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KEMP'S RIDLEY (*LEPIDOCHELYS KEMPI*) NESTING IN FLORIDA

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ABSTRACT: *Kemp's ridley is one of the world's most endangered vertebrates. The primary nesting site of the species is Rancho Nuevo, Tamaulipas, Mexico; secondary nesting beaches are located near Rancho Nuevo. Isolated nesting has occurred at various other locations within the Gulf of Mexico, and more recently on the eastern coast of the United States. We report the first confirmed nesting of a Kemp's ridley on the eastern coast of Florida (two nests in Volusia Co.) and an additional nesting on Florida's west coast (Lee Co.). Genetic analysis showed that hatchlings from one of the Volusia Co. nests were pure* L. kempi *and not hybrids. Including the nests reported here, five* L. kempi *nests, involving three individual turtles, have been confirmed on Florida's beaches thus far. There is no evidence that these individuals were part of the Kemp's ridley headstart program, although that possibility cannot be excluded.*

THE Kemp's ridley, *Lepidochelys kempi* (Garman), has experienced a precipitous population decline over the past 50 years. In 1947 an estimated 40,000 females came ashore at the primary nesting site, Rancho Nuevo, Tamaulipas, Mexico, during a mass nesting event, known as an "arribada" (Carr, 1963; Hildebrand, 1963). When a conservation and monitoring program was initiated in 1966, only an estimated 2,000 females arrived at Rancho Nuevo (Márquez, 1994). The population continued to decline during the next decade but now appears to be increasing (Márquez, 1994; Márquez et al., 1996; TEWG, 1998). Egg harvest and occasional harvest of subadults and adults were blamed for the initial decline, and mortality after 1966 was primarily due to shrimp trawlers. The recent increase has been attributed to binational protection of nesting adults and clutches in Tamaulipas, a head-starting program, and implementation of turtle excluder devices (TEDs) in the U.S. shrimp trawl fleet (Hildebrand, 1963, 1995; Ross et al., 1989; Na-

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tional Research Council, 1990; Márquez, 1994; Pritchard, 1997a; TEWG, 1998).

The vast majority of Kemp's ridley nesting activity occurs at a single beach, Rancho Nuevo, located in the western Gulf of Mexico in the state of Tamaulipas, Mexico. Additional nesting beaches are known in this state, including Barra del Toro to the south of Rancho Nuevo, Barra de Ostionales to the north, and the beach at Tecolutla in the state of Veracruz (Ross et al., 1989; Márquez, 1994; Márquez et al., 1996).

Isolated nesting by Kemp's ridleys has been documented at other locations in the western Gulf of Mexico, mostly on Mexican beaches (Ross et al., 1989; Márquez, 1994); however, a few nests have been documented in the United States. In the U.S., nesting individuals have been observed on beaches in Texas (Shaver and Caillouet, 1998), North Carolina and South Carolina (Anonymous, 1992; Palmatier, 1993; Bowen et al., 1994), and on the west coast of Florida (Meylan et al., 1990a, b; 1995).

We report the first confirmed observation of a Kemp's ridley nesting on the east coast of Florida, document an additional nesting of the species on Florida's west coast, and review previous records of *L. kempi* nesting in Florida. We also provide data on success of nests deposited during the 1996 season. Because there is potential for hybridization between Kemp's ridley females and loggerhead (*Caretta caretta*) males (Karl et al., 1995), particularly in the nearshore waters of east Florida during the summer, we conducted genetic analyses to determine paternity of a few hatchlings; we present the results of these analyses for one east-coast nest. Production of hybrid progeny by Kemp's ridleys that nest in Florida has important implications for the potential of colony establishment. We conclude by speculating on the origin of the Florida Kemp's ridleys.

METHODS—Nesting turtles were initially encountered by members of the public and reported to turtle patrol organizations responsible for monitoring sea turtle nesting activity in 1996. Due to threat of tidal inundation and erosion, one nest was relocated within 4 hours of deposition to a safer site a few kilometers from the original nest site. A few weeks prior to hatchling emergence this nest was covered with a self-releasing wire cage to prevent predation. The other two nests were left *in situ*. The precise location of each clutch was marked, and nest sites were monitored for signs of disturbance and hatchling emergence. After hatchlings emerged, the contents of each nest were examined to determine success of the nest. Nesting females were photographed and voucher specimens (dead hatchlings) were collected from each nest and deposited at the Florida Museum of Natural History, University of Florida (specimen nos. 105524–105539 and 105566–105570, see Table 1).

