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NOTES AND FIELD REPORTS

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Head-Started Kemp's Ridley Turtle (*Lepidochelys kempii*) Nest Recorded in Florida: Possible Implications

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Abstract. – **A head-started Kemp's ridley sea turtle (*Lepidochelys kempii*) was documented nesting on South Walton Beach, Florida on 25 May 2015. This record supports the possibility that exposure to Florida waters after being held in captivity through 1–3 yrs of age during the head-starting process may have influenced future nest site selection of this and perhaps other Kemp's ridley turtles. Such findings could have important ramifications for marine water experimentation and release site selection for turtles that have been reared in captivity.**

The Kemp's ridley (*Lepidochelys kempii*) is the world's most endangered sea turtle species. Ninety-seven percent of Kemp's ridley nesting occurs on the Gulf of Mexico (GOM) coast of Tamaulipas, Mexico (National Marine Fisheries Service [NMFS] and US Fish and Wildlife Service [US FWS] 2015), with the majority in the 30.2-km Rancho Nuevo (RN) area (Fig. 1). In the late 1970s, in response to an alarming decline in the population, a binational project was initiated to help recover the species by establishing a second viable nesting population at Padre Island National Seashore (PAIS) in South Texas, USA through translocation of eggs from RN and head-starting (i.e., rearing in captivity for several months) of resulting hatchlings at the NMFS Laboratory in Galveston, Texas (Shaver and Caillouet 1998; Shaver 2005; Caillouet et al. 2015). In addition to these Padre Island imprinted head-starts, hatchlings collected at RN and intended to someday return to RN to reproduce were also head-started (RN imprinted head-starts) (Fontaine and Shaver 2005; Shaver and Wibbels 2007).

Up to 4 types of external and internal tags were used to mark the nearly 24,000 head-started turtles before release (Fontaine et al. 1993; Caillouet et al. 1995, 1997; Fontaine and Shaver 2005). All turtles received external Inconel™ metal tags that were typically placed on the trailing edge of the right fore-flipper. Sixty-five percent of the turtles received living tags, where a small, light-colored piece of plastron tissue was grafted into the darker carapace on different scutes to designate different year-classes (Hendrickson and Hendrickson 1981; Caillouet et al. 1986; Fontaine et al. 1988). In addition, many head-started turtles were marked with internal coded wire tags and Destron Fearing™ passive integrated transponder (PIT) tags that were implanted into their flippers.

Most head-started turtles were released into the GOM off Texas but some were released elsewhere, including off the Gulf Coast of Florida (Caillouet 1995; Caillouet et al. 1995; Fontaine and Shaver 2005; Shaver and Wibbels 2007). However, prior to ultimate release, many of the head-started Kemp's ridleys were used in Turtle Excluder Device (TED) certification tests conducted in Panama City, Florida (Fontaine et al. 1991; Jenkins 2012; Gearhart et al. 2015). These tests included approximately 100 turtles per year between 1988 and 1993, which represented individuals from the 1986 through 1991 year-classes. Turtles involved in these trials were held in outdoor pens for conditioning and acclimation for about 4 wk prior to conducting the trials. During the trials, turtles were released into GOM waters and observed and timed as they passed through the nets. Turtles were captured and returned to the containment pens at the end of each day, but a few escaped to the wild during this process. When testing was completed, they were transported back to the NMFS Laboratory in Galveston in preparation for release into the western Gulf or, in a few instances, some were released on-site near Panama City.

The documented historic nesting range of Kemp's ridley in the United States is South Texas. Since 1989, one of the first years that head-started Kemp's ridleys could have been mature, Kemp's ridley nesting has been documented in low numbers in the United States beyond that range (Shaver and Caillouet 2015). A predominance of the nests found in North Texas have been linked to head-started turtles and it thus appears that nesting by head-started turtles contributed to the expansion of the Kemp's ridley nesting range to North Texas. However, through 2014 it was unknown whether any of the individuals that nested in other North American states were head-started as hatchlings. Thus, information about the nesting distribution of head-started turtles outside the historic nesting range remains a gap in our understanding of the impacts of the binational management project on Kemp's ridley recovery. Understanding the impacts of head-starting and release on the nesting behavior of Kemp's ridleys could provide critical insights to help guide management of sea turtles reared in captivity for experimentation and husbandry in the future.

