

**CAPE HATTERAS NATIONAL SEASHORE  
SEA TURTLE  
2009 ANNUAL REPORT**



Loggerhead sea turtle nesting early in the morning north of Buxton (5/27/09)

National Park Service  
1401 National Park Drive  
Manteo, NC 27954

## **INTRODUCTION**

Five species of sea turtles can be found along the Cape Hatteras National Seashore (CAHA) – the loggerhead (*Caretta caretta*), green (*Chelonia mydas*), leatherback (*Dermochelys coriacea*), hawksbill (*Eretmochelys imbricata*), and Kemp’s ridley (*Lepidochelys kempii*). In the 1970’s, the leatherback, Kemp’s ridley and hawksbill were listed under the Federal Endangered Species Act as endangered and the loggerhead as threatened (likely to become endangered within the foreseeable future). The green, listed on July 28, 1978, is designated as threatened in its entire range except in the breeding populations in Florida and on Mexico’s Pacific coast, where it is listed as endangered.

Non-breeding sea turtles of all five species can be found in the near-shore waters during much of the year. CAHA lies near the extreme northern limit of nesting for three of the five sea turtle species including: the loggerhead, green, and leatherback; loggerheads being the most common. Annual nest numbers have fluctuated greatly within the last 20 years with only 11 nests recorded in 1987, and a maximum of 112 nests in 2008. The Kemp’s ridley and hawksbill are not known to nest at CAHA, but are known to occur here through strandings.

CAHA follows management guidelines defined by the North Carolina Wildlife Resources Commission (NCWRC) in the *Handbook for Sea Turtle Volunteers in North Carolina*, as well as species recovery plans. In 2009, the US Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS) signed off on a new recovery plan for the Northwest Atlantic population of loggerheads. While this document did not change any of CAHA’s management protocols, it did provide more information on the status of the species in the area.

The beaches of CAHA have been monitored since 1987 for nesting activity. The quality of surveys has improved over time and has developed into the current standardized protocols. Each year data has been collected and analyzed to gain a better understanding of sea turtle use within CAHA. This report summarizes the monitoring results for 2009.

### **2008 Consent Decree**

In October 2007, Defenders of Wildlife and the National Audubon Society, represented by the Southern Environmental Law Center (plaintiffs) filed a lawsuit against the National Park Service (NPS) alleging inadequacies in the management of protected species at CAHA as specified by the 2007 Interim Protected Species Management Plan and the failure of CAHA to comply with the requirements of the ORV executive orders and NPS regulations regarding ORV use.

In April 2008, U.S. District Court Judge signed the Consent Decree (CD) to settle the lawsuit. The CD was agreed to by the plaintiffs and the NPS; as well as by Dare and Hyde Counties and a coalition of local ORV and fishing groups (Cape Hatteras Access Preservation Alliance) which participated in the lawsuit as interveners. The CD, which is enforceable by the court, provides for specific protection mandates and requires the NPS

to complete a long term ORV plan and required special regulation by December 31, 2010 and April 11, 2011 respectively.

The CD affected management of sea turtle nests and public recreation near nests and altered the protocols in the interim plan in the following ways:

- Nighttime driving is restricted between the hours of 10 pm-6 am, from May 1 – September 15. After September 15 nighttime driving is allowed only with a NPS permit for no fee. In winter months (November 1 – May 1) nighttime driving is not restricted on CAHA.
- After September 15, all unhatched turtle nests on ORV beaches that have reached their hatch window (50-55 days of incubation) receive a full beach closure between the hours of sunset and 6 am, in addition to the fencing methodology described in the Interim Strategy. A full beach closure extends from the water to the dune line, thus prohibiting ORV access behind these nests. After final excavation of these nests, the closure is removed.

The CD will remain in effect until the NPS completes the ORV Management Plan and Special Regulation. Any further questions about the CD can be addressed by contacting the Outer Banks Group Headquarters at (252) 473-2111 or visiting the CAHA website at: <http://www.nps.gov/caha/planyourvisit/off-road-vehicle-use.htm>

## **COOPERATING AGENCIES**

CAHA cooperates with the NMFS and USFWS on sea turtle protection. All original stranding reports and annual nesting activity reports are submitted to the North Carolina Sea Turtle Program Coordinator at the NCWRC. An annual permit is issued to CAHA by NCWRC under the authority of the USFWS for the possession and disposition of stranded marine turtles and relocation of nests.

## **SITE DESCRIPTION**

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. Federal ownership in CAHA extends from ocean to sound across three barrier islands—Ocracoke, Hatteras, and Bodie—spanning Dare and Hyde counties. 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. On the oceanside of the villages, federal ownership was established as a 500-foot strip measured landward from the mean low water at the time of acquisition. Fishing piers located in Rodanthe, Avon, and Frisco are operated as concessions within CAHA. The 5,880-acre Pea Island National Wildlife

Refuge, located at the northern end of Hatteras Island, is within the authorized boundary of CAHA, but owned and administered for refuge purposes by the USFWS.

## **METHODS**

### **Nest Activity**

Ocean beaches of CAHA were patrolled daily from May 1<sup>st</sup> to September 15<sup>th</sup> in search of turtle crawls/nesting activity and strandings. Protocols dictate that after September 15<sup>th</sup>, the beaches should be surveyed three to four times a week for possible late nests and/or hatchling emergence events from possible missed nests through November 15. However, since a nest was found on September 15<sup>th</sup>, patrols continued daily until October 1<sup>st</sup>, and then every 3-4 days until November 15<sup>th</sup>. Although another late nest was found on October 7<sup>th</sup>, it was not determined necessary to return to daily patrols after this nest was found.

CAHA staff monitored approximately 66.8 miles of beach covering Bodie, Hatteras, and Ocracoke Islands. For purposes of sea turtle management, Bodie Island District extends from Ramp 1 to Ramp 30; Hatteras District from Ramp 30 south to Hatteras Inlet; and Ocracoke District from Hatteras Inlet south to Ocracoke Inlet (*see Appendix E, Map 1*). The Hatteras District is further delineated as Hatteras North, which encompasses the area from Ramp 30 to Cape Point, and Hatteras South, which extends from Cape Point to Hatteras Inlet. Efforts began as early as possible (between 5:00 am and 6:30 am) so that all beaches had been patrolled by no later than 10:30 am. Nests were considered confirmed when the nest cavity with eggs was located.<sup>1</sup>

Nests were either left in place or relocated for environmental reasons. In general, nest relocation has been discouraged under recommendations of the NCWRC and USFWS; therefore, relocation was confined to nests that were threatened with loss from erosion and nests that were laid below the high tide line that would receive frequent tidal inundation. Some nests were relocated during the approach of storm events. In these cases, verbal permission was obtained from NCWRC.

A transponder ball was buried 45 cm in front of all nests sites. A series of three PVC posts were placed in line with and behind the nest with measurement distances recorded. The nest site was protected with symbolic fencing comprised of four to eight 2"x2" wooden posts with signs stating the area was closed to entry for a sea turtle nest and should not be disturbed. String with flagging was placed between the sign posts and the area was monitored for signs of violations and/or predation during daily morning patrols. After daily patrols ended, all active nests were checked daily.

The closure was expanded to encompass the area 30-50 feet duneward of the nest site down to the tide line 50-55 days into nest incubation<sup>2</sup>.

---

<sup>1</sup> In 2009 all nests had confirmed eggs and there were no "digs."

<sup>2</sup> Except in the case of NH53, which was laid on October 7. This nest was never expanded due to an exemption from US Fish and Wildlife. See Section VIII on page 24 for more information.

Width of the closures (running parallel to the shoreline) varied from 75/150/350 feet, depending on type and levels of recreational use on that particular beach. For example, a nest on a remote beach would receive a closure of 75 feet in width; a nest in a heavy pedestrian use area such as a village would be 150 feet in width; and a nest in an off-road vehicle (ORV) area would be 350 feet in width. If a nest was located on a beach open to ORV use, large signs were posted to notify drivers that the established closure included the shoreline at all tides. When possible, an ORV corridor was maintained duneward of the nest, except for nests that remained beyond September 15<sup>th</sup>, which all received full beach closures. Reflective arrows and detour signs were clearly posted to alert drivers of the change in traffic pattern. If a nest was laid high up on the beach or in the dunes and did not allow for traffic to be detoured around it, the beach was completely closed from dune to the surf as well as for a width of 350 feet. The perimeter of the closure was well posted and large signs warned visitors near ORV ramps of “No through traffic to the next ramp”. The public was notified of closures that would temporarily limit ORV traffic through weekly access reports published by CAHA. The reports were posted at visitor centers and ramps and distributed to the local tackle shops. Many of the local fishing and ORV groups also posted this information on their fishing web boards. Areas with limited or no access were also clearly marked on CAHA’s website, which contained a link to Google Earth, allowing people to find out about changes to access from anywhere. Within turtle closures all vehicle tracks were smoothed over manually with rakes or with a steel mat attached to an ATV, so as not to impede hatchlings attempting to reach the surf (NMFS, USFWS 2009).