Hatchlings from the Ponce Inlet nest (n = 30) were examined to determine if they exhibited any hybrid characteristics. Straight-line carapace length (SLCL, nuchal notch to tip of shell) and width (SLCW) were measured to the nearest 0.1 mm with a vernier caliper, and weight was determined to the nearest 0.1 g with a digital balance. The number of costal and inframarginal scutes was counted on the left side of each turtle, and coloration of carapace and plastron was noted.

Hatchlings from the Ponce Inlet nest (n = 4) were examined with molecular genetic markers to test for hybrid characteristics. We isolated whole genomic DNA from muscle samples of dead hatchlings. Isolations were conducted using standard phenol/chloroform method-

TABLE 1. Voucher specimens and photos in the Florida Museum of Natural History collection, University of Florida, from the three Kemp's ridley nests documented in Florida in 1996.

Nesting date	County	UF catalog #s	Description
10-May-96	Lee	105566–105569	Four dead hatchlings.
10-May-96	Lee	105570	18 color photographs of the adult female taken by residents Martin and Mille Allen.
14-May-96	Volusia	105528–105538	Five dead hatchlings and six dead fetuses from the Ponce Inlet nest.
1-Jun-96	Volusia	105524–105527	Two dead hatchlings, one pipped dead turtle, and one dead fetus from the New Smyrna Beach nest.
1-Jun-96	Volusia	105539	Three color photographs of the adult female taken by Marye Marshall.

ology (Hillis et al., 1996). Because the nesting female exhibited morphological features of *L. kempi,* we assumed that she was not a hybrid. We conducted polymerase chain reactions using primers pdCM-12R and pdCM-12L of Karl and co-workers (1992). These primers amplify an anonymous single-copy locus within the nuclear genome. Four nonhybrid specimens of the following species were amplified for comparison to the potential hybrid hatchlings: loggerhead turtle (*Caretta caretta*), green turtle (*Chelonia mydas*), hawksbill turtle (*Eretmochelys imbricata*), and Kemp's ridley (*L. kempi*). The CM-12 locus was used because digestion with the restriction enzyme *Rsa* I generates species specific banding patterns. These fragment-digestion profiles distinguish loggerhead from Kemp's ridley and green turtle or hawksbill from Kemp's ridley (for more details see Karl et al., 1995). The amplified locus was digested with *Rsa* I according to the manufacturer's instructions (Life Technologies). Resulting fragment digestion profiles were visualized in a 2% agarose gel stained with ethidium bromide.

RESULTS—*Nesting activity*—On 14 May 1996, at ca. 1400 h EST, a Kemp's ridley came ashore and nested on the beach at the town of Ponce Inlet, Volusia Co., FL. The turtle nested at the northern edge of a maintained vehicular access ramp (Old Timers approach). After the female completed the nesting process, she was measured with forester's tree calipers, examined for tags and tag scars, and photographed. No evidence of metal tags, tag scars, or living tags (see Fontaine et al., 1993) was observed, and we did not tag her. She had a SLCL of 63.8 cm and a SLCW of 61.5 cm. Initially the clutch was left in place; however, when the site was checked four hours later, it was in imminent danger of tidal inundation, and erosion of the site was deemed likely. For these reasons the clutch of 108 eggs was relocated to a safer site a few kilometers south of the initial location.

On 1 June 1996, at ca. 0800 h EST, the same female nested at New Smyrna Beach, Volusia Co., behind the residence at 1007 Hill Street. This site is approximately 7 km south of the first nest location. Photographs of this animal were compared to photos taken during the 14 May nesting. Although no significant carapace damage was seen, a few cosmetic flaws (neck-skin pigmentation and small pits in the carapace, Fig. 1a) allowed

