CAPE HATTERAS NATIONAL SEASHORE
COLONIAL WATERBIRD MONITORING
2009 ANNUAL REPORT

National Park Service
1401 National Park Drive
Manteo, NC 27954

ABSTRACT

In 2009 colonial waterbird monitoring at Cape Hatteras National Seashore (CAHA) consisted of identifying and protecting nesting habitat and counting nests, chicks, and fledglings. Least tern nest count totals have more than doubled from 2008, while fledgling counts have doubled since 2007. Common tern and black skimmer nest counts increased from 2008; however, no fledglings were documented for either of these species. Gull-billed terns were observed copulating, but a nest was never documented.

The Consent Decree (CD) states that for colonial waterbirds, in lieu of providing an annual report, NPS shall provide the data collected on colonial waterbird breeding activity. This report has been prepared by CAHA resources management staff to include not only a summary of the data collected, but also additional species-related information not specifically required by the CD.

INTRODUCTION

CAHA is located along the northern Outer Banks region of North Carolina. Consisting of more than 30,000 acres distributed along approximately 66.8 miles of shoreline, it is part of a dynamic barrier island system. CAHA was authorized as part of the National Park system on August 17, 1937. It was established as our nation's first national seashore on January 12, 1953. Federal ownership ofCAHA extends from ocean to sound across three barrier islands-Ocracoke, Hatteras and Bodie- spanning Dare and Hyde counties. The eight village enclaves are excluded from CAHA boundaries. The villages include Rodanthe, Waves, Salvo, Avon, Buxton, Frisco, and Hatteras on Hatteras Island and Ocracoke Village on Ocracoke Island.

CAHA provides traditional nesting habitat for several species of special concern and state-listed colonial-nesting waterbirds, including the common tern (*Sterna hirundo*), least tern (*Sterna antillarum*), gull-billed tern (*Gelochelidon nilotica aranea*), and black skimmer (*Rhynchops niger*). The federally threatened piping plover (*Charadrius melodus*), and the American oystercatcher (*Haematopus palliatus*) a North Carolina species of special concern, also nest on the seashore. Over the years there has been different levels of staffing and hence different levels of monitoring and data collection for colonial waterbird breeding activity. The varying levels of effort over the years, makes it difficult to attempt to compare years against each other.

Colonial-nesting waterbirds (CWB) refer to those species of birds that nest in large groups or colonies and obtain their food from the water. Terns, gulls, pelicans, skimmers, and cormorants are all examples of CWBs. Terns and skimmers nest above the high-tide line in sand, gravel, or shell beds.

The least tern (LETE), the smallest of the terns and gulls, is the most prevalent of the four species of CWBs monitored at CAHA. They are gray and white with a black cap, a white forehead, yellow legs, and a yellow bill with a black tip. Courtship typically takes place at the nesting site. Like all terns and skimmers, the male will entice a female through a method known as fish flashing, in which he presents her with a fish. Upon acceptance, the pair will copulate and scrape. LETEs nest on sandy beaches close to the water. A clutch of 2-3 eggs is laid in a

scrape (i.e. a small shallow depression) and are cryptic in coloration, making them difficult to see. Both adults will incubate the nest for approximately 20-22 days. Once a nest has hatched, the adults will feed the semi-precocial chicks, which have left the nest, for 19-20 days until they fledge. The LETE has the shortest incubation and fledging periods of the shorebird species monitored at CAHA.

The common tern (COTE) is larger than the LETE. It is gray and white with a black cap, reddish-orange legs, and a reddish-orange bill. COTEs will incubate for 21-27 days. The chicks typically fledge between 26-27 days. Gull-billed terns (GBTE) are similar in size and coloration to the COTE, with the exception being the black legs and thick, black, blunt bill. Nests are incubated for 22-23 days and chicks will fledge in 28-35 days. The black skimmer (BLSK) is a medium to large black and white waterbird. The bill is orange and black with the lower mandible extending past the upper mandible. The bird gained its name by its feeding habit of skimming over the water looking for prey. They are active more at dusk and dawn than during the day. Incubation of 3-5 eggs lasts 21-23 days. The semi-precocial chicks are ready to fledge within 23-25 days.

