of individuals detected in each marsh by year. The most common species, Virginia Rail, seems to be gradually declining over the past seven years, although it may simply be that 1996 and 1998 were especially good years.

The Common Moorhen, on the other hand, has had a very large drop in numbers from 1996 to 2002. Figure 19 depicts this decline in several ways within the WMAs as a whole and within Mud Creek WMA where a large number of moorhens were detected early in this study. The decline is especially evident within the Mud Creek WMA, but it is also present at the other Wildlife Management Areas. Station G within Mud Creek WMA had a very large density of moorhens in 1996, with five detected within that one survey point, but this has gradually declined to none in 2001 and 2002. It may be that the large numbers detected in 1996 as seen in Figure 19, don't correspond to the pre-1996 norm from which the population has declined, but are actually a temporary population explosion of moorhens at these marshes in response to the 'cookie cutter' vegetation management undertaken at all three of these marshes in early 1996. There was a large amount of floating, dead, chopped up vegetation present in 1996 due to the 'cookie cutter' which was solid enough for the moorhens to walk on and probably supplied abundant invertebrates and succulent roots to eat. The 1995 data point for station G on Figure 19 was from some preliminary work done by this author using a slightly different protocol so it may not be comparable, but it is at the same point as G and is the only pre-cookie cutter data available. It appears as though moorhens, and possibly Virginia Rail as well, were attracted to the habitat or food supply created by the 'cookie cutter'.

Looking at the marshbird data overall, the same trends in marsh bird numbers were seen in 2002 as in previous years. Each marsh seems to have its own cohort of marsh species, which doesn't vary greatly year-to-year. By combining all of the data from all the marshes and years it is possible to make some general comparisons of the preferences of the various marsh birds for the marshes surveyed.. Table 6 combines all of the data to give mean numbers of individuals per station for each marsh. The overall mean for each species is listed at the bottom, the values in **bold** are those greater than the mean for that species, and the underlined value shows the marsh with the highest density for each species. It can be seen that no one marsh is obviously better than the rest, each species has a preference for a different marsh. For instance, Mud Creek has the highest overall density of Virginia Rail, but not of any other species. On the other hand, it is clear that some species have a greater diversity of marshbirds. For instance, Little Otter Creek has greater than average amounts of all species surveyed except American Bittern, while West Rutland Marsh has been found to have only Virginia Rail present (Table 6).

CONCLUSIONS

For the second year in a row, the entire Vermont black tern nesting population was concentrated at the north end of Lake Champlain at Mud Creek WMA and Missisquoi NWR. The estimated breeding population of 66 pairs was below the thirteen year mean of 69 nesting pairs. Because of the restricted nesting area and the highly variable lake levels, the impoundments at Mud Creek and Cranberry Pool become very important to the survival of this species in Vermont. These impounded areas are critical because they can act as refugia during very high (and maybe low) water years on Lake Champlain. Other reasons for their importance include: ability to vary the water level or hold it constant, isolation from human disturbance, ability to manage the vegetation if appropriate. The black tern now meets the criteria for listing as a state endangered species and I believe it is time to move forward with this action. Because this species is concentrated in such a small area a single adverse weather event could virtually eliminate nesting for a year, especially if Cranberry Pool is unavailable due to periodic draining that year.

Management activities which I believe should be seriously considered for this species include:

Cranberry Pool:

1) Drop water level to desired level by late May and do whatever is possible to keep it constant until July 1, including not letting it rise, whenever environmental conditions permit.
2) Supplement perches with posts and logs.
3) Experiment further with hay bale nest platforms.

Mud Creek

1) Drop water level one to two feet in May and hold it constant thru June, if weather permits and beaver can be controlled.
2) Supplement perches with posts and logs.
3) Experiment with hay bale nest platforms if #1 above encourages emergent growth by early June.

Charcoal Creek South

1) Experiment with hay bale nest platforms
2) Supplement perches with posts and logs.
3) Consider filling, dredging or blasting several potholes to increase the diversity of water depths so this marsh would be useable at a wider range of lake water depths.

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TABLE 1. VERMONT BLACK TERN POPULATION DATA, 1990-2002.

COLONY (POPULATION)	NUMBER OF BREEDING PAIRS												
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Charcoal Creek N. (Missisquoi)	15	24	22	15*	31	14	10	17	21	24	22	26	35
Charcoal Creek S. (Missisquoi)	5	13	11	2*	2	12	0	3	15	10	5	0	0
Cranberry Pool (Missisquoi)	17	6	5	5	13	0	0	5	4	8	11	11	14
Big Marsh (Missisquoi)	**	0	0	15	1*	**	16	17	19	33	10	0	1
Goose Bay (Missisquoi)	**	**	13	6	1*	7	0	0	0	10	0	0	0
Gander Bay (Missisquoi)	0	**	0	**	**	6	**	0	0	0	0	0	0
Mud Creek WMA (Missisquoi)	**	7	24	20*	15*	17*	8*	5*	8*	3	5	6	1
First Creek (Missisquoi)	**	**	**	**	**	**	**	6	**	0	1	2	0
Long Marsh (Missisquoi)	**	**	0	**	**	0	**	**	5	9	9	8	15
South Bay WMA (Memophremagog)	4	4	4	**	2	5	3	5	3	3	0	0	0
Panton Road N. (Dead Creek)	1	2	1	2*	0	3	0	0	0	0	0	0	0
Panton Road S.(Dead Creek)	0	4	3	**	0	0	0	0	0	0	0	0	0
Route 17 N(Dead Creek).	6	0	0	**	5	0	3	0	0	0	0	0	0
Route 17 S.(Dead Creek)	5	0	0	**	2	0	0	0	0	0	0	0	0
West Road(Dead Creek)	0	2	4	**	0	0	0	0	0	0	0	0	0
Little Otter Creek(Dead Creek)	6	9	8	**	2	0	4	1	2	0	0	0	0
TOTAL	**59**	**71**	**95**	**	**74**	**64**	**44**	**59**	**77**	**100**	**63**	**53**	**66**
MISSISQUOI POPULATION	37	50	75	63	63	56	34	53	72	97	63	53	66
MEMPHREMAGOG POPULATION	4	4	4	**	2	5	3	5	3	3	0	0	0
DEAD CREEK POPULATION	18	17	16	**	9	3	7	1	2	0	0	0	0

* estimated
** unknown

TABLE 2. VERMONT WILDLIFE MANAGENT AREA MARSH BIRD SUMMARY, 1996-2002.*

SURVEY ROUTE	VIRA	COMO	LEBI	SORA	AMBI	PBGR	AMCO
(number of stations)							
BRILYEA 1996 (4)	0.75	1.5	0	1	0	0	0
BRILYEA 1997 (4)	0.75	1.5	0	0.75	0	0	0
BRILYEA 1998 (4)	0.75	0	0	0	0	0	0
BRILYEA 1999 (4)	1	0.25	0	0.5	0.25	0	0
BRILYEA 2000 (4)	0.75	0.75	0	0.25	0	0	0.25
BRILYEA 2001 (4)	1	0	0	0.25	0	0	0
BRILYEA 2002 (4)	0.75	0	0	0	0	0	0
BRILYEA MEAN	0.82	0.57	0	0.39	0.04	0	0.04
ROUTE 17 1996 (8)	1.75	0.25	0	0.125	0	0	0
ROUTE 17 1997 (8)	1	0	0	0	0	0	0
ROUTE 17 1998 (8)	1.5	0.375	0	0.5	0	0	0
ROUTE 17 1999 (8)	0.625	0	0	0	0	0	0
ROUTE 17 2000 (8)	0.75	0.125	0	0.125	0	0	0
ROUTE 17 2001 (8)	1	0.5	0	0.25	0	0	0
ROUTE 17 2002 (8)	1.125	0	0.125	0.625	0.125	0	0
ROUTE 17 MEAN	1.11	0.18	0.02	0.23	0.02	0	0
MUD CREEK 1996 (9)	2.22	1	0.11	0	0.11	0.11	0
MUD CREEK 1997 (9)	1.56	0.67	0.11	0	0.11	0	0
MUD CREEK 1998 (9)	2.125	0.44	0.22	0	0.11	0	0
MUD CREEK 1999 (9)	1.44	0.33	0.22	0	0	0	0
MUD CREEK 2000 (9)	1.44	0.22	0.22	0	0.11	0	0
MUD CREEK 2001 (9)	0.89	0.11	0.11	0	0	0	0
MUD CREEK 2002 (8)	1.25	0.125	0.125	0	0	0	0
MUD CREEK MEAN	1.63	0.41	0.16	0	0.06	0.02	0
SOUTH BAY 1998 (6)	0	0	0.5	0.17	0	0.5	0
SOUTH BAY 1999 (5)	0.6	0	0.4	0	0	0.8	0.4
SOUTH BAY 2000 (6)	1.17	0	0	0.17	0.17	1.67	0
SOUTH BAY 2001 (6)	0.5	0	0	0	0.17	1.33	0.33
SOUTH BAY 2002 (no data)							
SOUTH BAY MEAN	0.57	0	0.22	0.08	0.08	1.08	0.18

* Maximum number of each species detected during a single survey in a given year, divided by the number of stations within that survey.