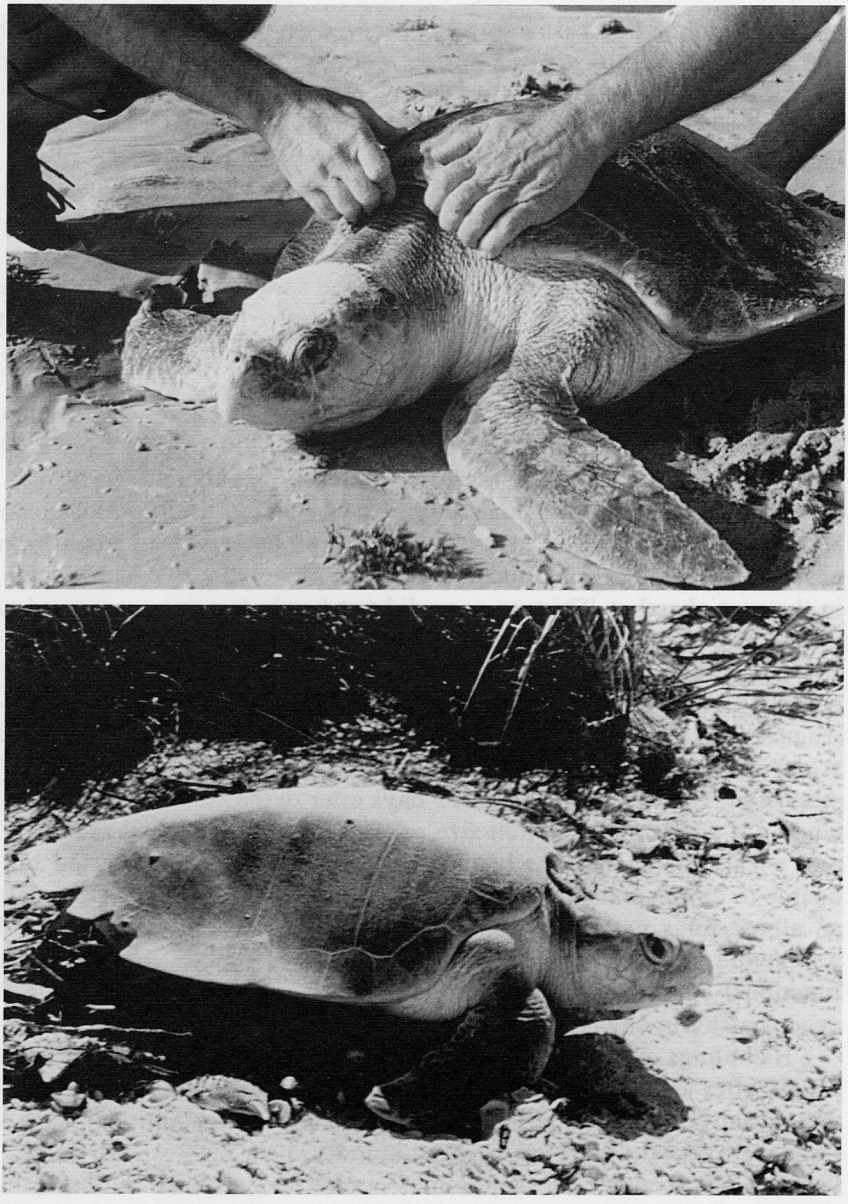

FIG. 1. Kemp's ridleys that nested in Florida in 1996. a. Post-nesting female, Volusia Co., 1 June 1996. b. Post-nesting female, Lee, Co., 10 May 1996.

positive identification as the same turtle in both instances. Both emergences occurred during the day and during periods of strong onshore winds and rough surf. Daytime nesting during high winds and rough surf is typical for the species (Márquez, 1994).

A Kemp's ridley nest also was observed on the west coast of Florida in 1996. This nesting took place during midmorning (specific time not recorded) on Sanibel Island, Lee Co. The clutch was deposited behind the residence at 3735 West Gulf Drive on 10 May 1996. Biologists with the Florida Department of Environmental Protection compared photographs of the Sanibel turtle with photos of the two other Kemp's ridleys that nested in the state during previous years (see below). Because of a distinctive area of damage to the carapace visible in photos of the Sanibel turtle (Fig. 1b), state biologists concluded that this turtle was the same individual that nested in 1994 at Clearwater Beach (Foley, 1997a) approximately 200 km north of Sanibel Island.

Success of nests in 1996—Hatchlings emerged from the Ponce Inlet nest on the evening of 17 July between 2100 and 2200 h EST after a 64-day incubation period. Thirty of these were closely examined (see below). The success of the nest was evaluated three days later. Of the 108 relocated eggs, 85 hatched (hatching success = 78.7%) and 80 hatchlings emerged from the nest (hatchling emergence success = 74.1%); the other five were found dead in the nest chamber. Thirteen eggs did not hatch; ten eggs contained turtles that pipped the shell but were unable to extricate themselves from the egg.