As hatchlings can become disorientated by artificial light, silt fencing was installed at most nest sites 50-55 days into incubation in order to block sources of light pollution from nearby villages or ORV’s operating with headlights after dark. The fencing was placed in a “U” shape behind the nest and extended oceanward to the high tide line. Sites were then checked on a daily basis for hatching events. Most nests hatched during the evening/night hours either in one event, known as a boil, or intermittently over several nights, known as a trickle.

In the event of approaching storms that threatened turtle nests, several measures were taken. Silt fencing has the potential to funnel ocean overwash onto a nest site. To avoid this potential damage to the nests, all silt fencing was removed from nest site locations prior to impending storms. After the storm passed, silt fencing was replaced for active nests. Prior to overwash from the storms, all nests that had shown signs of hatching or emergence (i.e. a depression was present or the nest already had some emergence) were excavated early. Hatchlings that have already “pipped” out of their eggs have little chance of surviving overwash, so they were pulled from the nest before storm overwash occurred. Hatchlings were then held until after the storm has passed and then released. In certain circumstances, some nests were relocated in the approach of a major storm event. NCWRC was consulted prior to any nest being relocated for this reason.

With the exception of the nests that washed out, all nests were examined after hatching to determine productivity rates. Nests were excavated no earlier than 72 hours after hatching, except in cases when nests were excavated early due to impending storms.

After storm activity, nests that were known to be dead were excavated and removed. In cases where hatching events or dates were unknown or if a nest failed to hatch, nest cavities were unearthed 80-90 days after the lay date in accordance with NCWRC guidelines. Hatching closures were promptly removed after completion of each nest excavation.

When fresh dead green turtle hatchlings were removed from nests they were frozen for later analysis and examination for an on-going state research project. Additionally in 2009, NCWRC requested that live green hatchlings found during excavations (stragglers) be transported to the NC Aquarium on Roanoke Island for later use as education animals.

### **Stranding Events**

All species of sea turtles that stranded on CAHA in 2009 were documented in cooperation with the NCWRC, USFWS, and NMFS. Handling and collection permits were issued to CAHA by NCWRC and all reports were submitted to them within 24 hours of stranding events. Live animals were transported to a permitted rehabilitation facility for immediate care. A stranding report was completed for each animal (live and dead) documenting such information as species, condition, sex, carapace measurements, tags, wounds or abnormalities, and evidence of fishing gear entanglement or other possible causes leading to injury or death. When possible, photos were taken of each stranding. For dead strandings, samples were collected for ongoing DNA and aging studies. Flippers, eyes and muscle tissues were collected and transferred to the NMFS Beaufort laboratory. When possible, stranded turtles were necropsied by CAHA staff in order to determine sex, health condition, and occurrences of human interaction.

In 2009, CAHA also worked with the NC Department of Marine Fisheries (DMF) to identify and necropsy sea turtle incidental takes by the flounder fishery in Pamlico Sound. These turtles were all found dead by DMF fisheries observers and brought to the CAHA for analysis and documentation. Samples and documentation were sent to NCWRC within 24 hours.

During the winter months, CAHA received numerous cold-stunned strandings (live and dead). These strandings were most commonly found on the soundside shoreline. Due to the number of live strandings in the winter months, CAHA worked with volunteers and staff members to develop standardized survey protocol to locate and respond to these animals. Dead strandings were sampled and necropsied, while live strandings were immediately taken to the Roanoke Island Animal Clinic in Manteo, NC for triage and blood work.

### Temperature Study

In 2009, a HOBO (temperature reading device) was placed in each nest as a part of ongoing temperature dependent sex determination study. This study records the incubation temperature for all nests on CAHA to determine the effect of spatial and temporal changes on the sex ratio of developing hatchlings. This was the third and final

year that CAHA has operated this study, which was funded by Eastern National in 2007. A final report will be out early in 2010.

### Lighting Project

In 2009 CAHA received a grant from Eastern National in order to carry out research designed to assist biologists in better understanding the effect of artificial lighting on the sea-finding behavior of emerging hatchlings. The objectives of this project were to (1) record the effects of varying artificial lights on hatchlings, (2) determine possible differences in artificial lighting effects on hatchlings from the northern range of the loggerhead turtle and hatchlings from other nesting areas of the loggerhead range, and (3) to determine the best possible options for beachfront lighting along the ocean shoreline of CAHA in order to begin development of a lighting management plan. The first trials of this project took place in September with 63 hatchlings. Since the project got a late start in the 2009 season, an effort will be made to start this study earlier during the 2010 and 2011 seasons.

### Volunteer Project

In an effort to involve the public in sea turtle management, CAHA implemented two new sea turtle volunteer programs in 2009.

The first program was designed to allow volunteers to assist biologists with three main aspects of nesting sea turtle management; the location and protection of nests, public interpretation, and “nest sitting.” Volunteers could ride along with the morning turtle patrol to help find new sea turtle activities, while other volunteers helped by teaching the general public about sea turtle biology during public excavations. “Nest sitting” volunteers sat near nests at night to document hatchling emergences and minimize predation.

The second volunteer program was developed to have volunteers assist staff members in the response to cold-stunned sea turtle strandings. Since CAHA receives so many cold-stunned strandings, the volunteers in this program helped patrol difficult terrain such as sound side areas which are not easily accessible in order to look for turtles as well as transport them up to the rehabilitation facility if the animal was alive.

Both programs were implemented in 2009, and are planned to continue.

## **RESULTS**

### **Nesting**

Sea turtle nest numbers encountered at CAHA vary from year to year. The yearly nest numbers used in this report were taken from a thorough search of CAHA’s turtle database and represent the most accurate turtle management data for CAHA (Figure 1).

The first recorded nesting activity for the 2009 season occurred on Hatteras Island with a loggerhead nest on May 22. The last recorded nest of the season was laid on Hatteras Island (just north of Ramp 49) on October 7. In some years there are nests that are only located at the time of their hatching. This year no missed nests were documented. The 2009 sea turtle nesting season lasted for 139 days. A total of 205 activities were documented of which 104 were confirmed nests and 101 were false crawls (Table 1). The 104 nests on CAHA (101 loggerhead nests, two green nests, and one leatherback nest) constituted 16.8 % of North Carolina’s total 619 nests. In 2009 the State documented a total of 619 nests comprised of 610 loggerhead nests, six green nests, and three leatherback nests.

Of the confirmed nests found this season, 53 (51%) were found in Hatteras District, 32 (31 %) were found in Ocracoke District, and 19 (18%) were found in the Bodie District (Figure 2). For maps of all turtle nests and false crawls refer to Appendix E, Maps 2-11.

There were several storms that caused severe damage to sea turtle nests on CAHA in 2009, resulting in a total of six nests that could not be excavated due to storm activity. All six of these nests were assumed to have 0% hatching or emergence success as the storms hit prior to any documented emergence.

Figure 1. CAHA Sea Turtle Nest Numbers from 2000-2009.