VIRA = Virginia rail COMO = common moorhen LEBI = least bittern SORA = sora
AMBI = American bittern PBGR = pie-billed grebe AMCO = American coot

TABLE 3. MISSISQUOI NATIONAL WILDLIFE REFUGE MARSH BIRD SUMMARY 1996-2002*

SURVEY ROUTE (number of stations)	VIRA	COMO	LEBI	SORA	AMBI	PBGR	AMCO
CHARCOAL CREEK 1996 (8)	0	0	0	0	0	0	0
CHARCOAL CREEK 1997 (8)	0	0	0.125	0	0	0.125	0
CHARCOAL CREEK 1998 (7)	0.286	0.286	0	0.143	0.143	0.286	0
CHARCOAL CREEK 1999 (7)	0.14	0.125	0.125	0.375	0	0.125	0
CHARCOAL CREEK 2000 (9)	0.44	0.11	0	0.22	0.11	0	0
CHARCOAL CREEK 2001 (9)	0.55	0.375	0	0.375	0.25	0	0
CHARCOAL CREEK 2002 (8)	0	0.125	0	0	0	0.25	0
CHARCOAL CREEK MEAN	0.21	0.15	0.04	0.16	0.07	0.11	0
GOOSE BAY 1998 (6)	0	1	0	0	0.17	0.5	0
GOOSE BAY 1999 (6)	0	0.5	0	0	0	0.667	0
GOOSE BAY 2000 (5)	0	1.6	0	0.2	0	1.6	0
GOOSE BAY 2001 (5)	1	0.2	0.2	0	0	0.2	0
GOOSE BAY 2002 (no data)							
GOOSE BAY MEAN	0.23	0.82	0.04	0.04	0.04	0.73	0
DEAD CREEK (MNWR) 1998 (5)	0.2	0.2	0	0	0	0	0
DEAD CREEK (MNWR) 1999 (5)	0.8	0.2	0	0	0.8	0	0
DEAD CREEK (MNWR) 2000 (5)	1.2	0.4	0	0.2	0	0.6	0
DEAD CREEK (MNWR) 2001 (5)	0.2	0	0.2	0	0	0	0
DEAD CREEK (MNWR) 2002 (4)	0.5	0.25	0	0.25	0.5	0	0
DEAD CREEK (MNWR) MEAN	0.58	0.21	0.04	0.08	0.25	0.12	0
LONG MARSH 1998 (6)	0	1.7	0	0.17	0	0.17	0
LONG MARSH 1999 (5)	1	0.2	0	0.4	0	0.2	0
LONG MARSH 2000 (5)	0.6	0.2	0.2	0.8	0	0.6	0
LONG MARSH 2001 (5)	0.8	0.6	0	0.2	0	0	0
LONG MARSH 2002 (5)	0	1.2	0	0.4	0	1.2	0
LONG MARSH MEAN	0.46	0.81	0.04	0.38	0	0.42	0
CRANBERRY POOL 1999 (5)	1.4	0.6	0	0	0.6	0.6	0
CRANBERRY POOL 2000 (5)	0.4	0.2	0	0.2	0	0.4	0
CRANBERRY POOL 2001 (5)	0	2.2	0	0	0.2	1.2	0
CRANBERRY POOL 2002 (no data)							
CRANBERRY POOL MEAN	0.6	1	0	0.07	0.27	0.73	0

* Maximum number of each species detected during a single survey in a given year, divided by the number of stations within that survey.

VIRA = Virginia rail COMO = common moorhen LEBI = least bittern SORA = sora
AMBI = American bittern PBGR = pie-billed grebe AMCO = American coot

TABLE 4. VERMONT IMPORTANT BIRD AREA MARSH BIRD SUMMARY1999-2002

SURVEY ROUTE (number of stations)	VIRA	COMO	LEBI	SORA	AMBI	PBGR	AMCO
BOMOSEEN 1999 (5)	1.6	0.2	0	0	0	0	0
BOMOSEEN 2000 (5)	0.8	0.4	0	0.2	0	0	0
BOMOSEEN 2001 (5)	1.6	0.2	0.2	0.2	0	0	0
BOMOSEEN 2002 (5)	0.6	0	0	0.2	0	0	0
BOMOSEEN MEAN	1.15	0.2	0.05	0.15	0	0	0
SAND BAR 1999 (5)	0.4	0	0	0	0	0.2	0
SAND BAR 2000 (5)	1.2	0	0	0	0	0	0
SAND BAR 2001 (5)	0.4	0	0	0	0	0	0
SAND BAR 2002 (5)	0	0	0	0	0	0.2	0
SAND BAR MEAN	0.5	0	0	0	0	0.1	0
HERRICK'S COVE 1999 (7)	0.143	0	0	0.14	0.14	0	0
HERRICK'S COVE 2000 ** no data							
HERRICK'S COVE 2001 (7)	0.286	0	0	0	0	0	0
HERRICK'S COVE 2002 (7)	0.143	0	0	0	0	0	0
HERRICK'S COVE MEAN	0.19	0	0	0.05	0.05	0	0
LITTLE OTTER CREEK 1999 (7)	0.86	1.57	0.14	0.14	0	0.714	0
LITTLE OTTER CREEK 2000 (7)	0.29	0.86	0	0	0	0.57	0
LITTLE OTTER CREEK 2001 (7)	0.29	1.86	0	0.14	0	0.43	0
LITTLE OTTER CREEK 2002 (7)	0.43	2	0.14	0.43	0.14	0.71	0.57
LITTLE OTTER CREEK MEAN	0.75	1.57	0.07	0.18	0.04	0.6	0.14
BERLIN POND 1999 (3)	1.33	0	0	0	0	0	0.333
BERLIN POND 2000 (3)	1.67	0	0	0	0.33	0	0
BERLIN POND 2001 (3)	1	0	0	0	0.67	0	0
BERLIN POND 2002 (3)	0.33	0	0.33	0	0.33	0	0
BERLIN POND MEAN	1.08	0	0.08	0	0.33	0	0.08
W. RUTLAND MARSH 2001 (5)	0.6	0	0	0	0	0	0
W. RUTLAND MARSH 2002 (5)	0.8	0	0	0	0	0	0
W. RUTLAND MARSH MEAN	0.7	0	0	0	0	0	0
PANTON ROAD 2002 (3)	0.67	0	0	0	0	0	0
PANTON ROAD MEAN	0.67	0	0	0	0	0	0

* Maximum number of each species detected during a single survey in a given year, divided by the number of stations within that survey.

VIRA = Virginia rail COMO = common moorhen LEBI = least bittern SORA = sora
AMBI = American bittern PBGR = pie-billed grebe AMCO = American coot

TABLE 5. MARSHBIRD TRENDS AT DEAD CREEK WMA AND MUD CREEK WMA, 1996-2002.

YEAR	VIRA	COMO	LEBI	SORA	AMBI	PBGR
1996	37*	17	1	5	1	1
1997	25	12	1	3	1	0
1998	34	7	2	4	1	0
1999	22	4	2	2	1	0
2000	22	6	2	2	1	0
2001	20	5	1	3	0	0
2002	22	1	2	5	1	0
MEAN	26	7.4	1.6	3.4	0.9	0.1

* Sum of the maximum individuals counted during a single survey from the three routes: Route 17, Brilyea, and Mud Creek.

VIRA = Virginia rail COMO = common moorhen LEBI = least bittern SORA = sora
AMBI = American bittern PBGR = pie-billed grebe AMCO = American coot

TABLE 6. MEAN NUMBER OF MARSHBIRDS PER STATION, BY MARSH 1996-2002.