Monitoring of colonial waterbirds at CAHA focuses on identifying nesting habitat, protecting nesting areas and chicks, and performing routine nest, chick, and fledgling counts. This report contains a summary of the management techniques used, monitoring results for the 2009 breeding season, and comparisons to results from previous years.

METHODS

Consent Decree

In October 2007, a lawsuit was brought against the NPS by the Defenders of Wildlife and the National Audubon Society for failure to provide adequate protection of threatened and endangered species and species of concern from the impacts of off-road vehicle (ORV) use at CAHA. On April 30, 2008, a settlement to the lawsuit was reached between all parties and Federal District Court Judge Terrence Boyle signed a CD. The purpose of the CD was to provide additional protection measures pending the development of an ORV management plan and special regulation. Examples of changes in management as a result of the CD included earlier dates for the establishment of pre-nesting closures and larger buffer requirements for nesting birds and chicks. The CD will be in effect until the ORV Management Plan and special regulation are finalized.

Closures

In addition to the pre-nesting closures for piping plovers (PIPL) that are described in the 2009 PIPL annual report, closures for colonial waterbirds were installed in areas where breeding behavior, scrapes, nests, or chicks were observed. This included areas of the seashore where pre-nesting closures had not been established. As per the CD, LETEs required a 100 meter buffer for breeding behavior, scrapes and nests and a 200 meter buffer for chicks (Table 1). Other protected colonial waterbird species required a 200 meter buffer for all breeding and nesting activity. Closures were modified as the colonies expanded or nests hatched to maintain the required buffer sizes from the outer most nest or chicks in the colony. When multiple species were present, the greatest applicable buffer distance was used.

Table 1. Colonial Waterbird Nesting and Chick Buffers Required by the 2008 CD.

Species	Breeding Behavior/Nest Buffer (m)	Unfledged Chick Buffer (m)
LETE	100	200
Other Protected Colonial Waterbirds	200	200

Monitoring

CAHA is broken into three resources management operational districts: Bodie/Hatteras, Hatteras, and Ocracoke. Each district had a team of technicians responsible for monitoring the species in that area. The Bodie/Hatteras District covered the area from Ramp 1 to Oregon Inlet, which includes Bodie Spit, and Rodanthe to Ramp 30. The Bodie/Hatteras District also included Green Island, a small, semi-vegetated island on the sound-side of Oregon Inlet. The Hatteras District is the largest of the three districts and extends from Ramp 30 south to Hatteras Inlet and includes Cape Point, South Beach, and Hatteras Inlet Spit. The Ocracoke District covers the area from Hatteras Inlet to South Point at Ocracoke Inlet.

Technicians were responsible for locating areas where colonies were forming. This involved observing terns for courtship, copulation, and scraping behaviors. When such behavior was observed and closure approval was received, a closure was installed around the area utilizing the required buffer. Once a closure was established, the area was surveyed at least once a week by resource management field staff. The survey consisted of two to five staff members walking transect lines through the closure. The number of nests, number of eggs in each nest, and chicks found were recorded during each visit. GPS waypoints were also taken of the colony boundaries. The distance from the outer most nests/chicks to the closure boundary was checked to ensure they were within the required buffer. If a nest/chick was outside of the buffer, the closure was modified to meet the buffer requirements. Once nests began to hatch, closures were modified to meet the required 200 meter distance. Once chicks reached fledgling age, counts were conducted either from the closure boundary or shoreline depending on the size of the colony. Any chick deemed a fledgling was watched to ensure an adequate ability to sustain flight.