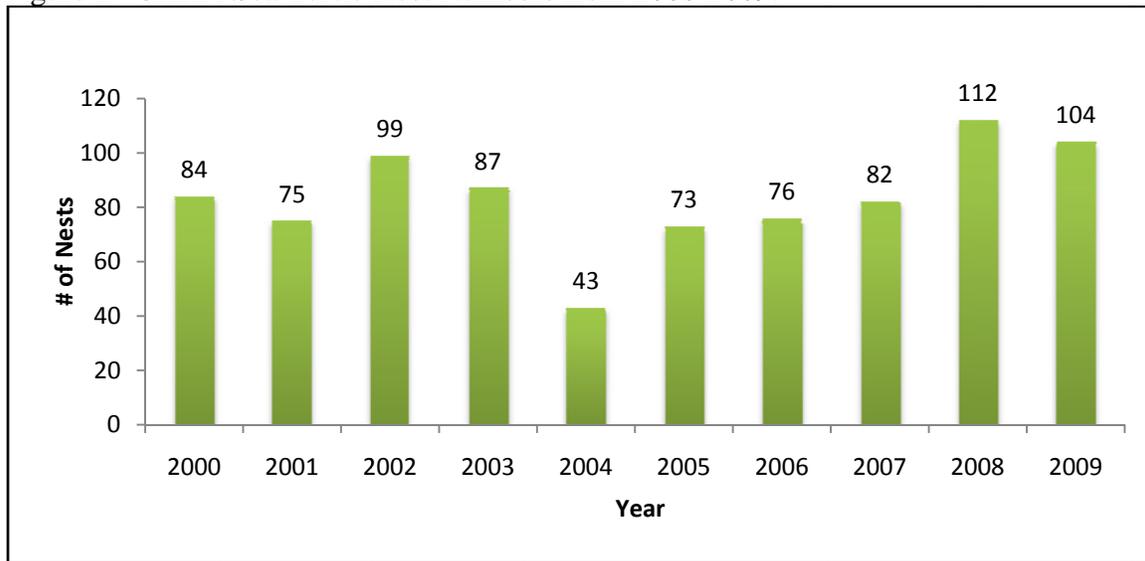


Table 1. Nest Activity by District in 2009.

	<b>Bodie</b>	<b>Hatteras</b>	<b>Ocracoke</b>	<b>CAHA Total</b>
<b>Nests</b>	19	53	32	104
<b>False Crawls</b>	9	46	46	101

Table 2. Percentage of Total Nests for North Carolina.

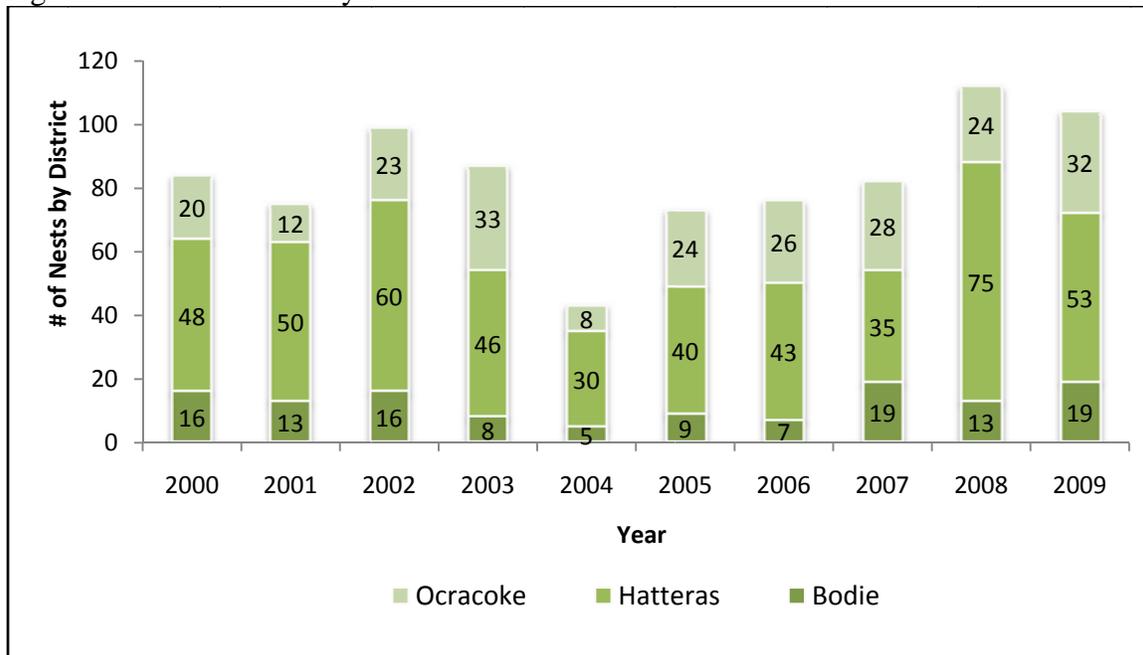
Year	CAHA Nests*	NC Nests**	%
2000	84	784	10.7
2001	75	663	11.3
2002	99	708	14.0
2003	87	867	10.0
2004	43	352	12.2
2005	73	660	11.1
2006	76	800	9.5
2007	82	565	14.5
2008	112	878	12.8
2009	104	619***	16.8

\*from CAHA

\*\*from M. Godfrey, NCWRC

\*\*\*preliminary results from M. Godfrey, NCWRC

Figure 2. Nest Numbers by District from 2000-2009.



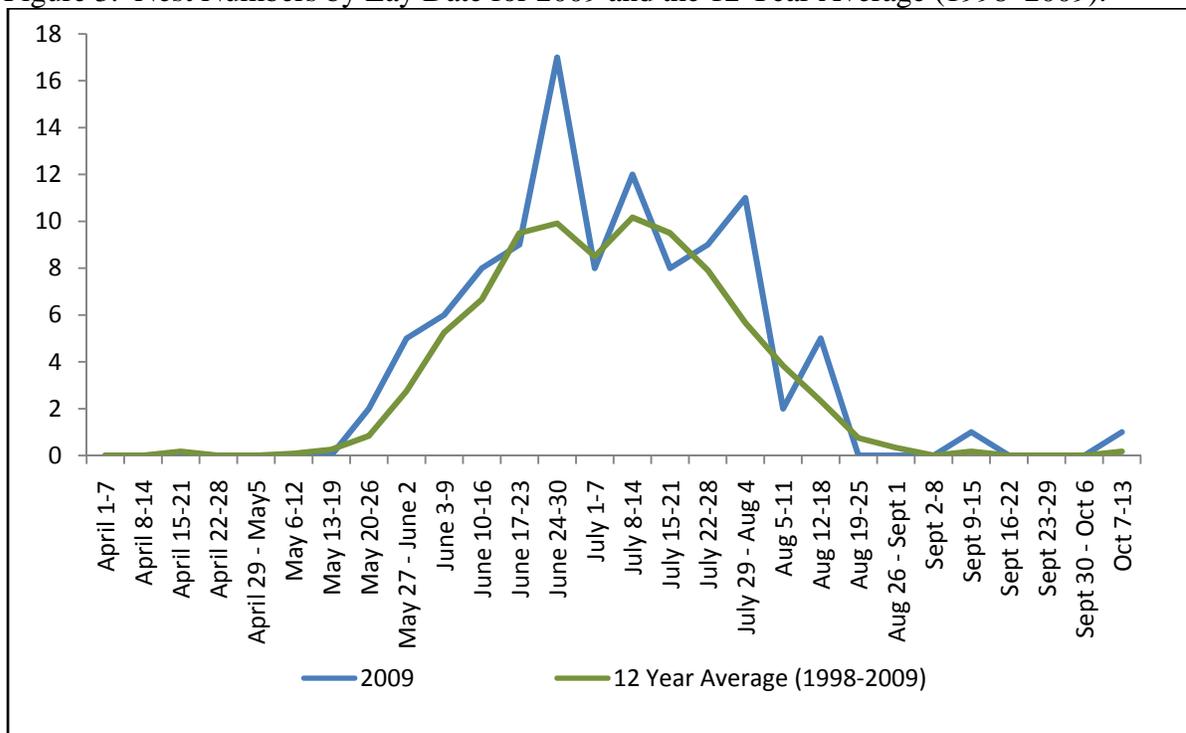
### Nests by Lay Date

In early 2009, the negotiated rulemaking natural resources subcommittee requested information about the number of nests laid throughout the nesting season. The purpose was to draw conclusions about which weeks during the nesting season received the most nests. The following graph (Figure 3) indicates the dates that nests were laid during the

2009 season in comparison to CAHA’s 12 year average (1998–2009). Nests that did not have known lay dates (i.e. were found only when hatchlings emerged) are not included in this graph. It is important to note that these numbers are potentially misleading. Prior to 2007, turtle patrols were conducted between May 15–Sept 1. Prior to 2006, patrols did not begin until June 1. Any nests found before the start date or end date of turtle patrol were found by chance (i.e., reported by visitors, staff on the beach performing other duties, etc.) since no coordinated, scheduled patrols were conducted. It is unknown how many nests were missed during these times. Beginning in 2007, the USFWS has required CAHA to begin patrols May 1 and continue until Sept. 15 in order to reduce the chance of missed early and late nests.