MARSH (years of data)	VIRA	COMO	LEBI	SORA	AMBI	PBGR
BRILYEA (7)	**0.82**	**0.57**	0.00	**0.39**	0.04	0.00
ROUTE 17 (7)	**1.11**	0.18	0.02	**0.23**	0.02	0.00
MUD CREEK (7)	**1.63**	**0.41**	**0.16**	0.00	0.06	0.02
CHARCOAL CREEK (7)	0.21	0.15	0.04	**0.16**	**0.07**	0.11
GOOSE BAY (4)	0.23	**0.82**	0.04	0.04	0.04	**0.73**
DEAD CREEK (5)	0.58	0.21	0.04	0.08	**0.25**	0.12
LONG MARSH (5)	0.46	**0.81**	0.04	**0.38**	0.00	**0.42**
CRANBERRY POOL (3)	0.60	**1.00**	0.00	0.07	**0.27**	**0.73**
SOUTH BAY (4)	0.57	0.00	**0.22**	0.08	**0.08**	**1.08**
BOMOSEEN (4)	**1.15**	0.20	0.05	**0.15**	0.00	0.00
SAND BAR (4)	0.50	0.00	0.00	0.00	0.00	0.10
HERRICK'S COVE (4)	0.19	0.00	0.00	0.05	0.05	0.00
LITTLE OTTER CREEK (4)	**0.75**	**1.57**	**0.07**	**0.18**	0.04	**0.60**
BERLIN POND (4)	**1.08**	0.00	**0.08**	0.00	**0.33**	0.00
W. RUTLAND MARSH (4)	0.70	0.00	0.00	0.00	0.00	0.00
PANTON ROAD (1)	0.67	0.00	0.00	0.00	0.00	0.00
OVERALL MEAN	**0.70**	**0.38**	**0.05**	**0.11**	**0.08**	**0.24**

FIGURE 1.MISSISQUOI NWR MARSH BIRD STATIONS

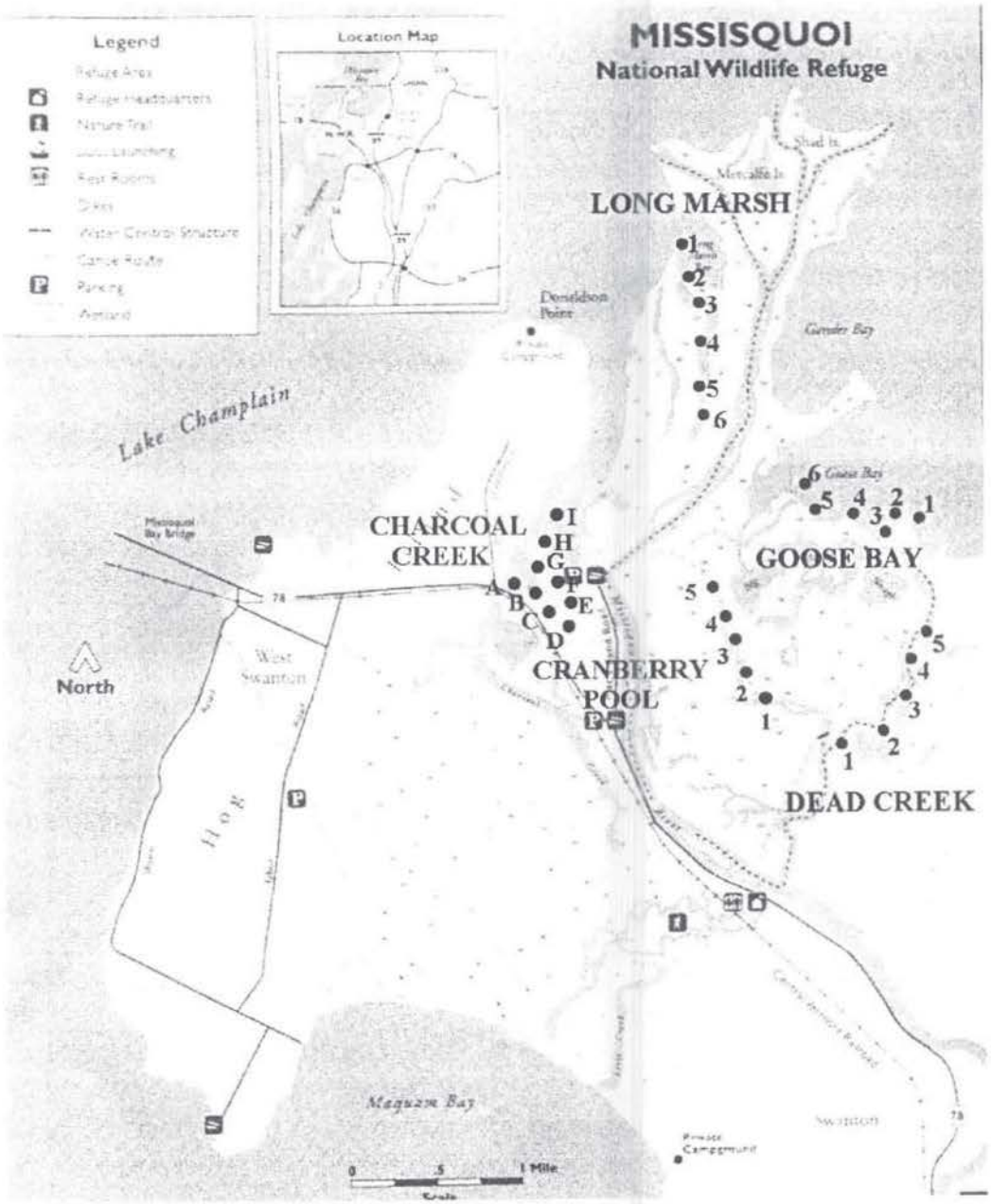


FIGURE 2. MUD CREEK MARSH BIRD STATIONS

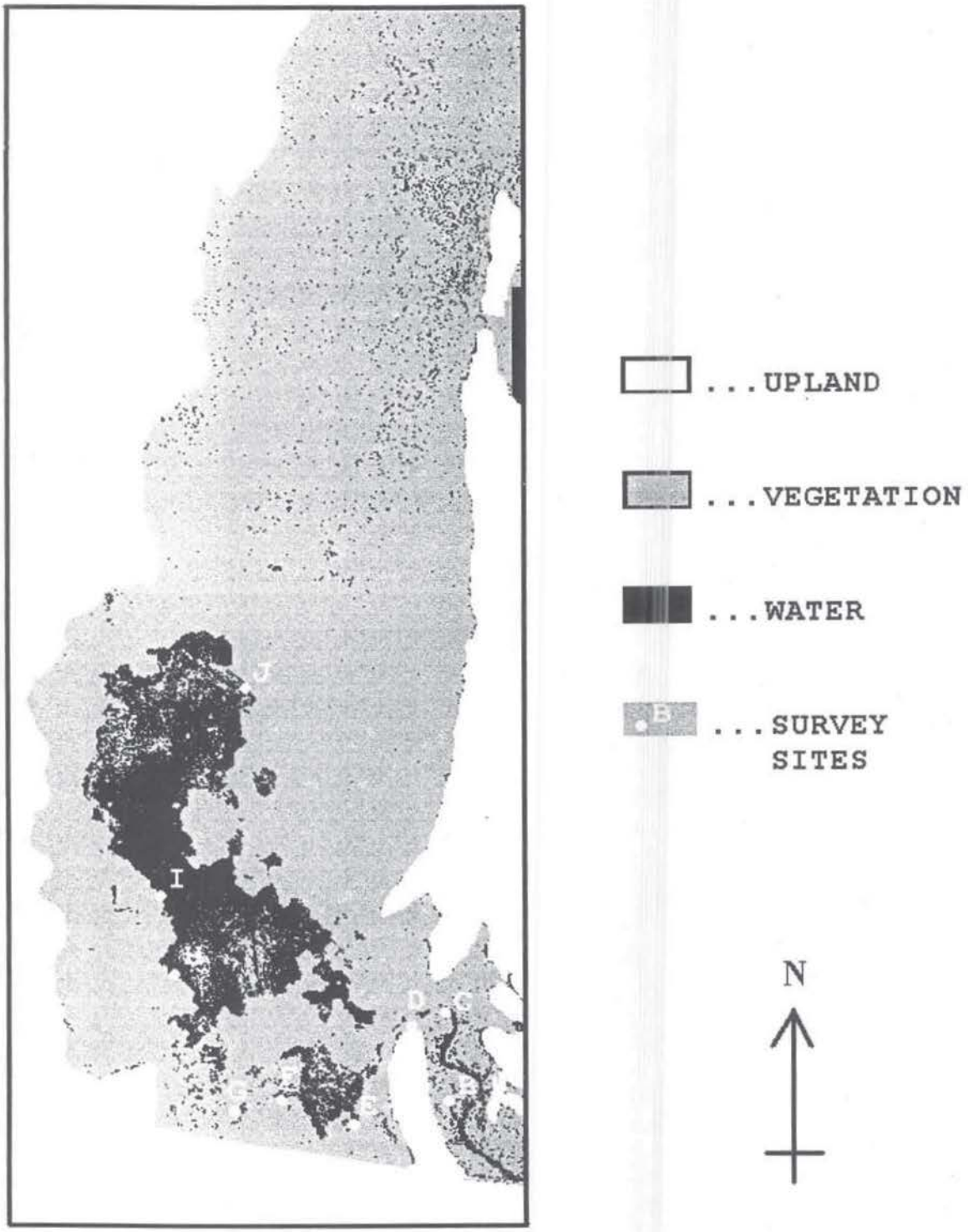
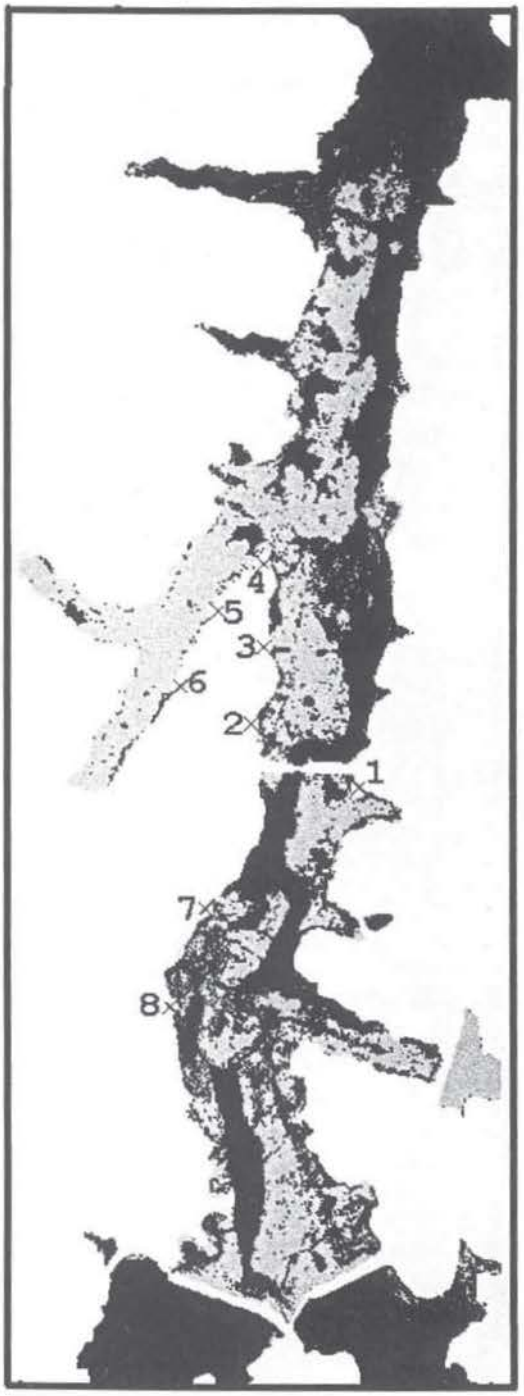