This year, a sampling protocol was initiated to gain a better understanding of how many nests and chicks were present in a given colony and how many nests were potentially lost to predators. Six colonies were selected, including one at Bodie-Hatteras, two in Hatteras, and one on Ocracoke. These colonies were walked every three days. Each nest found was given a nest number. A nest marker with the corresponding number was placed approximately one foot from the nest. The date and number of eggs or chicks present were recorded on a data sheet. Nest markers were removed after a nest was lost to predation or successfully hatched and the chicks were no longer present in the nest cup or surrounding area. Chick and fledgling counts were conducted either by walking or driving the shoreline of the closure or from a location on the edge of the closure where the observer(s) had full view of the entire area, specifically the high tide line and the dunes. The observer(s) would then count the number of chicks and fledglings present in the colony. Colonies without nest markers present were only surveyed once a week for nests or chicks.

Chick Shelters

Chick shelters were placed in colonies where vegetation was sparse to provide more shade and cover for the chicks. This year, they were placed in three colonies: Bodie Spit, North of Buxton, and South Beach. These shelters were checked for chicks during walk-throughs and observation periods. The shelters were constructed out of two pieces of 1" x 12" x ~1' material fastened together so as when placed in the colony they resembled an inverted "V". If pallets had washed up in the area, they were often placed above the wrack line and chicks were also observed using them.

RESULTS

Productivity

The nesting population of colonial waterbirds was determined by taking the peak nest count (approximately the last week of May or first week of June), the peak hatching count (21 days later), and the maximum number of fledglings counted for each colony. Results for each district are presented below. Fledgling counts recorded were conservative and reflect the single most fledglings seen during one survey, as it was difficult to know whether the fledglings were from that colony or elsewhere, or were counted in an earlier survey.

Bodie/Hatteras District

Colonial waterbirds produced seven colonies in the Bodie/Hatteras District (Appendix A; Maps 1-2) during the 2009 nesting season. These colonies accounted for 50.3% of the peak nest totals and 51.7% of the peak fledgling totals for LETE (Table 2), 90.6% of COTE nests (Table 3), and 70.5% of BLSK nests (Table 4) for CAHA. There were not any GBTE nests observed in this district (Table 9).

Table 2. LETE Peak Nest Counts at Bodie/Hatteras District for 2009.

Colony Designation:	Location:	Peak Nest Count:	Total Nests:
Bodie Island Colony 1	Bodie Spit	5/29/2009	219
Bodie-Hatteras Colony 1	0.3 mi S of Ramp 27	6/1/2009	50
Bodie-Hatteras Colony 2	1.1 mi N of Ramp 27	5/25/2009	17
Bodie-Hatteras Colony 3(a)	2.5 mi N of Ramp 27	N/A	0
Bodie-Hatteras Colony 4	Ramp 23	6/4/2009	3
Bodie-Hatteras Colony 5	0.1 mi N of Ramp 27	6/1/2009	2
Green Island	Southern side of Oregon Inlet	5/29/2009	0
DISTRICT TOTAL			**291**

(a) - colony was lost to ghost crab predation on 5/15/09, prior to survey window

Table 3. COTE Peak Nest Counts at Bodie/Hatteras District for 2009.

Colony Designation:	Location:	Peak Nest Count:	Total Nests:
Bodie Island Colony 1	Bodie Spit	6/2/2009	20
Bodie/Hatteras Colony 1	0.3 mi S R27	6/1/2009	0
Bodie/Hatteras Colony 2	1.1 mi N R27	5/31/2009	0
Bodie/Hatteras Colony 3	2.5 mi N R27	N/A	0
Bodie/Hatteras Colony 4	Ramp 23	61/2009	0
Bodie/Hatteras Colony 5	0.1 mi N R27	6/1/2009	0
Green Island Colony	Green Island	5/29/2009	28
DISTRICT TOTAL			**48**

Table 4. BLSK Peak Nest Counts at Bodie/Hatteras District for 2009.