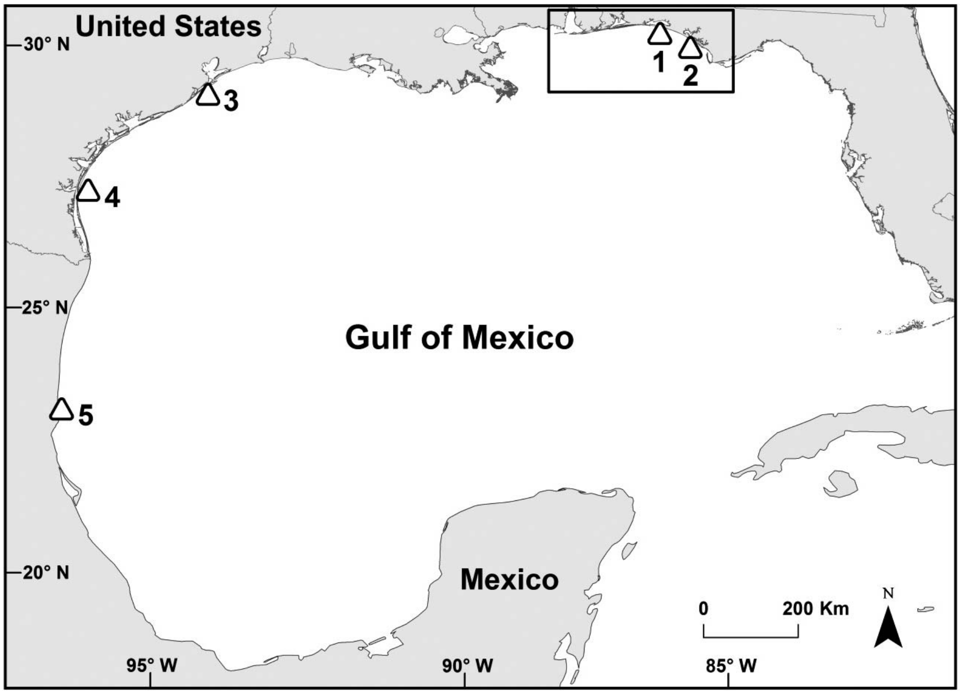

Figure 1. Locations referenced for head-started Kemp's ridley turtles (*Lepidochelys kempii*) including (1) South Walton Beach, Florida, (2) Panama City, Florida, (3) Galveston, Texas, (4) Padre Island National Seashore, Texas, and (5) Rancho Nuevo, Tamaulipas. The rectangle in the upper right encloses the area from Alabama eastward through Franklin County, Florida.

This study documents the first confirmation of a head-started Kemp's ridley nesting in the wild outside of Texas and Mexico, discusses possible implications, and suggests follow-up investigation of Kemp's ridley nesting.

Methods. — At approximately 0900 hrs on 25 May 2015, K.D. observed a female Kemp's ridley turtle as she emerged onto the beach, crawled towards the dunes, laid eggs, covered the nest, and returned to the GOM at South Walton Beach, Walton County, Florida (GPS 30.353536, –86.256745). K.D. documented this observation with several photographs and videos. This turtle was also observed by a South Walton Turtle Watch Group (SWTWG) volunteer while it was returning to the water. We examined the photographs and videos collected by K.D. for the presence of a living tag on the carapace, external tags on the flippers, and tag scars on the fore-flippers of the nesting turtle (Fig. 2). We compared these images to those on file at PAIS for head-started turtles that had been documented nesting in Texas (Fig. S1; see all supplementary material online at http://dx.doi.org/10.2744/CCB-1192.1.s.1).

Volunteers with the SWTWG located and marked the nest for in situ incubation and monitored it daily throughout incubation. Two days after hatchling emergence, the nest was excavated and evacuated eggshells and unhatched eggs were enumerated.