FIGURE 3. DEAD CREEK MARSH BIRD STATIONS



...UPLAND

...VEGETATION

...WATER

×1 ...SURVEY SITES

N

FIGURE 4. BRILYEA MARSH BIRD STATIONS

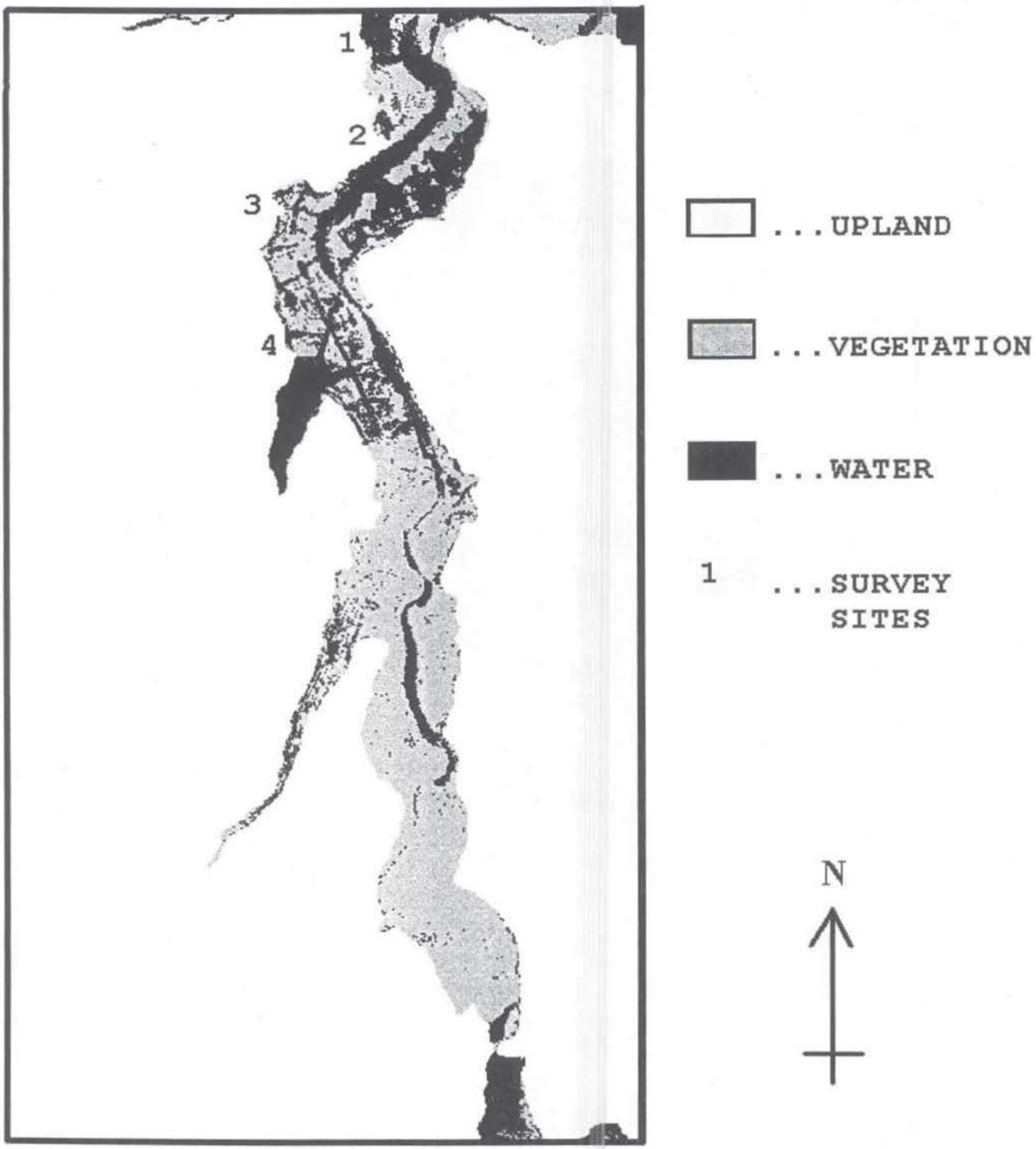


FIGURE 5. SOUTH BAY WMA MARSH BIRD STATIONS.