Colony Designation:	Location:	Peak Nest Count:	Total Nests:
Bodie Island Colony 1	Bodie Spit	6/2/2009	22
Bodie/Hatteras Colony 1	0.3 mi S R27	6/1/2009	0
Bodie/Hatteras Colony 2	1.1 mi N R27	5/31/2009	0
Bodie/Hatteras Colony 3	2.5 mi N R27	5/16/2009	0
Bodie/Hatteras Colony 4	Ramp 23	6/1/2009	0
Bodie/Hatteras Colony 5	0.1 mi N R27	6/1/2009	0
Green Island Colony	Green Island	5/29/2009	21
DISTRICT TOTAL			**43**

Hatteras

This year, colonial waterbirds produced nine colonies (Appendix A; Maps 3-4) in the Hatteras District (Table 5). Of those, seven colonies were included in the peak nest counts. These colonies produced 30.3% of the nest totals and 44.8% of the fledging totals for LETE in 2009 (Table 9). Hatteras Island Colony 7 and Hatteras Island Colony 8 were not included in the peak nest counts, because they started after June 7th and were considered to be re-nesting colonies. These two small colonies were on the eastern (Hatteras Island Colony 8) and western (Hatteras Island Colony 7) ends of Hatteras Island Colony 2, which was lost to predation. This meant their numbers were possibly previously counted in that colony, or another colony in the area. No COTE or BLSK nests were found in Hatteras District this year. A pair of GBTEs was observed copulating on South Beach, but a nest was never documented.

Table 5. 2009 LETE Peak Nest Counts for the Hatteras District.

Colony Designation:	Location:	Peak Nest Count:	Total Nests:
Hatters Island Colony 1	Ramp 45	5/27/2009	55
Hatters Island Colony 2	1.3 mi SW of Ramp 45	6/2/2009	82
Hatters Island Colony 3	Ramp 34	5/27/2009	29
Hatters Island Colony 4a	East Cape Point	6/4/2009	2
Hatters Island Colony 4b	West Cape Point	6/1/2009	1
Hatters Island Colony 5	Hatteras Inlet	6/3/2009	2
Hatters Island Colony 6a	1.3 mi S of Ramp 38	6/1/2009	0
Hatters Island Colony 6b	1.5 mi S of Ramp 38	6/6/2009	3
Hatters Island Colony 7	0.4 mi W of Ramp 45	N/A	0
Hatters Island Colony 8	Salt Pond Road Ramp	N/A	0
DISTRICT TOTAL			**174**
(a) – Timing unknown for single nest found abandoned.			

Ocracoke

Colonial waterbirds on Ocracoke produced two colonies (Appendix A; Map 5) this year. These colonies produced 19.4% of the nests and 3.5% of the LETE fledglings (Table 6), 9.4% of the COTE nests (Table 7), and 29.5% of the BLSK nests (Table 8) reported. South Point was considered one colony, but divided into three sub-colonies. While scrapes were found in Ocracoke Island Colony 2a, nests were never observed. This area was repeatedly over-washed throughout the season.

Table 6. 2009 LETE Peak Nest Counts for the Ocracoke District.

Colony Designation:	Location:	Peak Nest Count:	Total Nests:
Ocracoke Island Colony 1	N Ocracoke	6/4/2009	48
Ocracoke Island Colony 2a	SW South Point Hook	6/2/2009	0
Ocracoke Island Colony 2b	1.3 mi S of Ramp 72	6/2/2009	54
Ocracoke Island Colony 2c	1.1 mi S of Ramp 72	6/3/2009	10
DISTRICT TOTAL			**112**

Table 7. 2009 COTE Peak Nest Counts for the Ocracoke District.

Colony Designation:	Location:	Peak Nest Count:	Total Nests:
Ocracoke Island Colony 1	N Ocracoke	6/4/2009	0
Ocracoke Island Colony 2a	SW South Point Hook	6/2/2009	0
Ocracoke Island Colony 2b	1.3 mi S of Ramp 72	6/2/2009	5
Ocracoke Island Colony 2c	1.1 mi S of Ramp 72	6/3/2009	0
DISTRICT TOTAL			5

Table 8. 2009 BLSK Peak Nest Counts at Ocracoke District.