Individual lay dates for 2009 nests can be found in Appendix A.

Figure 3. Nest Numbers by Lay Date for 2009 and the 12 Year Average (1998–2009).



### False Crawls

During the 2009 breeding season, 101 false crawls or aborted nesting attempts were recorded (Table 1). False crawls accounted for 49% of the total turtle activities within CAHA. Of the 101 false crawls, 46 (45.5%) were documented in the Hatteras District, another 46 (45.5%) in the Ocracoke District, and nine (8.9%) in the Bodie Island District. Loggerheads accounted for all 101 (100%) of the false crawls.

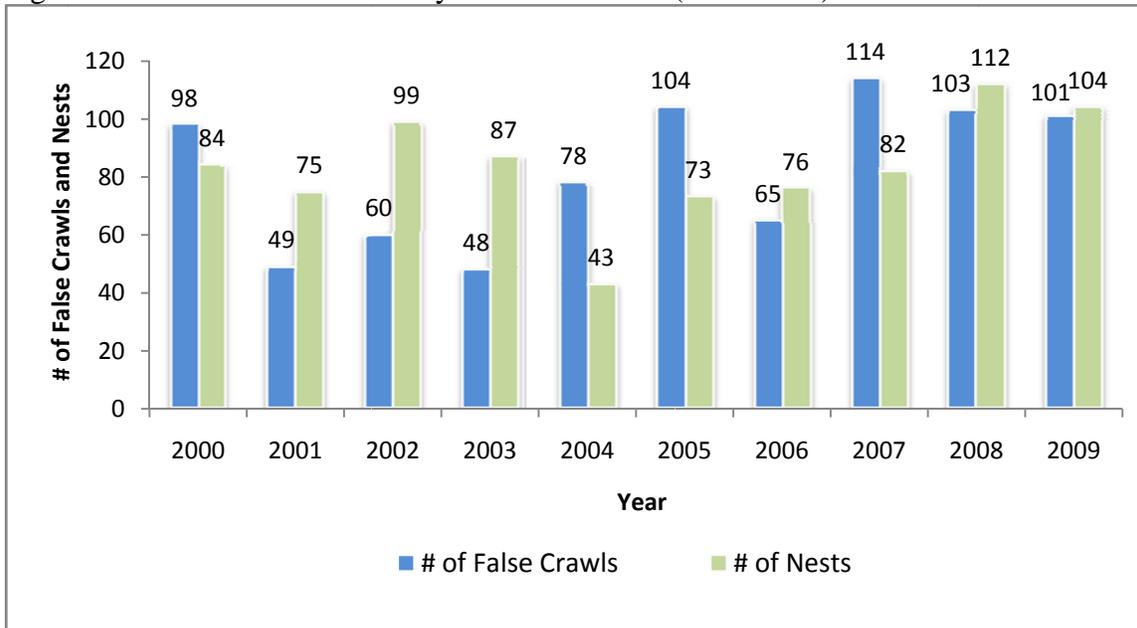
In 2009 101 false crawls and 104 nests were documented, resulting in a 0.97:1 false crawl to nest ratio. Therefore CAHA met the target level of a false crawl to nest ratio of less

than or equal to 1:1 annually, which is a performance measure of CAHA’s Biological Opinion. CAHA has met the desired target level in six of the last 10 years (Table 3).

Table 3. False Crawl to Nest Ratios for CAHA (2000-2009)

Year	# of False Crawls	# of Nests	Ratio
2000	98	84	1.17 : 1
2001	49	75	0.65 : 1
2002	60	99	0.61 : 1
2003	48	87	0.55 : 1
2004	78	43	1.81 : 1
2005	104	73	1.42 : 1
2006	65	76	0.86 : 1
2007	114	82	1.39 : 1
2008	103	112	0.92 : 1
2009	101	104	0.97 : 1

Figure 4. Nests to False Crawls by Year for CAHA (2000-2009)



### Nests and False Crawls by Beach Type

In 2009, Resource Management staff recorded the type of beach each nest and false crawl was located on at the time the activity occurred. This has become of particular interest as people have attempted to correlate recreation activities with the propensity for turtles to have successful nesting attempts. Nine separate beach types were identified and used to categorize the nests and false crawls. The descriptions of these beach types are listed below:

- ORV: ORV open access site
- Village: Village beaches (Rodanthe, Waves, Salvo, Avon, Buxton, Frisco, and Hatteras)
- Ped High: High use pedestrian only access beaches outside of villages (Lifeguarded beaches, beaches in front of campgrounds, and beaches within 0.2 miles of an access parking lot). This is a change from the 2008 definition of Ped-High (0.3 miles). It is believed that 0.2 miles is a more accurate representation of the density of human recreation in these areas.
- Ped Low: Low use pedestrian only access beaches (any part of the beach that is not open to ORVs, not in a village, does not receive high visitation, and is not closed for resource management activity).
- Limited: Beaches that are open, but access is limited due to one or more resource management closures.
- Ped Cor: Beaches that are designated as a pedestrian corridor.
- RC-Ped Cor: Nest or false crawl extends into a resource closure (RC) that is located duneward of a pedestrian corridor.
- RC-Ped: Pedestrian only access beaches outside of villages that are closed for resource management activity.
- RC-ORV: ORV access beaches that are closed due to resource activity.

It is important to recognize that these beach types changed on a daily basis during nesting and hatching season. Therefore, there is not a ‘total miles of beach’ per beach type. Due to this limitation, it is difficult to make a definitive assessment on how the level of recreation influences sea turtle nesting activity.

Table 4. Nests and False Crawls by Beach Type on CAHA in 2009

Beach Type	# of Nests by Management District			# of False Crawls by Management District		
	Bodie	Hatteras	Ocracoke	Bodie	Hatteras	Ocracoke
ORV	2	17	14	0	16	19
Village	5	11	N/A	1	7	N/A
Ped High	0	6	6	0	3	6
Ped Low	0	9	8	0	6	10
Limited	5	4	0	6	1	1
Ped Cor	0	1	0	0	0	1
RC-Ped Cor	0	0	0	0	0	0
RC-Ped	0	1	2	0	2	0
RC-ORV	7	4	2	2	11	9

### Nest Relocation

Of the 104 nests, 72 (69%) were protected at the original nest site and 32 (31%) were relocated (Table 4). Nests were relocated in all districts. A total of 3,493 eggs were relocated of which 1,117 emerged for an emergence success of 32% for relocated nests. 1,871 of the relocated eggs hatched, for a hatching success of 54%.

A total of 4 nests were relocated during the approach of an impending storm. Three of these nests are not included in the relocation totals as the majority of their incubation occurred at their original location (NH48, NH49, NO27). The 4<sup>th</sup> is included in the totals, as it was relocated when it was originally located, and then moved again in the approach of Tropical Storm Danny (NO29). The leatherback nest (NH21) was also moved prior to Hurricane Bill, but when it was excavated it was found that all the developing embryos had died around the time of the storm. It is hypothesized that the nest mortality was caused by a rising water table as the storm approached.

The highest number of relocations took place in the Hatteras District where 17 (32%) of 53 nests in the district were relocated. Eight of the 32 nests (25%) on Ocracoke were relocated and 7 of the 19 nests (37%) were relocated in the Bodie District (Table 5). Of the 32 relocated nests, all (100%) were moved because of natural factors such as being laid at or below the high tide line or due to erosion occurring in the area.

Table 5. Relocated Nests by Management District in 2009

<b>Nest Type</b>	<b>Bodie</b>	<b>Hatteras</b>	<b>Ocracoke</b>	<b>Total</b>
In Situ Nests	12	36	24	72
Relocated Nests	7	17	8	32
Total	19	53	32	104

## Hatching

Follow-up of nesting activity involved observing nest sites for signs of hatching, recording relevant data (i.e. overwashes, violations), and excavating the site. Nests were excavated no earlier than 72 hours post-hatching, unless it was felt that an early excavation was needed in order to uncover live hatchlings that were entombed due to environmental conditions or in the approach of an impending storm.