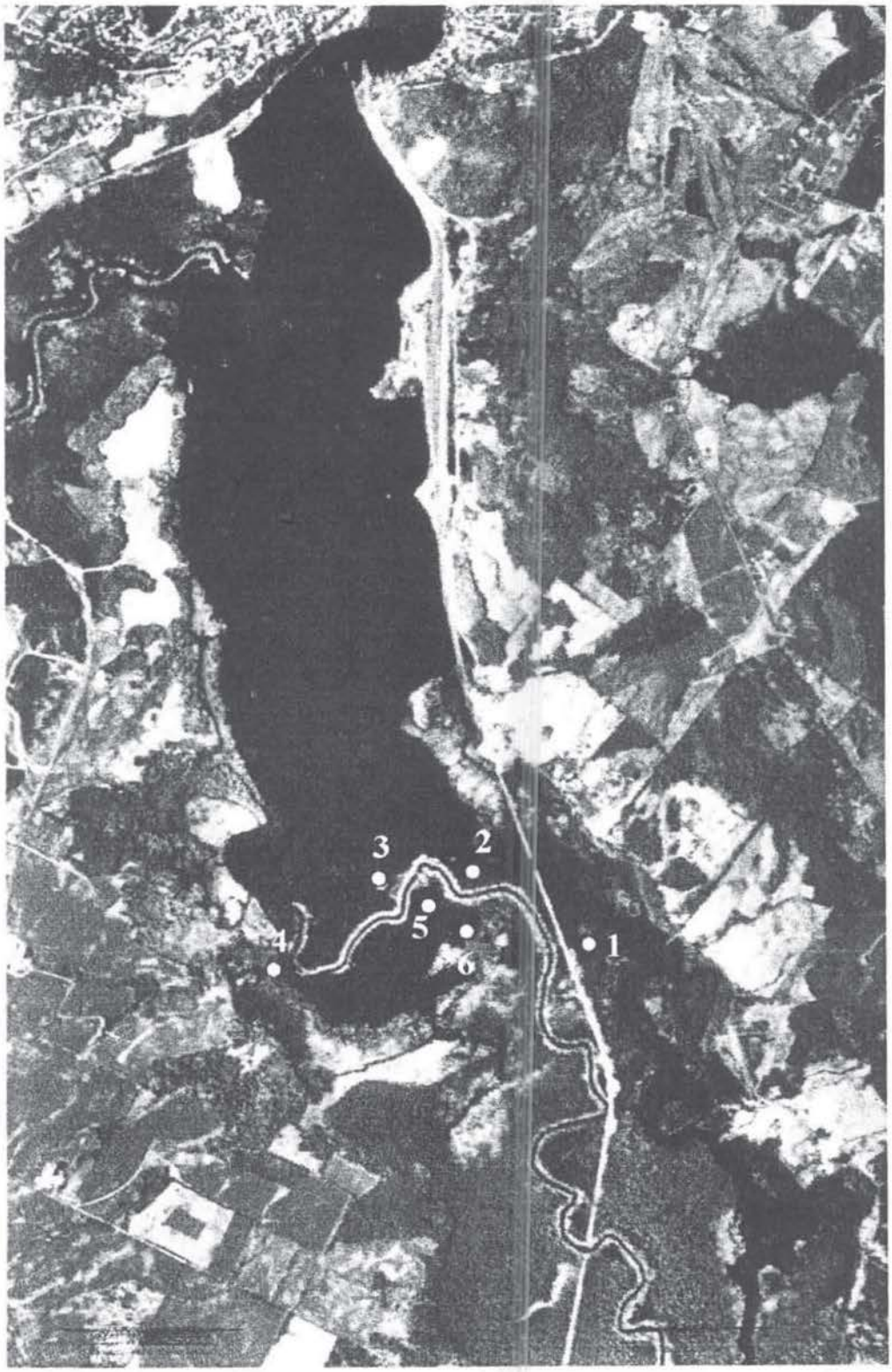


FIGURE 6. SANDBAR WMA MARSH BIRD STATIONS

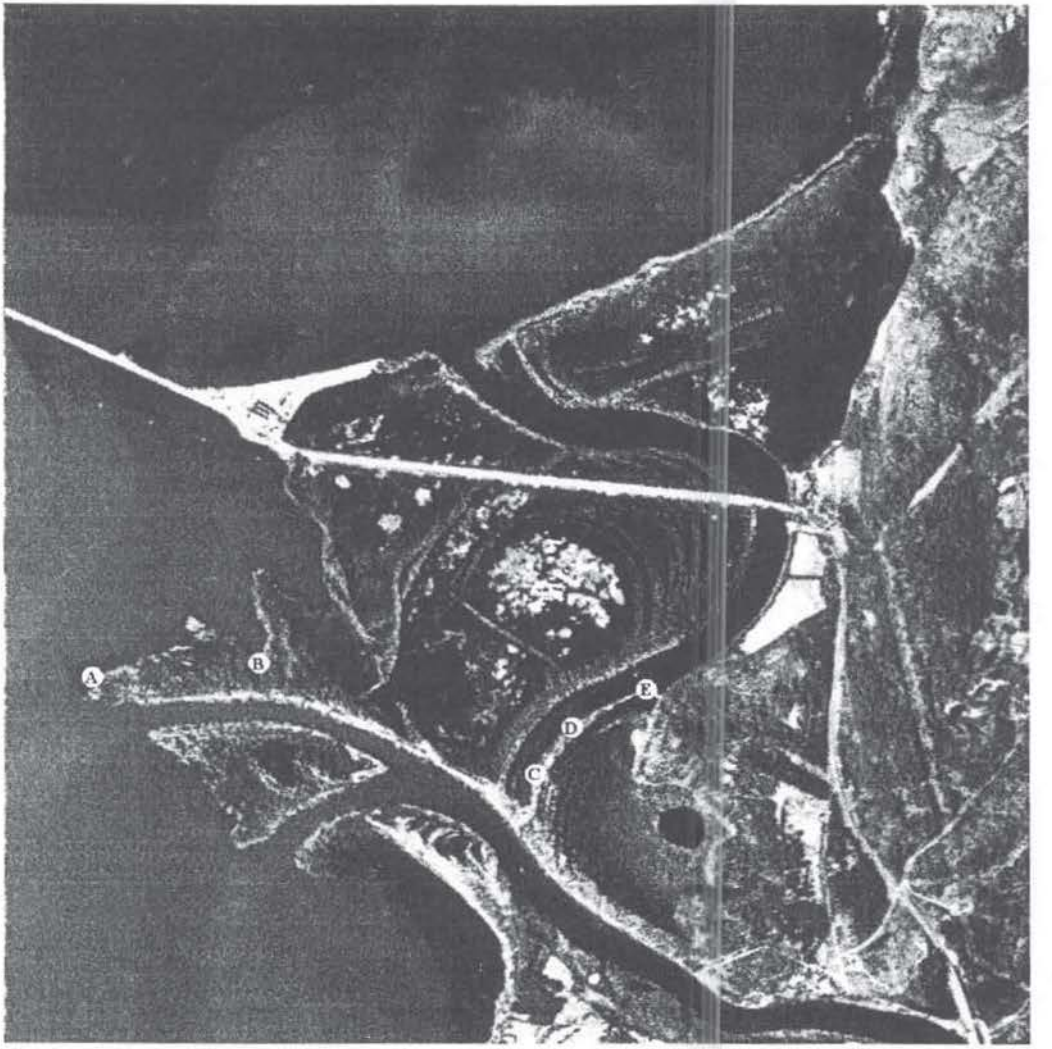
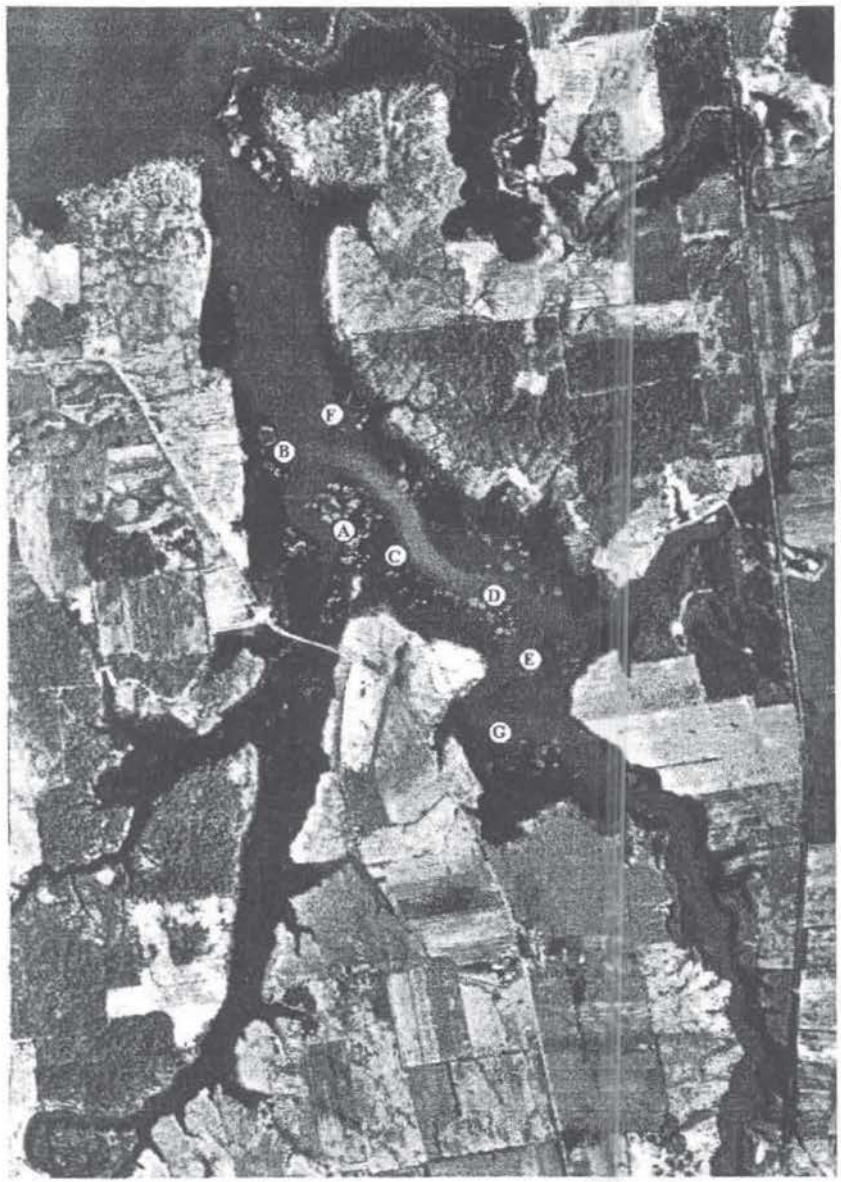