Colony Designation:	Location:	Peak Nest Count:	Total Nests:
Ocracoke Island Colony 1	N Ocracoke	6/4/2009	0
Ocracoke Island Colony 2a	SW South Point Hook	6/2/2009	0
Ocracoke Island Colony 2b	1.3 mi S of Ramp 72	6/2/2009	17
Ocracoke Island Colony 2c	1.1 mi S of Ramp 72	6/3/2009	1
DISTRICT TOTAL			18

Productivity

Using a very crude estimate (i.e. no chicks were banded), LETEs fledgling counts were up slightly in 2009 compared to 2008 and 2007 (Table 9). Even though the level of effort to survey colonial waterbirds was greater in 2009 than in all previous years, it's still not possible to put a number to productivity (i.e., chicks per pair), except for the species which had none; COTEs, GBTEs and BLSKs. LETE fledgling counts have doubled since 2007, but in 2009, without including re-nests, nest totals tripled from 2007 (194 to 577). Including re-nests, there were a total of 748 LETE nests observed in 2009, of which at least 480 were lost, leaving at most 268 nests that may have hatched.

The fledgling counts only include the survey during which the most fledglings observed were counted for each colony. For example, if in three consecutive weeks, there were 32, 45 and 12 fledglings observed in a colony, only the 45 fledglings will be included in the totals. Chicks which fledged from nests that may have hatched later are not included in the totals due to the difficulty in differentiating one fledgling from another. The increase in survey effort in 2009 also prevents accurate comparisons of this data to previous years' data as an indicator of increasing or decreasing populations or productivity for LETEs.

COTE and BLSK nest numbers appear to have increased from 2008; however no chicks were documented as successfully fledging from nests of either species. Black skimmer chicks close to fledging age were observed in Ocracoke Island Colony 2b, but flight was never observed and the chicks disappeared. There were no observations of nests or chicks from GBTEs in any district on CAHA.

Table 9. Nest Count Comparisons from 2007 to 2009.

Year:	Peak Nest Count(a):			Peak Hatching Count (b):			Peak Fledgling Count (c):		
	LETE	COTE	BLSK	LETE	COTE	BLSK	LETE	COTE	BLSK
2009	577	53	61	196	10	18	174	0	0
2008	232	19	4	148	2	0	165	0	0
2007	194	109	11	N/A	N/A	N/A	85	1	0

(a): Peak nest counts were conducted between May 25th and June 7th.

(b): Peak hatching count were taken approximately 21 days after the peak nest count.

(c): Maximum number of fledglings counted on the seashore.

Nest/Chick Loss

Three factors were thought to have contributed to the loss of nests or chicks: predation, weather, or abandonment. On multiple occasions, more than one factor occurred. Therefore, nest loss totals presented below were grouped into categories (Table 10). The categories are general and sometimes overlapping because it was often difficult to identify one specific cause for loss when there were multiples signs, especially in areas where predation was high or overwash was prevalent. For instance if there were both opossum tracks and raccoon tracks through a nest scrape or colony, it wouldn't be possible to determine which species depredated the nest.

Table 10. 2009 Nest Loss Totals and Potential Causes for nest loss.