The New Smyrna Beach nest never showed any sign of hatchling emergence. A single Kemp's ridley hatchling was found washed ashore on 9 August near the nest. Another hatchling was found dead on the sand surface at the nest on 10 August, apparently depredated by ghost crabs (*Ocypode quadrata*). On 14 August 1996, 75 days after oviposition, the nest was evaluated. Of an estimated clutch size of 94 eggs, eight hatched (hatching success = 8.5%), 85 did not hatch, and one turtle pipped the shell but was unable to extricate itself from the egg. One of the unhatched eggs contained an albino fetus with deformities to the head and shell. One live hatchling was found with severe deformities to the head (microcephaly and lacked functional eyes) but was released in the surf. Three hatchlings were found dead (hatchling emergence success = 4.3%).

Hatchlings emerged from the Sanibel Island nest on 30 June at ca. 0645 h EST after a 51-day incubation period. The next day three dead hatchlings were discovered on the beach near the nest site. Two additional dead hatchlings were found the following morning, also near the nest. On 3 July 1998 the nest was evaluated to determine success of the clutch. Of an estimated 136 eggs deposited, 126 hatched (hatching success = 92.6%), nine did not hatch, and one turtle pipped the shell but was unable to extricate itself from the egg. The turtle that pipped the shell was still alive and it was released with a live hatchling that was also found in the nest (hatchling emergence success = 91.9%).

Photographs of the adults and voucher specimens (dead hatchlings and fetuses) were placed in the Florida Museum of Natural History. Information regarding the specimens and photos can be found in Table 1.

Hatchling phenotypes and genetic analysis—The east coast of Florida annually hosts one of the world's largest nesting aggregations of the loggerhead turtle (Meylan et al., 1995). Because of the presumed large number of male loggerheads in the nearshore waters, it is possible that the Kemp's ridley that nested on the east coast could have been inseminated by a loggerhead. Hybridization between these two species is known to occur. Karl and co-workers (1995) reported a juvenile sea turtle from Chesapeake Bay, which "appeared to be the F_1 product of a cross involving a Kemp's ridley female and a loggerhead male." Therefore, we had reason to suspect that hatchlings from Florida nests could include *Lepidochelys* X *Caretta* hybrids.

Suspected marine turtle hybrids are often initially identified by phenotype, usually exhibiting "intermediate features in otherwise diagnostic morphological characters" (Karl et al., 1995). With this in mind, we examined thirty of the hatchlings from the Ponce Inlet nest. All hatchlings examined were a uniform charcoal gray color, characteristic of Kemp's ridley hatchlings (Pritchard, 1979), rather than the brownish-red color characteristic of *Caretta* hatchlings from the east coast of Florida (S. A. Johnson, personal observation). All but one of the hatchlings had four inframarginal scutes (one had three) rather than the three inframarginals found in the loggerhead (Pritchard, 1979). Thus, all examined hatchlings appeared to be pure *L. kempi.*

Hatchlings ranged in SLCL from 39.7 to 44.5 mm (mean = 43.1 mm) and from 34.6 to 37.4 mm in SLCW (mean = 36.2 mm). The mean mass was 16.4 g with a range from 14.0 to 17.7 g. These measurements are similar to those reported for Kemp's ridley hatchlings (National Research Council, 1990; Ernst et al., 1994).

The molecular evidence further supported our supposition that the hatchlings were not hybrids. Fragment digestion profiles (Fig. 2) were generated for four of the offspring from the Ponce Inlet nest. The profiles indicated that the father of these hatchlings was not a loggerhead, green, or hawksbill turtle. The offspring profiles exactly matched that of known Kemp's ridleys. Therefore, we conclude that the father of the four offspring was a Kemp's ridley. Based on the phenotype of the hatchlings examined in the Ponce Inlet nest, as well as the few from the New Smyrna Beach nest, we assume that all hatchlings observed were pure *L. kempi.*

DISCUSSION AND CONCLUSIONS—The first documented nesting activity of *L. kempi* in Florida occurred on 30 May 1989 on Florida's west coast at Madeira Beach, Pinellas Co. (Meylan et al., 1990b). Another Kemp's ridley nested in Pinellas Co. at Clearwater Beach on 8 June 1994 (Harman, 1998). There is no published record of the 1994 event in the scientific literature, but it is referred to in the Spring/Summer edition of the *Velador,* the newsletter of the Caribbean Conservation Corporation, Gainesville, FL. Therefore, the Sanibel Island nest we report here is the third confirmed nest for the species on the west coast of Florida.