FIGURE 7. LITTLE OTTER CREEK MARSH BIRD STATIONS



N

FIGURE 8. WEST RUTLAND MARSH MARSH BIRD STATIONS

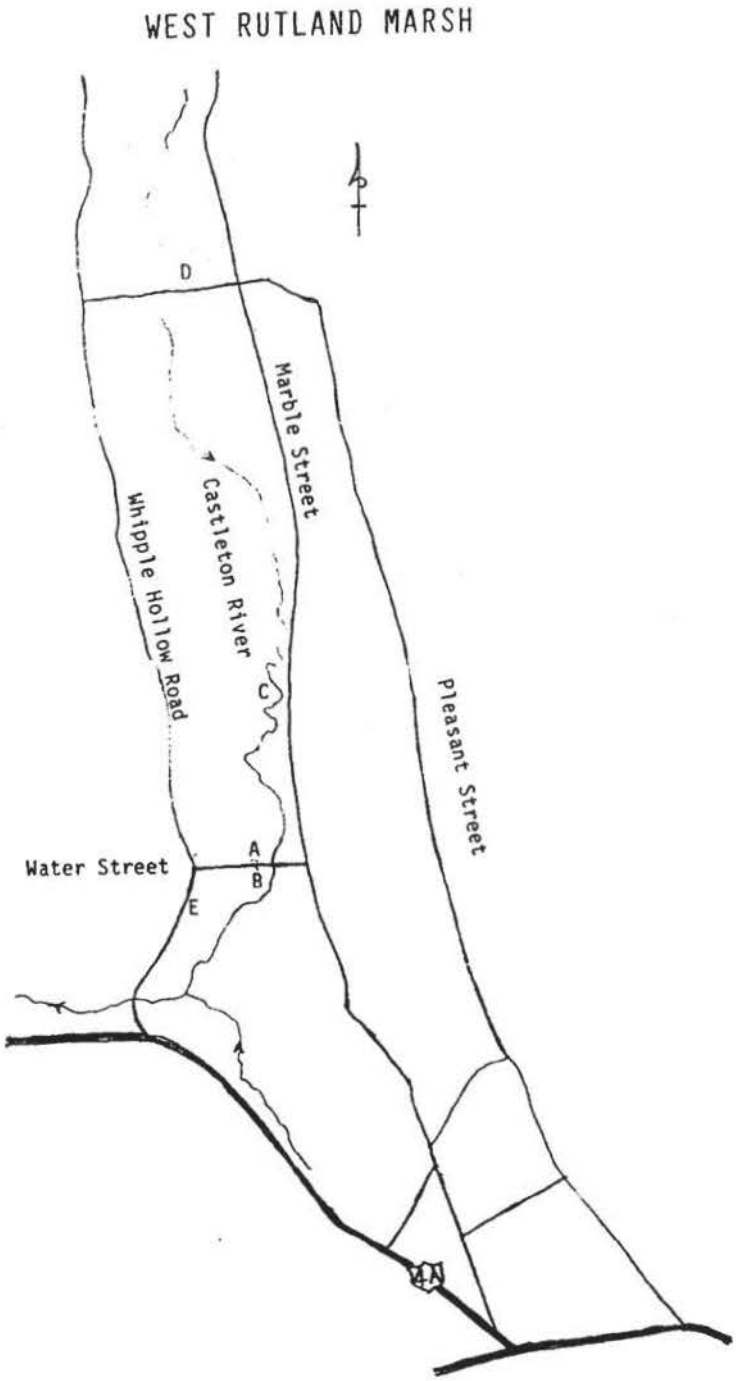
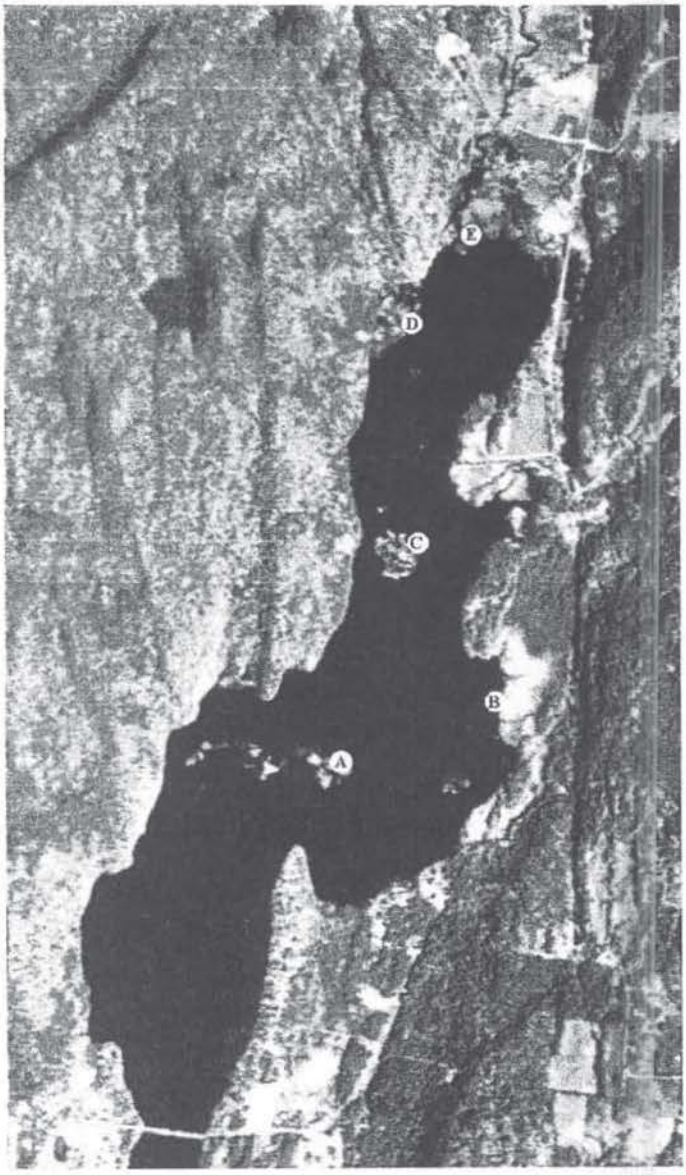