For sea turtles, there is a difference between hatching success and emergence success. Emergence success is the total number of hatchlings that emerge from their nest on their own. Any live hatchlings that are found during excavations are not considered to have “emerged”. Emergence success can be calculated using the following formula

$$\frac{\text{Total \# of Eggshells} - (\text{\# of Live Hatchlings} + \text{\# of Dead Hatchlings})}{\text{Total Clutch Size}} \times 100$$

Hatching success includes the live hatchlings that are found during excavations, which means it also includes any hatchlings that were pulled from nests prior to storm events. Hatching success can be calculated using the following formula:

$$\frac{\text{Total \# of Eggshells} - \text{\# of Dead Hatchlings}}{\text{Total Clutch Size}} \times 100$$

In order to determine Total Clutch Size, the # of eggshells is added to the # of unhatched eggs. In this report, an effort has been made to show both the hatching and emergence success for each nest, as well as the CAHA as a whole.

Of the 103 nests that success can be calculated for<sup>1</sup>, 65 (64%) nests had a hatching success of greater than or equal to 1%<sup>2</sup>. 52 of these nests had an emergence success of greater than or equal to 1%<sup>2</sup>. The average clutch size for nests at CAHA was 115<sup>3</sup>.

Six excavations could not be conducted due to storm activity which resulted in the nests being washed out (NH24, NH37, NH43, NBH02, NO15, and NO16). Nests took an average of 65 days to incubate (average calculated from the 42<sup>4</sup> nests with known lay and emergence dates). Some emergences may have gone undetected because of low emergence rates or as a result of rain, wind, or tide. Figure 5 shows the average time it took nests to incubate based on the week they were laid.

A total of 11,121<sup>5</sup> eggs were excavated post hatching and 3,430 (30.8%)<sup>5</sup> of these eggs produced hatchlings that emerged from the nests on their own (Table 3). An additional 1,614<sup>4</sup> live hatchlings were discovered during nest excavations and were released. The overall percentage of eggs that produced hatchlings is therefore 45.4%.

In 2009 the overall emergence success was 30.8%, and the overall hatching success was 45.4%. See page 17-23 for discussion on how storm activity and other factors influenced the success of nests in 2009.

For detailed information regarding specific numbers, dates and locations refer to Appendix A for nests and Appendix B for false crawls.

---

<sup>1</sup> Excludes NH48. NH48 lost eggs during Hurricane Bill. After the storm the nest was relocated to higher ground, which resulted in 18 hatchlings, but since a total clutch size cannot be calculated, success cannot be determined.

<sup>2</sup> Assumes that all nests that were washed out (NH24, NH37, NH43, NBH02, NO15, and NO16) had a hatching and emergence success of 0%.

<sup>3</sup> Average calculated from 98 nests with known clutch sizes (total of 11262 eggs). Excludes NH24, NH37, NH43, NH48, NBH02, NO16. All clutch sizes determined by data collected during excavations, except in the case of NO15, which washed out. For this nest, the relocation information provided the total clutch size.

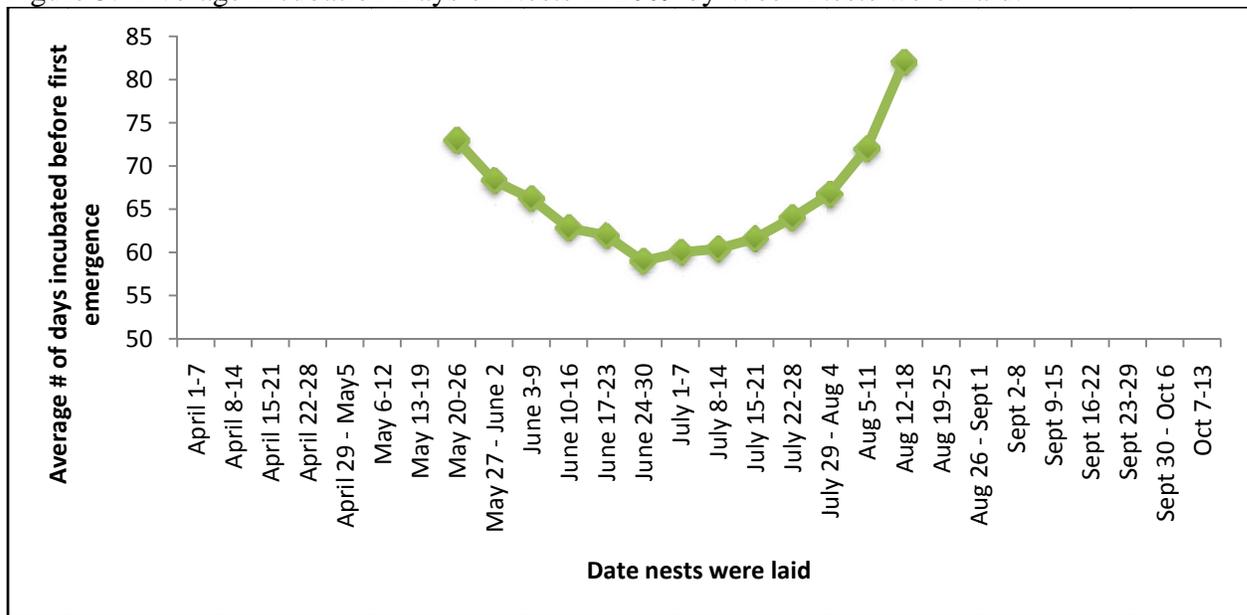
<sup>4</sup> In some cases it cannot be determined which was the first night that a nest had emerged hatchlings. For this calculation, only nests with a known emergence date were used. Any nest that was excavated early due to storm activity is excluded, as the hatchlings from those nests did not emerge on their own.

<sup>5</sup> Excludes the six nests that were washed out, plus NH48.

Table 6. Sea Turtle Hatch Summary 2001-2009

Year	Nests	Avg. Clutch	Average Incubation (days)	Total Eggs	# Emerged	EMR%
2001	75	111.7	64.5	6257	3402	54%
2002	99	108.7	58.6	10108	7201	71%
2003	87	115.7	69.1	4627	2708	58%
2004	43	103.4	58.5	2999	1609	53%
2005	73	114.6	58	6072	4142	68%
2006	76	114.8	62.9	7059	4444	63%
2007	82	112.1	60.7	9078	6075	58%
2008	112	109.0	59.7	11573	5965	52%
2009	104	114.9	65	11121	3430	31%

Figure 5. Average Incubation Days of Nests in 2009 by Week Nests were Laid.<sup>1</sup>



## Strandings

During much of the year, both breeding and non-breeding sea turtles can be found in nearby waters, especially inshore sounds. A stranded turtle is a non-nesting turtle that comes to shore either dead, sick or injured. Stranding information assists regulatory agencies in implementing and modifying conservation measures, as well as provides vital biological information about the health of the species.

In 2009, 297 stranded sea turtles were documented (Table 7, Figure 5) of which 109 (37%) were on ocean beaches and 188 (63%) were on the soundside shoreline.

<sup>1</sup>This graph was created by calculating the average incubation days for each nest that was laid during the defined weeks. In total, 42 nests had known lay dates and emergence dates. Nests that were excavated early due to storm are excluded, as the hatchlings from those nests did not emerge on their own.

Strandings on the oceanside were easily found and responded to, whereas most of the soundside shoreline was only monitored for strandings in accessible areas (i.e., ORV areas, pedestrian beaches, and soundside ramps). Therefore it is likely that there are a high number of soundside strandings that are not reported.

Park-wide, 53 (18%) were identified as loggerhead, 57 (19%) were Kemp’s ridley, 183 (62%) were green, 2 (>1%) were leatherbacks, 2 (>1%) could not be identified, and none were hawksbills.