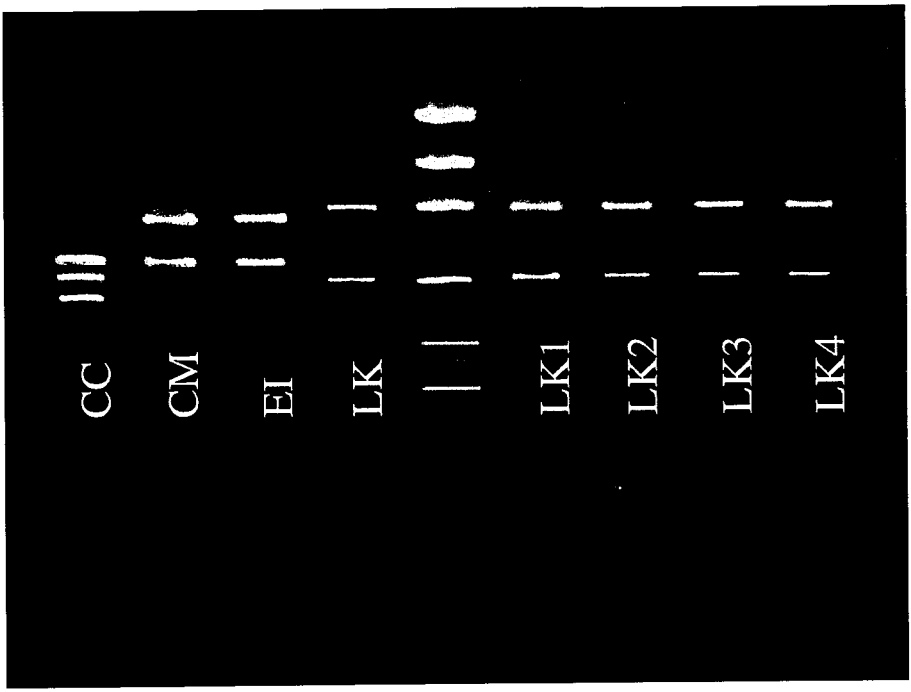

FIG. 2. Nuclear DNA restriction fragment profiles (CM-12 locus cut with *Rsa* I) for known specimens of *Caretta caretta* (CC), *Chelonia mydas* (CM), *Eretmochelys imbricata* (EI), *Lepidochelys kempi* (LK), and four hatchlings from the Ponce Inlet nest. A molecular weight standard is in the middle lane. Profiles for the four hatchlings (LK1—LK4) match the profile for the known Kemp's ridley (LK).

The two nests in Volusia Co. are the first confirmed nesting records for *L. kempi* on Florida's east coast, although one individual had earlier attempted to nest on the east coast in south Florida. On May 22, 23, 30, and 31, 1989, what was thought to be the same animal came ashore in Palm Beach Co. but did not lay eggs (Meylan et al., 1990b).

As of the end of the 1998 sea turtle nesting season, five *L. kempi* nests have been confirmed on Florida's beaches (Table 2). Three nests were observed along the west coast and two on the east coast (Fig. 3). Comparison of photographs taken during each nesting event suggest that no more than three individuals were responsible for the five nests. All nesting activity occurred during daylight, which is typical for the species, and on beaches with high levels of human activity. No evidence of tags or tag scars was observed on any of the nesting females.

Where are these females coming from? Data from molecular studies of marine turtle DNA are consistent with the idea that most female sea turtles return to their natal beach to nest (Bowen and Avise, 1996). However, this is probably not the case with the Kemp's ridleys that nested in Florida.

TABLE 2. Summary of confirmed Kemp's ridley nests in Florida through 1998 (also see Fig. 3).

Date of nesting	County	Scientific literature references to the nesting event	Comments
30-May-89	Pinellas	Ross et al., 1989; Meylan et al., 1990a, b, 1995; Bowen et al., 1994; Marquez, 1994	First confirmed nest of the species in Florida.
8-Jun-94	Pinellas	This paper	Nest referred to in the 1994 Spring/Summer issue of *Velador*.
10-May-96	Lee	This paper	Nest by same turtle that nested in Pinellas Co. in 1994.
14-May-96	Volusia	This paper	First confirmed nest of the species on Florida's east coast. Referred to in two popular articles by Pritchard (1996, 1997b).
1-Jun-96	Volusia	This paper	Nest by same turtle that nested in Volusia Co. on 14-May-96. Referred to in two popular articles by Pritchard (1996, 1997b).