FIGURE 9. BERLIN POND MARSH BIRD STATIONS

N

FIGURE 10. LAKE BOMOSEEN MARSH BIRD STATIONS



N

FIGURE 11. HERRICK'S COVE MARSH BIRD STATIONS

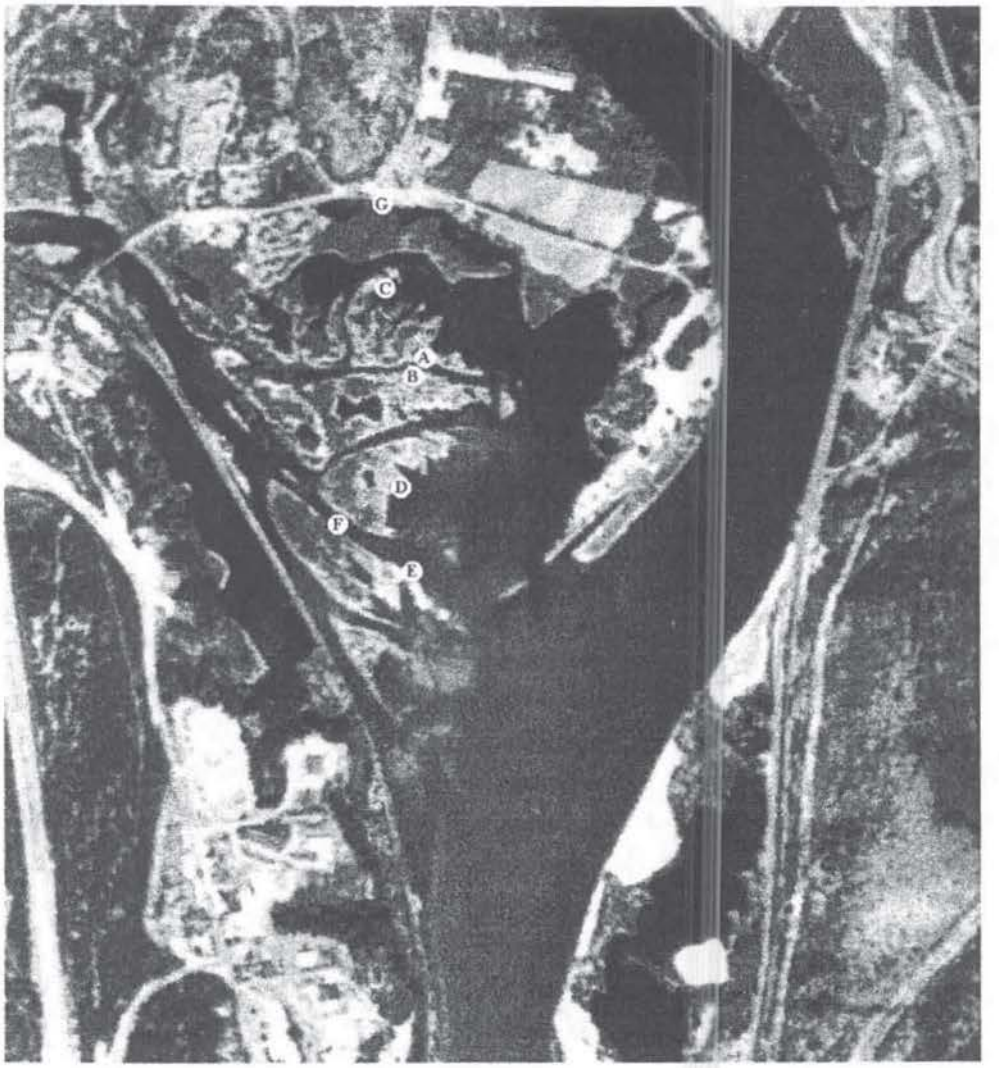


FIGURE 12. PANTON RD. MARSH BIRD STATIONS

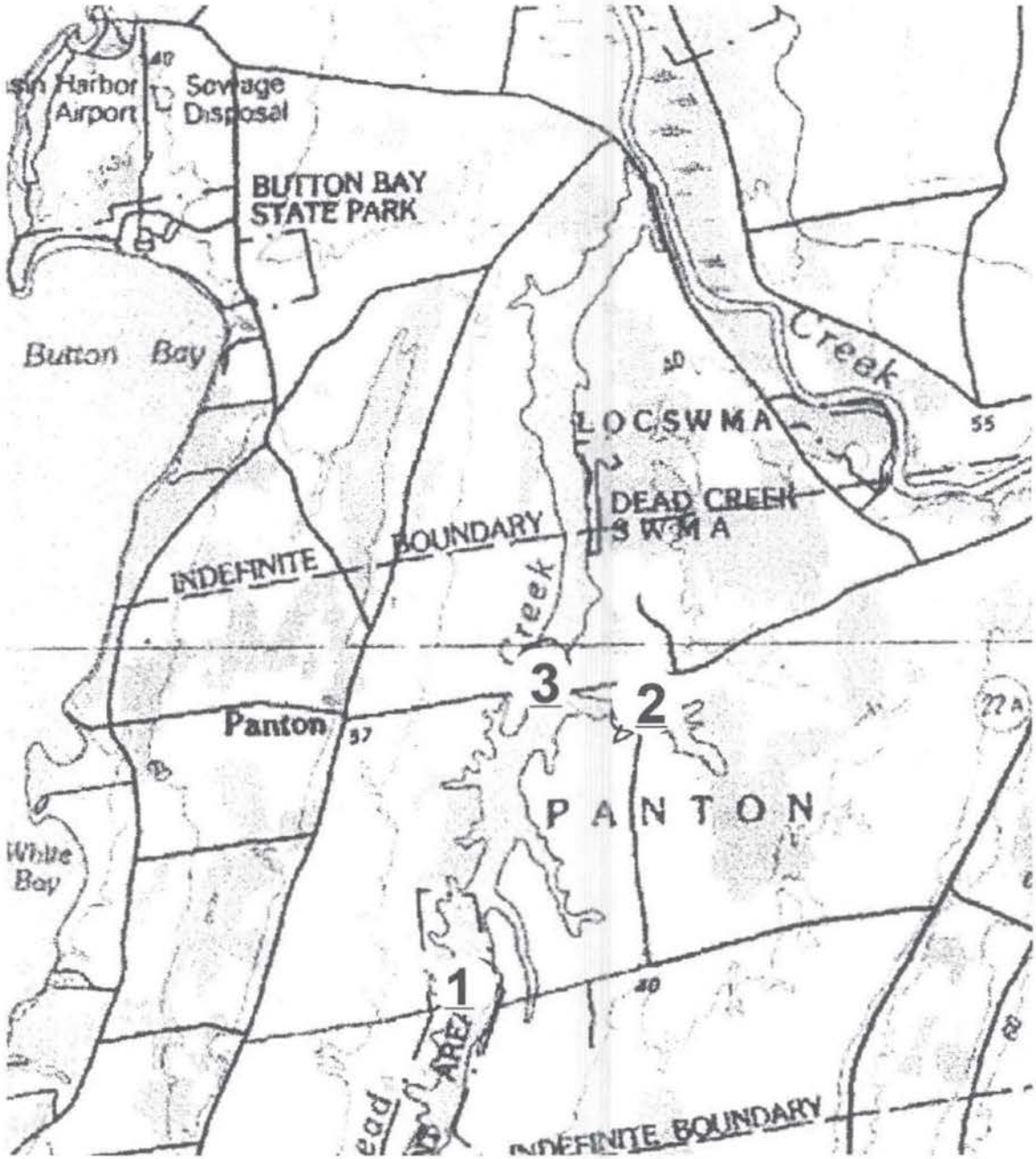


FIGURE 13. BLACK TERN NEST ON FLOATING DEBRIS.

FIGURE 14. AREAS WITHIN MISSISQUOI NWR PROPOSED FOR JUNE 1 POSTING.

FIGURE 15. VERMONT BLACK TERN POPULATION TRENDS

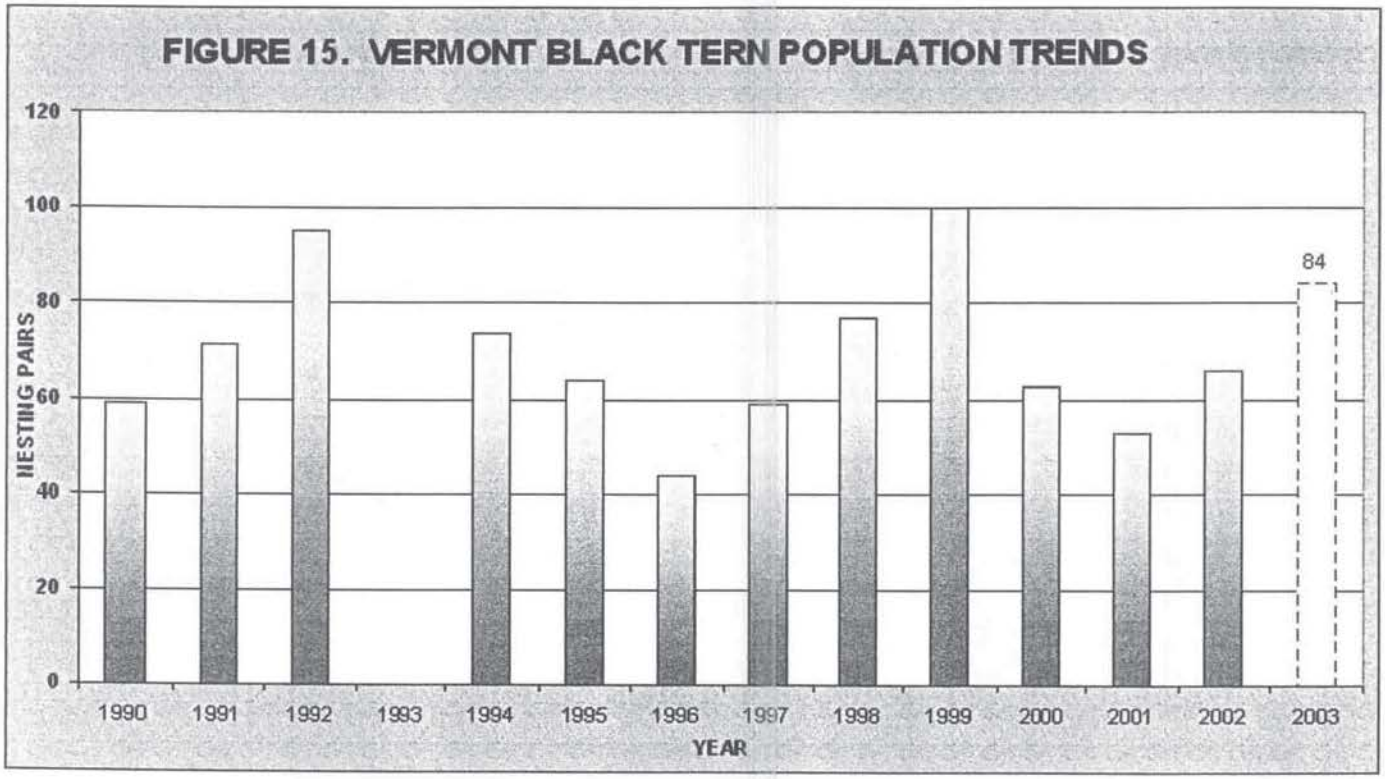


FIGURE 16. BLACK TERN NUMBERS vs. LAKE LEVEL.