Figure 6. Sea Turtle Stranding Totals at CAHA (1997-2009)

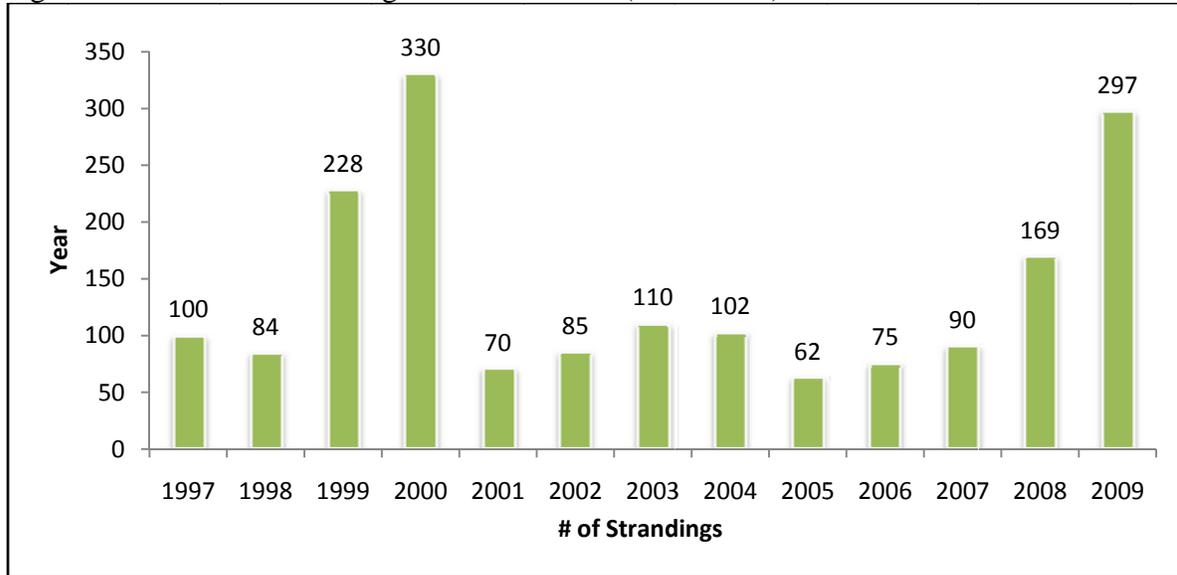


Table 7. Sea Turtle Strandings at CAHA (1997-2009).

Year	Stranding Totals	Species Composition						Location	
		Logger-head	Kemp's Ridley	Green	Leather-back	Hawksbill	Unk.	Ocean	Sound*
1997	100	65	17	11	3	0	4	Unk.	Unk.
1998	84	45	26	10	2	0	1	Unk.	Unk.
1999	228	150	56	22	0	0	0	140	88
2000	330	252	31	43	2	0	1	240	90
2001	70	41	11	11	4	1	2	46	23
2002	85	54	6	23	0	0	2	54	31
2003	110	87	8	11	2	1	1	88	21
2004	102	38	11	42	5	0	6	47	55
2005	62	33	3	20	1	1	4	41	22
2006	75	45	11	16	2	0	1	65	10
2007	90	32	5	50	1	0	2	46	44
2008	169	39	34	94	2	0	0	39	130
2009	296	53	57	183	2	0	2	109	188

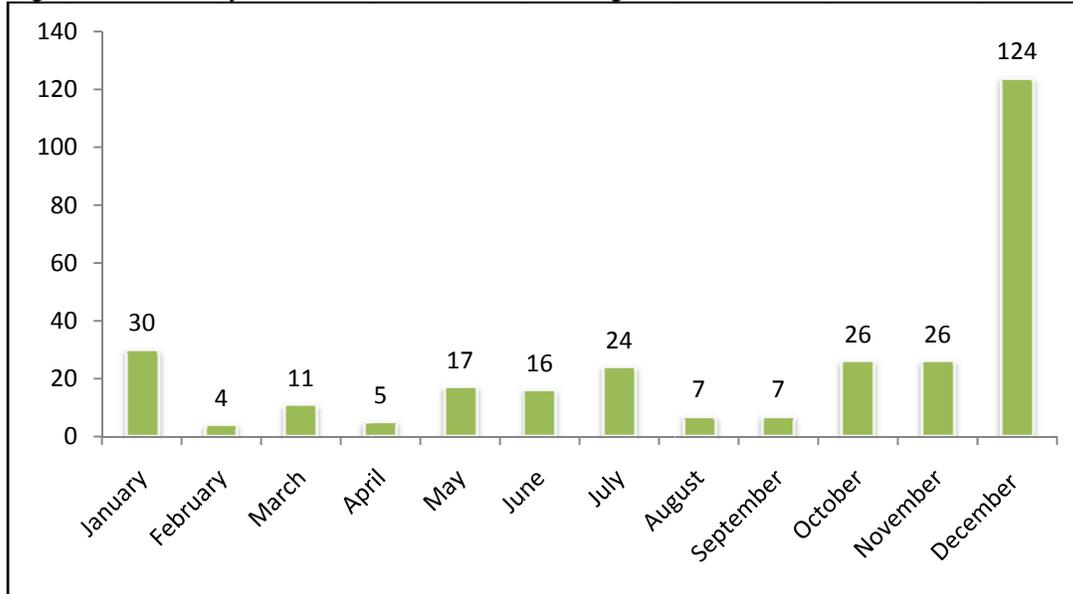
\*Soundside strandings include any strandings found on inlets, spits, interior islands, and soundside shoreline

Of the total strandings, 242 (81%) turtles were dead when found. Of the 55 live strandings (19%), all were transferred to the North Carolina Aquarium on Roanoke Island for rehabilitation, except for one live stranding that was released. Most of these live strandings were a result of ‘cold stunning’ where water temperatures become too cold for sea turtles to function normally. Often, these turtles had pre-existing conditions that made them more susceptible to a cold stun event. Examples of pre-existing conditions include old boat strike wounds, plastic (e.g. wrappers, toys) in the gastrointestinal tract, etc. Necropsies were performed on 191 of the 241 dead strandings (79%). Additionally, some strandings have been frozen and saved for later necropsy training sessions. Cause of death in most cases was unknown; however eight strandings had obvious signs of human interaction (prop wounds, hooks, or plastic). Additionally, seven turtles had signs of fisheries interactions from entanglement or drowning (as determined by NCWRC biologists-often evidenced by remaining gear or obvious entanglement lesions around the neck or flippers). Cold temperatures attributed to 137 strandings (50 live and 87 dead). Only live and fresh dead strandings were conclusively determined to be cold stuns. The mortality of dead strandings that were found around the same time that were not as fresh are listed as CBD (cannot be determined), but are also most likely due to cold temperatures.

The largest number of strandings occurred in the month of December, when 124 turtles were documented (Figure 7). “Cold stunned” strandings occurred throughout the winter months (November–February) and were found predominantly on the soundside.

Injuries and abnormalities for each stranded turtle were recorded on a stranding report. Samples, including eyes, flippers, tags, and muscle samples were collected from stranded turtles according to NCWRC guidelines. Most turtles in 2009 were responded to by NPS staff or volunteers. Some turtles were responded to and reported by DMF biologists in the area. Turtles that stranded soundside in the villages are included in the stranding totals.

Figure 7. Monthly Total of Sea Turtle Strandings at CAHA in 2009.



## DISCUSSION

### Storm Activity

Loss of nests to storm events continues to negatively impact hatching and emergence success. During the 2009 season, CAHA felt the effects of Hurricane Bill, Tropical Storm Danny, and several nor'easters. Dates with exceptionally large high tides included June 23, July 10-12, August 21-24 (Hurricane Bill), August 28-29 (Tropical Storm Danny), September 7, 11, and 18, October 15-18, and November 11-16 (Nor' Ida). There were a total of six nests that were washed out entirely or could not be found post-storms (NH24, NH37, NH43, NBH02, NO15, and NO16). All of these nests were assumed to have 0% emergence and 0% hatching success due to storm activity. An additional 25 nests saw a severe decrease in nest success (little or no hatching success) due to Hurricane Bill and/or Tropical Storm Danny. There were 16 other nests that also experienced reduced nest success due to storm overwash, but the decrease could not be correlated with one particular storm event.

The NCWRC biologist was consulted prior to conducting any early excavations (prior to impending storms) in order to save pre-emergent hatchlings from overwash that would have resulted in drowning. Post-storm, all remaining nests were checked for compaction, which can cause live hatchlings to become entombed in the egg chamber. Prior to storm activity, 16 nests were excavated early, resulting in 1,195 hatchlings. Without conducting early excavations, the overall hatching success of 45.4% would have been much closer to the overall emergence success of 30.8%. Although Hurricane Bill and Tropical Storm Danny did not greatly affect the human residents of the Outer Banks, the fact that the storms arrived so early in hatching season meant that a large number of nests

that were nearly ready to hatch got overwashed. As sea turtle eggs move into the later stages of development, they have less chance of withstanding inundation. Since so many nests were due to hatch around the time of the storms, they were unable to survive the impacts of storm overwash. Therefore, although neither storm was considered a major event, the timing of the storms resulted in a high mortality of nests at CAHA, which led to a low emergence success.