Considering the conspicuous daytime nesting behavior of the species, we feel it unlikely that Kemp's ridley nesting events have gone unnoticed in Florida in the past and that these females are the progeny from such nests. The late Archie Carr spent nearly two decades searching for nesting grounds of the Kemp's ridley, and he found no evidence that individuals of this species nested in Florida (Carr, 1984). Nevertheless, we cannot rule out the

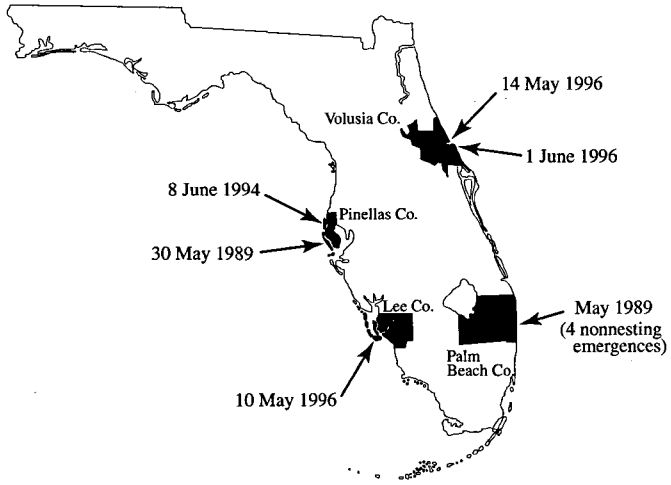

FIG. 3. Locations of all known Kemp's ridley nests and nesting attempts in Florida through 1998.

possibility that some scattered nesting historically occurred in the state. Females may have gone unnoticed or may have been misidentified as loggerheads. However, the recent appearances by Kemp's ridleys on Florida's beaches probably represent a novel event.

Another possible explanation is that these females are individuals from the Kemp's ridley headstart program (see Bowen et al., 1994). Bowen and co-workers (1994) have argued that timing of the nesting events in Florida and elsewhere along the Atlantic coast corresponds to the maturation time expected for head-started Kemp's ridleys. Indeed, a few females confirmed as head-started individuals recently nested in Texas (Shaver and Caillouet, 1998). Nevertheless, none of the Florida turtles showed any evidence of tags or scars to indicate they were products of the headstart program. On the other hand, the Kemp's ridley that nested in North Carolina in 1992 "bore a scar on the right foreleg where a tag may once have been attached" (Palmatier, 1993). Although the Florida Kemp's ridleys, as well as the females that nested in the Carolinas, could be head-started individuals, we suggest that these individuals could be colonists from the wild population (but see Bowen et al., 1994).

When they are considered over geologic time, sea turtle nesting rookeries are ephemeral (Bowen et al., 1992; Bowen and Avise, 1996). Therefore, occasional "breakdown" of natal homing behavior must occur for new colonies to be established. The Kemp's ridleys that nested in Florida may be the first "natural" (rather than head-started turtles) colonists of a future nesting rookery. There is no doubt that the number of *L. kempi* nesting at Rancho Nuevo is increasing (TEWG, 1998). Colony expansion into areas well outside the species' accepted range might be a concomitant characteristic associated with population recovery. Evidence for such a phenomenon might be the increase in nesting in southern Texas. Although head-started turtles are contributing to the increase, most individuals (10 of 16) examined for tags showed no indication of being part of the headstart program (Shaver and Caillouet, 1998). Further evidence suggesting concomitant range expansion with sea turtle population recovery can be found in the population of green turtles (*Chelonia mydas*) that nests in Florida. Although the historical size of the Florida assemblage is unclear (Carr and Ingle, 1959; Dodd, 1981; it is presumed to have been much larger historically), there has been an overall trend of increase in numbers of nests during the past two decades (Meylan et al., 1995; Foley, 1997b). During this period green turtles have been documented nesting in areas where they were not previously known to nest (Litwin, 1981; Foley, 1997b). Unfortunately, the mere absence of tags and tag scars on the Florida ridleys is not a robust test of the turtles' origins. Thus, there is no way to determine if the Florida ridleys are head-started individuals or natural colonists.

Although the nesting events in Florida and the Carolinas are unprecedented (at least in the scientific community), the possibility exists that a new Kemp's ridley colony may be in the early stages of establishment. Colony

establishment is not likely to occur in the near future because the chance of a single female hatchling surviving to maturity is very low. However, additional colonists (wild or head-started individuals) could hasten the growth of such a colony. Despite the uncertain source of females, if Kemp's ridleys begin to regularly nest on Florida's beaches, natural resource managers may have to consider additional conservation measures to ensure that nesting females, nests, and hatchlings are protected from potentially detrimental beach activities.

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