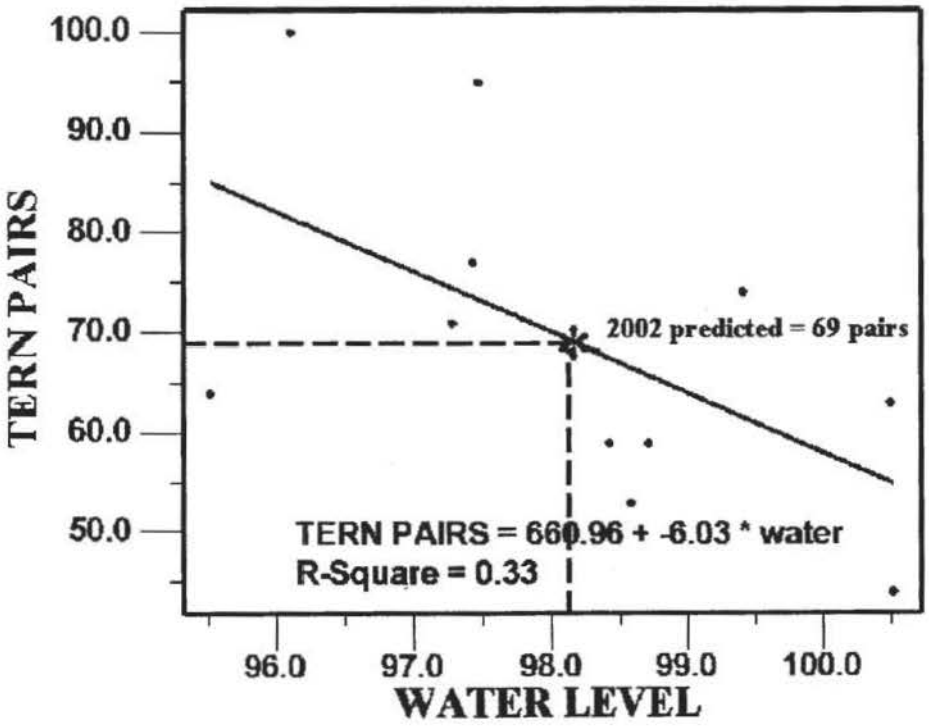
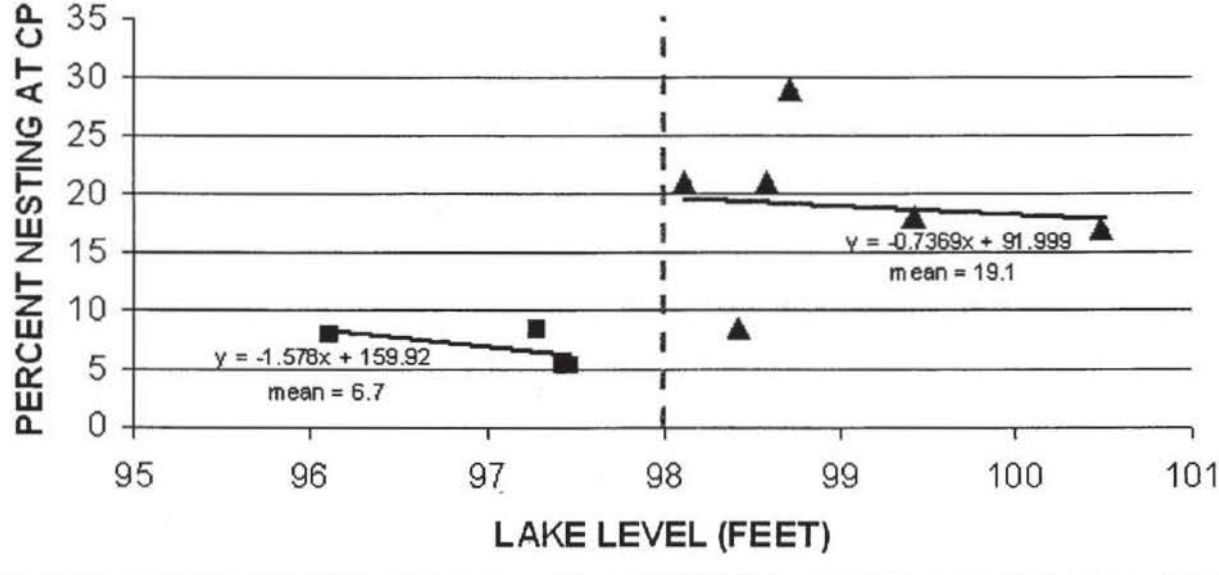


FIGURE 17. CRANBERRY POOL NESTING PATTERN



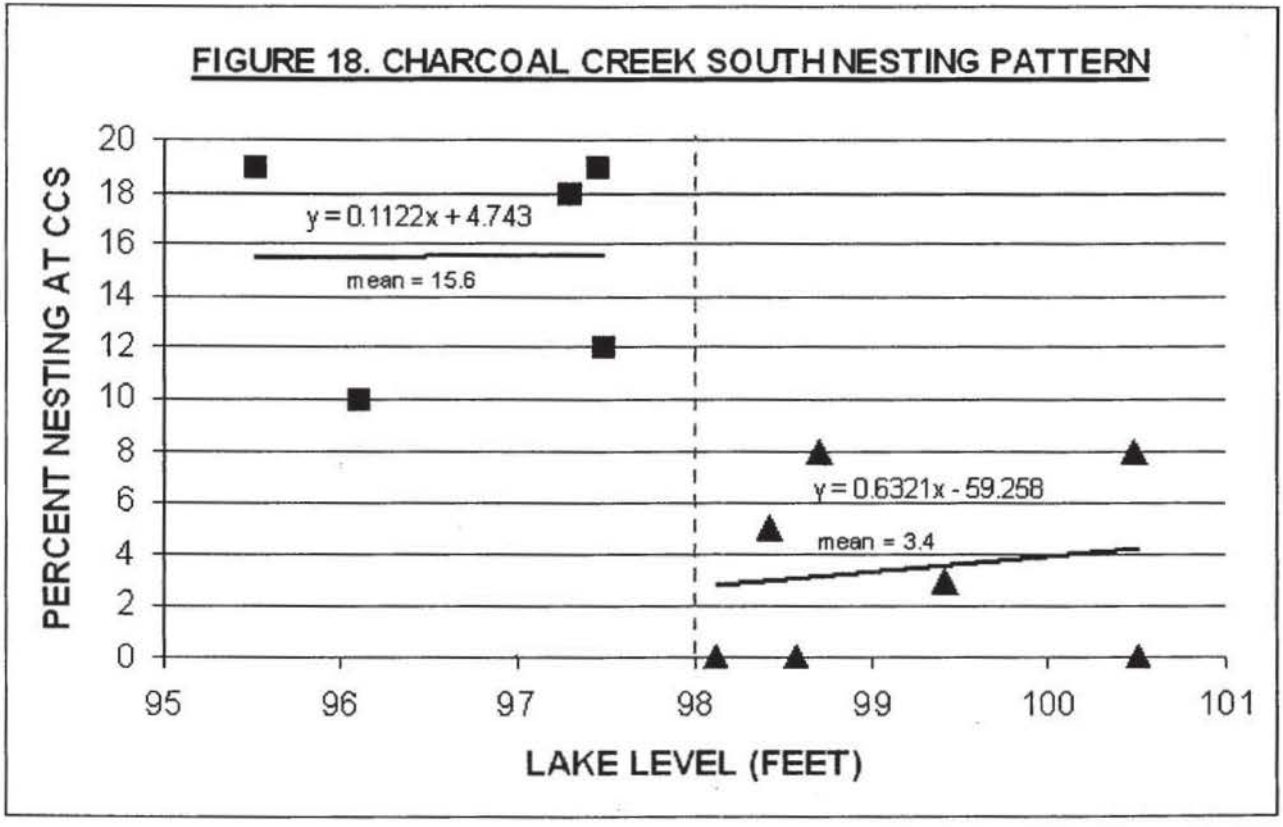


FIGURE 18. CHARCOAL CREEK SOUTH NESTING PATTERN
PERCENT NESTING AT CCS
20
18
16
14
12
10
8
6
4
2
0
y = 0.1122x + 4.743
mean = 15.6
y = 0.6321x - 59.258
mean = 3.4
95
96
97
98
99
100
101
LAKE LEVEL (FEET)

FIGURE 19. MOORHEN POPULATION TRENDS AT DEAD CREEK W.M.A. AND MUD CREEK W.M.A.