Four other nests were excavated early due to cold temperatures and/or the incoming November Nor'Ida, resulting in an additional 264 hatchlings (NH50, NH51, NO30, NO32). See discussion of how cold temperature affected nest success on page 18.

## **Predation**

Sea turtle nests and hatchlings were predated at multiple nest sites in 2009 by both ghost crabs and mammalian predators. There was no red fox predation this year as occurred in 2007. Cat tracks were found in and around turtle closures throughout the season, particularly in the villages. Many of these incidents occurred on nights when hatchlings were known to emerge. It is unknown exactly how many hatchlings during the season were predated by domestic/feral cats. In 2009, CAHA Resource Management staff continued to trap predators such as fox, mink, feral cats, and raccoons within the CAHA boundary year-round. The majority of the trapping efforts at CAHA are focused on areas where predation of protected species has been known to occur.

Loss of eggs and hatchlings to ghost crabs continues to be documented. In 2009, 27 nests had recorded predation loss due to ghost crabs (eggs, hatchlings, or both). There were several incidents where ghost crab tracks were found within the silt fencing on nights when hatchlings were known to emerge. It is unknown how many total hatchlings were predated by ghost crabs in 2009. During excavations, a total of 122 eggs<sup>1</sup> (1.1%) were found to have been predated.

Ghost crab predation was found on all Districts. In some cases, ghost crabs were found within the nest cavities predated on hatchlings during excavation.

## **Other Egg Mortality**

Upon excavation, eight nests were found to have unhatched eggs with the egg contents exhibiting a bright pink color and/or aqua blue color (yolk sac, amniotic fluid, etc.). The locations of these nests were predominantly in the Hatteras District, but two nests in the Bodie District and one nest on Ocracoke were also affected.

It was hypothesized that the unusual color was or came from bacteria or fungus. It is unclear if the pink substances was the cause of the eggs' mortality or if the substance only showed up in eggs that were unhatched.

---

<sup>1</sup> This total does not include any predation that may have occurred to eggs that washed out and were not excavated.

Cold temperatures affected the success of several nests during the 2009 season. Beginning in early November, air temperatures dropped to a level that made it difficult for emerging hatchlings to make it to the water. In the case of NO30, a green nest, some of the emerging hatchlings were found the following morning upside down and cold. The cold temperatures had slowed the hatchlings down so much that they were not capable of moving more than a few feet away from the nest.

After that incident, all remaining nests were watched closely. When nests began to show signs of hatching, staff biologists excavated the nest and pulled the hatchlings. Hatchlings were then sent to the NC Aquarium on Roanoke Island for later release directly into the Gulf Stream. This was done for hatchlings from NO30, NO32, NH50, and NH51.

Three nests (NO31, NH52, and NH53) had no success due to cold temperatures. Interestingly, although NO31 and NO32 were laid on the same night, NO31 did not hatch while NO32 did. NO32 hatched before Nor' Ida hit in November, while NO31 lingered past 100 days of incubation when it succumbed to cold temperatures. The excavation of NH52, which was laid on September 15<sup>th</sup>, showed no development of any of the eggs. The last nest of the season, NH53, which was laid on October 7, was excavated on December 16 after roots were found to be invading the nest site. During the excavation, it was found that none of the eggs showed any development.

### **Human Disturbance**

It is unknown to what extent human activities disrupted nesting activities. Although CAHA remains open to pedestrians 24 hours a day, CAHA staff was not available around the clock to safeguard and monitor all the various natural resources.

Many visitors at CAHA, especially in front of the villages, left their recreational beach equipment and chairs or loungers on the beach overnight. This equipment and furniture can cause turtles to forgo laying eggs by hampering or trapping animals attempting to locate a nesting site (NMFS, USFWS 1991). This is the ninth season that Resource Management staff has tied notices to personal property found on the beach after dawn, advising owners of the threats to nesting sea turtles as well as safety issues and NPS regulations regarding abandoned property. The date and time items were tagged was clearly written on each tag. Items left on the beach 24 hours after tagging were removed by NPS staff. Not all tagged items were removed within 24 hours as staff patrolling on ATVs or UTVs could not safely remove the property from the beach. At other times, not all abandoned property could be removed because of the abundance encountered and staff availability. In 2009 there was one incident of a beach canopy blowing into a sea turtle nest site. No damage was observed to the nest. The canopy was removed from the closure and tagged.

Beaches fronting villages are closed to ORV use in the summer months to provide for the safety of an increased pedestrian population. While many of these beaches were wide enough to support sea turtle nesting, the high amount of human activity and density of

development (i.e. lighting within the villages) make these beaches less than optimal nesting sites for nesting turtles. With an increase in visitor use, the potential of human disturbance of nesting turtles increases. There continue to be concerns that turtles may be deterred from nesting on beaches of their first choice and forced to lay eggs at a less optimal site.

### **Artificial Lighting**

Artificial light is known to disturb nesting females and can disorient hatchlings. Outdoor lights, un-shaded indoor lights, beach fires and vehicle headlights outshine the natural glow of moonlight on the ocean waves, which can guide hatchlings away from the sea as well as possibly deter nesting females. Filter fencing is a high maintenance and costly response to lighting issues. Fencing is often washed out by incoming tides, buried by winds and/or completely uprooted by storm activity. Nest sites in their hatching window are checked and maintained daily; however, this does not help hatchlings at nest sites where the filter fence has been knocked down during the night. Hatchlings may become entangled in the fencing if it is not properly maintained. In 2009 there was one report of a hatchling being tangled in filter fencing. This incident occurred at NH47 on the morning of October 7. The hatchling was immediately removed and released later that evening. CAHA will continue to use the filter fencing until a better option is identified. Since 2005, the majority of all turtle nests within their hatching window have received filter fence treatment. This treatment was continued in 2009. Filter fencing was removed from all nests prior to an impending storm for the safety of nests and emerging hatchlings.

### **Potential Incidental Take / Human Disturbance**

All species of sea turtles nesting on CAHA are protected under the Endangered Species Act of 1973. Under the ESA, “take” is any human induced threat to a species that is listed. Take is defined as “to harass, harm, pursue, hunt, shoot, wound, kill, capture or collect, or to attempt to engage in any such conduct.” On CAHA, this can include the death, harassment, or disorientation of nesting females and/or hatchlings due to human influence. It is difficult to document all of these potential take incidents, but those reported from the 2009 season are listed below.

CH17: This false crawl occurred on Lighthouse Beach on the night of July 3. The tracks were documented as coming right up to a still warm fire pit, at which point the animal turned around and went back into the water.

CO34: This false crawl was found on the morning of July 15 near a walkover on Ocracoke Island. It was evident that the nesting turtle had dug an egg chamber and then abandoned the site. The following day a visitor contacted CAHA to ask about the turtle, and informed biologists that there had been several families watching with cameras and flashlights.

NH06: This nest in Hatteras Village was expanded and within the hatch window when a wind storm on the night of August 3 blew a beach canopy directly onto the nest site. The canopy was removed by morning turtle patrol and tagged. No hatchlings emerged from this nest on that night and there was no observed damage.

NH12: This nest was located just north of Hatteras Village in Isabel Inlet. On the night of August 10, approximately 25 hatchlings came out of the filter fencing and headed south toward Hatteras Village. It is unknown how many hatchlings made it to the water. Cat tracks were found near the nest on the same night.

NH16: This nest was laid in the early morning hours of June 27 just north of Ramp 44 inside the pedestrian corridor that was in place at the time. When turtle patrol came out of Ramp 43 that morning at 5:30 am, a vehicle was already south of the ramp with its headlights on (vehicles are restricted by the CD regulations until 6 am). Turtle patrol asked the vehicle to leave the beach until the allotted time, and then entered the pedestrian corridor. A nesting loggerhead was just finishing a very low nest about 30 yards from where the vehicle was parked. The nest was moved to higher ground.

NH46: This nest was located between Ramp 43 and Ramp 44 on Hatteras Island. On the night of Oct 11, approximately 30 hatchlings came out of the protected filter fencing area and headed south from their nest toward Cape Point. They exited the closure at the south end and then moved toward the water. About five of the hatchlings went into a tire track, and either made it to the water or were predated.

NBH05: This nest was laid on the night of June 16 in the tri-village area. That night, CAHA staff received a call from Dare County Central reporting that pedestrians on the beach were harassing a nesting turtle. The following morning the nest was found, but was so low on the beach that it had already been mildly washed over. The nest was relocated to higher ground. Since the nest had a good success, it is unlikely that any damage was sustained.