Potential Cause:	LETE Nests Lost:	% Lost:	COTE Nests Lost:	% Lost:	BLSK Nests Lost:	% Lost:	GBTE Nests Lost:	% Lost:
Opossum	69	14.4%	0	0.0%	0	0.0%	0	0.0%
Opossum/Raccoon	29	6.0%	0	0.0%	0	0.0%	0	0.0%
Overwash	139	29.0%	3	5.9%	22	33.3%	0	0.0%
Ghost Crab	15	3.1%	0	0.0%	0	0.0%	0	0.0%
Overwash/predation	189	39.4%	48	94.1%	44	66.7%	0	0.0%
Abandoned/predated	30	6.3%	0	0.0%	0	0.0%	0	0.0%
Fox/ghost crab	9	1.9%	0	0.0%	0	0.0%	0	0.0%
Total:	**480**		**51**		**66**		**0**	

In 2009, eight of 17 colonies including three sub-colonies on South Point were affected by predation. Ten of the colonies (59%) had no LETE productivity and all of the three colonies which contained COTEs and BLSKs had no observed productivity for those species. Whereas in 2008, there were 13 colonies including three sub-colonies on South Point and ten of the colonies (77%) had no productivity. In 2007 there were 12 colonies including four sub-colonies on South Point and five of the colonies (41%) had no productivity. Ocracoke, once home to the largest colony inCAHA, fledged six LETE chicks. This was the first time in more than four years that any LETEs have fledged from Ocracoke.

When predation was documented, the number of eggs, nests, and chicks lost was recorded and a potential cause was listed. When predation was determined to be the cause, the species identification of the predator was conducted by resource management supervisory staff.

Opossums, raccoons, canids, and ghost crabs were the main causes of predation to several of the colonies this year. A fifty-five nest colony at Ramp 45 was completely lost to opossum predation during a six-day period. All known nests in this colony had been marked with a nest marker. Opossum tracks were observed leading to and from the nest scrapes and in a few cases, shell fragments were found along-side the opossum tracks.

Opossum and raccoon predation also occurred to colonies at Ramp 34 and Cape Point. Several sets of tracks and predated eggs were found during surveys of the area.

The main colony at Bodie Spit (Bodie Island Colony 1) was both overwashed by high tides and predated by opossum, raccoon, fox and coyote. Tracks were found throughout the colony on several occasions. Another colony at Bodie/Hatteras lost 15 nests to ghost crab predation. These nests had been marked with nest markers.

While there were no major storm systems (i.e. tropical storms, hurricanes) during the 2009 nesting period, low lying areas such as Bodie Spit, Hatteras Inlet, North Ocracoke, and South Point were affected by several extreme high tides. Colonies nesting in these areas were either partially or completely lost to overwash.

Abandoned nests were determined based on the lack of adults or territorial behavior present in the area and/or the coloration/condition of the eggs. For example, a remaining single egg nest in the Bodie/Hatteras Colony 5 was deemed abandoned after no adults were observed incubating the nest. The egg was faded by the sun, which indicated incubation on the nest had ceased.

Human Disturbance/Closure Intrusions

In determining the cause of loss of nests or chicks, human disturbance was considered as the primary cause if/only if direct observation or documentable evidence could support that conclusion. Any unobserved, potential or assumed effects of human disturbance were therefore not included in the recording of violations and potential causes.

A violation was any human act (intentional or unintentional) that could cause disturbance to the birds nesting inside resource protection areas. A violation was considered deliberate when the violation resulted in the destruction or damage of resource property (signs, sign poles or string) delineating a closure, or damage to eggs or chicks was documented. Examples of violations include pedestrians walking through the closure, ORVs running over resource protection signs, dogs off leash inside a resource closure, and kite-boarders/surfers landing inside the closure.

<u>Closure Intrusions</u>

Closure Intrusions were violations of resource closures that did not involve damage to resource property or damage to eggs or chicks. Intrusions were reported by resource field staff when footprints, tracks, or people were observed inside of the resource protection closures. The total number of recorded intrusions is conservative as most intrusions were not witnessed. The number of intrusions documented for colonial waterbirds colony closures are presented below (Table 11).

Table 11. CWB Closure Intrusions Recorded by Field Staff for 2009.