NBH12: This nest was laid on the night of June 28<sup>th</sup> in the tri-village area. This nest was not found by morning turtle patrol due to the amount of pedestrian tracks obscuring the crawl. One of the pedestrians who had been out the night before contacted CAHA to report that there was a nest that had not been marked. The visitor informed CAHA that that the animal had been surrounded by more than 20 people. The visitor indicated where the nest was located and staff was able to confirm eggs and install a closure. The nest was not relocated.

NO30: This green nest was located between Ramp 70 and Ramp 72 on Ocracoke Island. After Ramp 72 closed due to flooding, there were several times when vehicles attempted to drive below the full beach closure to reach South Point. On the night that some of the hatchlings emerged, at least two vehicles went below the closure in the surf line. It is unknown whether any of the emerging hatchlings were impacted.

## Closure Violations

In 2009, there were numerous violations of turtle closures, some more serious than others. Although closure signs were highly visible and could be read easily, law enforcement and resource management staff documented violations at turtle closures throughout the nesting and hatching seasons. Entry into a turtle nesting area would require people to pass under, drive through flagged string tied between signed posts, or pass below signs by the tide line. Signs were posted as low on the beach as possible. Because of extremely high sign loss near the shoreline at all expanded turtle nests, the closure signs closest to the water were replaced with carsonite, which holds better in the moist sand. Although carsonite is extremely costly, staff roped them together so that if the tide washed them out, there was a better chance of recovering them.

The most common type of violation occurred with the entry of pedestrians in the intertidal zone of expanded turtle closures. At 50-55 days of incubation, when turtle closures are expanded, the new closure extends to the mean low tide line. Each nest was clearly marked on each side at the tide line that visitors should not walk in front of the nest. Access was nearly always available behind the nest at the dune line or behind the primary dune. However, due to the difficulty in keeping signs in below the high tide line, many visitors walked in the intertidal zone in front of nests. It is unknown how many, if any, hatchlings were affected by the huge number of visitors in the intertidal zones. This problem was reported most often on Village beaches, high pedestrian beaches (such as Lighthouse Beach), and popular ORV beaches (such as near Ramp 49). As footprints are often washed out prior to the area being checked, this type of violation is highly under-documented.

It was found that some visitors also walked up into expanded turtle closures near the filter fencing and nest. For some observations, it was apparent that visitors ducked under string and flagging in order to enter/exit turtle closures. It is unknown if hatchlings were affected by the presence of visitors within closures. This type of violation was most reported in front of the tri-village area (Rodanthe, Salvo, and Waves), where a high number of visitors walked through closures to get to the other side of the closure where they could continue their walk. The beach in this area is fairly narrow, so most of the closures were full beach closures. At NBH12 in the tri-village area, broken string and several sets of footprints were documented over the nest site. This incident did not result in any observed damage to the nest. At NH26 on Lighthouse Beach, pedestrian tracks were documented directly over the nest itself. Since this nest had no success due to storm activity, it is unknown if there was any impact to the nest from pedestrians.

Domestic pets constitute another form of violation. In 2009 there were several reports of dogs and/or dog tracks within turtle closures. Often these were accompanied by multiple sets of footprints. Dogs were primarily found to be a problem in the tri-village area as well as on Lighthouse Beach.

Domestic and/or feral cats continued to be a problem in 2009. Cat tracks were found within at least 20 turtle closures over the season, most commonly in the villages. Cat

predation was difficult to document, but it is known that cats pose a serious threat to emerging hatchlings, particularly in Frisco. In the tri-villages area, every nest had documented cat tracks though the closure.

ORV violations of turtle closures were relatively rare. There were several accounts of vehicles driving below (i.e. ocean-side of) the expanded turtle closures in the morning before any washed out signs in the intertidal zone could be replaced. It is unknown how many hatchlings, if any, were affected by these actions, either by being run over or by being stuck in tire tracks. There were no observed losses to this type of violation, although it is known that hatchlings were emerging from NO30 (a green nest) during the same night that some of these violations took place (see above).

There were two violations that were considered to be serious or intentional violations under the CD. The closures were expanded by 50 meters (as per the CD) for both incidents. These violations are listed below:

NBH10: On the morning of July 26<sup>th</sup>, staff on turtle patrol for the Bodie Hatteras District noticed that a nest closure was “missing” in the tri-village area. After going back through the area, she found that someone had removed the four signs, string, flagging, and PVC poles that were surrounding the nest site. Two of the signs were later found 0.2 miles down the beach. One sign was found behind the primary dune line with the PVC poles and the fourth sign was never recovered. Many sets of pedestrian footprints were found over the nest site. The eggs were checked and the closure re-installed at the expanded size. As the nest had a good success, it is unlikely that this incident resulted in any harm to the nest itself.

NH33: On the morning of September 2, staff on the turtle patrol for the Hatteras South run noticed that string was down at the NH33 nest site, which was an expanded closure just north of Ramp 49. It was found that a vehicle had driven through the string at one end of the closure, run through the filter fencing, and then exited the closure by driving through the string at the other end. It is unknown whether the vehicle was also in violation of the CD nighttime driving restriction. The filter fencing was repaired and the closure expanded. There was no observed damage to the actual nest.

## **US FISH AND WILDLIFE BIOLOGICAL OPINION (BO)**

In accordance with the BO received from USFWS August 14, 2006, Resource Management staff performed daily nest surveys on the ocean beach from May 1 to September 15. Daily nest checks were performed until the last nest was removed from the beach. This annual report fulfills the reporting requirements of the BO.

Performance measure targets for sea turtles consist of having a total of 10% of the statewide average number of nests for the previous five years and having a sea turtle false crawl to nest ratio of less than or equal to 1 : 1 annually. Re-initiation of consultation with USFWS is required if the total number of nests is fewer than 10% of the State’s total

annual nesting number and/or if the false crawl to nest ratio is greater than 1.3 : 1 annually. The first measure was met with 104 nests, making up 17.0% of the state's total. The second measure was met with a 0.97 : 1 false crawl to nest ratio.

## **LATE SEASON NEST EXPANSION EXEMPTION**

The last nest of the season, NH53, which was laid on October 7, required a change in protocols in order to manage. Since no nest laid beyond September 1 in the state of North Carolina has ever had any success, it was considered unlikely that the eggs would develop. Due to the high intensity of management that it would require to maintain this large ORV closure on a daily basis into the month of January, it was decided to request an exemption from the Interim Plan protocols from US Fish and Wildlife Service (see Appendix E). This exemption was requested on November 25, 2009 and granted on December 3. The new protocol required CAHA to continue to check the nest daily for signs of hatching, and for the expansion to be installed on day 80 of incubation. The nest would be excavated at day 90 or later if eggs were still viable. On December 8 the nest that was laid on CAHA on September 15 was excavated on day 84 of incubation (the nest had been expanded on day 55 of incubation). During the excavation it was found that none of the eggs showed any development. Therefore it was determined to be even more unlikely that the October 7 nest would have any success.

On December 16, (day 70 of incubation) during the daily nest check, it was noticed that there were roots invading the area of the nest cavity. When the roots were removed, it was found that all of the eggs were beginning to mold and were completely undeveloped. The nest was immediately excavated. None of the 119 eggs showed any development.

## **APPENDICES**

### **APPENDIX E: MAPS**

- Map 1: 2009 Turtle Management Districts
- Map 2: 2009 Bodie Island Sea Turtle Nests
- Map 3: 2009 Bodie Hatteras Sea Turtle Nests
- Map 4: 2009 North Hatteras Sea Turtle Nests
- Map 5: 2009 South Hatteras Sea Turtle Nests
- Map 6: 2009 Ocracoke Sea Turtle Nests
- Map 7: 2009 Bodie Island Sea Turtle False Crawls
- Map 8: 2009 Bodie Hatteras Sea Turtle False Crawls
- Map 9: 2009 North Hatteras Sea Turtle False Crawls
- Map 10: 2009 South Hatteras Sea Turtle False Crawls
- Map 11: 2009 Ocracoke Sea Turtle False Crawls

**LITERATURE CITED**

National Marine Fisheries Service and Fish and Wildlife Services. 2009 Recovery Plan for U.S. Population of Loggerhead Turtle. National Marine Fisheries Service, Washington D.C.