District:	Intrusion Type:			
	Pedestrian	Dog	ORV	Other*
Bodie/Hatteras	128	7	10	0
Hatteras	78	6	0	2
Ocracoke	31	4	0	0
Total	**237**	**17**	**10**	**2**
*** - includes boats, horses, etc.**				

Deliberate Violations

Those violations that result in the destruction of resource protection signs and/or string and flagging and/or the loss of nests or chicks are considered deliberate violations. The CD defined a confirmed deliberate violation as "an act that disturbs or harasses wildlife or vandalizes fencing, nests, or plants". Deliberate violations of the established pre-nesting areas and buffers, as determined by NPS staff, were required to be automatically expanded by 50 meters. The second and third deliberate violations required an automatic expansion of 100 and 500 meters, respectively.

Six deliberate violations to colonial waterbird closures in the Bodie-Hatteras District were documented during the breeding season. Three of the colonial waterbird colonies in the district were violated on the same day. An ORV drove through both closures at Ramp 27, breaking a number of signs and string and the barricades at Ramp 23 were displaced and several signs broken. These violations resulted in the expansion of all three colony buffers by 50 meters and the immediate closing of Ramp 27.

Three additional and separate deliberate ORV violations occurred to the colonial waterbird closure at Ramp 23. The barricades blocking the ramp were displaced on all occasions and several signs were broken. ORV tracks were observed passing through the ramp and continuing north through the closure and into Salvo Village. These violations resulted in the closure being modified and expanded more than 600 meters.

DISCUSSION

While the number of nesting LETEs appears to have increased over the last three years, it is difficult to attribute this increase with certainty to any known factor. There were a number of things that could have contributed to this. The first is, based on the last state-wide survey in 2007, the LETE population is increasing in the state and it is a safe assumption that CAHA is the beneficiary of immigrants from other colonies in the state.

Another factor is that the level of survey and protection effort has increased. Colony surveys were conducted at least once a week instead of once every two or three years for peak nest counts. In some colonies, the number of nests almost doubled from the last week of May to the first week of June. These nests could have been missed in previous years. Monitoring also included observing species for territorial and breeding behavior, which allowed field technicians to locate areas where potential colonies may form, or expand. An increase in staff allowed more time to be devoted to monitoring colonial waterbirds and American oystercatchers. Predator

control efforts have increased as well. Greater emphasis was also placed on areas where predator tracks were seen.

This year, through the help of nest markers, CAHA staff was able to gain a better idea of the number of nests lost to predation. In the past, when a colony was lost, the number of nests lost was an estimate at best. These were usually determined by shell fragments, or tracks through scrapes, but the scope of the predation was mostly unknown because it was unclear if the scrapes had ever contained eggs. With the nest markers and increased frequency of walkthroughs, technicians were able to identify the number of nests that were lost and the cause. This information is beneficial to park management and will aid in management decisions regarding those predator species in the future.

It cannot be definitively determined whether or not the triggers for, or the size of the buffers dictated by the CD has had any significant influence on the number of LETE pairs, or other colonial waterbird pairs, nesting at CAHA. The majority of colonies that occurred outside of the existing PIPL pre-nesting closures in 2009 had initiated breeding activity, or laid nests prior to the implementation of a closure. In some cases colonial waterbird breeding activity or nests were initially observed near the perimeter or outside of the prescribed buffers before a closure was expanded.

One thing that can be reasonably inferred from the 2009 data is that while LETE nesting pairs may have increased, CAHA continues to be a sink - a breeding group that does not produce enough offspring to maintain itself in coming years without immigrants from other populations – for LETEs and the other colonial waterbird species populations that have historically had successful breeding populations at CAHA.

APPENDICES

APPENDIX A: MAPS

Map 1: Bodie Island & Green Island Colonial Waterbird Colonies 2009
Map 2: Bodie Hatteras Colonial Waterbird Colonies 2009
Map 3: North Hatteras Colonial Waterbird Colonies 2009
Map 4: South Hatteras Colonial Waterbird Colonies 2009
Map 5: Ocracoke Hatteras Colonial Waterbird Colonies 2009