Results. — We identified a living tag on the fourth right costal scute (RC4) of the carapace in multiple photos and videos where the right side of the turtle was visible as she ascended the beach and began to nest (Fig. 2A). It was more difficult to clearly see the trailing edge of the right fore-flipper in the images, but it appeared that there was a large tag scar on the right fore-flipper (Fig. 2B). The living tag location indicates that this was an RN-imprinted head-started turtle from the 1989 or 1999 year-class; turtles from both of these year-classes were marked with living tags on RC4. With a minimum age of 10 yrs at first nesting recorded for a head-started turtle in the wild (Shaver 2005), and an estimated mean age to maturity of 12 yrs for Kemp's ridley (Zug et al. 1997; NMFS et al. 2011), turtles from both the 1989 and 1999 year-classes could have been mature and nesting during 2015.

Hatchlings emerged from the nest sometime between the late hours of 25 July 2015 and the early hours of 26 July 2015 (day 62 of incubation). When excavated on 28 July 2015, the nest contained 85 eggshells from which hatchlings had emerged, 5 unhatched eggs, and no trapped live or dead hatchlings. Emergence and hatching success were both 94.4%.

Discussion. — The known nesting range for Kemp's ridleys in the United States has expanded since 1989, and renewed consideration to the possible role of head-starting in this expansion may be warranted. Most nesters observed in North Texas (outside the documented historic nesting range) between 2002 and 2014 were head-started (Shaver and Caillouet 2015). Bowen et al. (1994) hypothesized that the first Kemp's ridleys recorded nesting in the United States outside their documented historic nesting range, in Florida and the Carolinas, were head-started. Although none of the nesters in the United States outside of Texas were conclusively identified as Padre Island or RN imprinted head-starts, few were thoroughly examined for tags by biologists either directly or through photographs

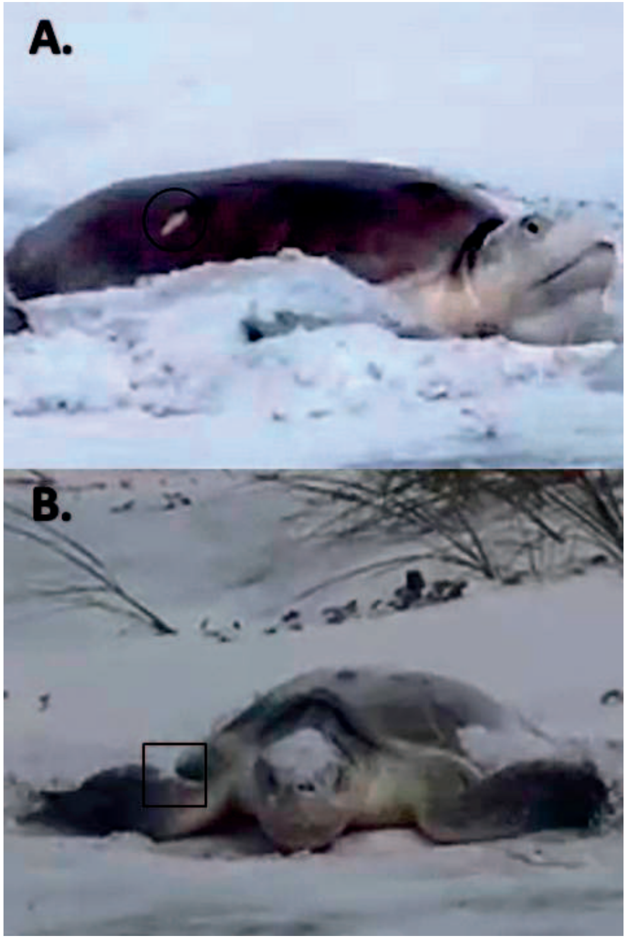

Figure 2. Head-started Kemp's ridley turtle (*Lepidochelys kempii*) that nested on South Walton Beach, Florida on 25 May 2015. Note location of a living tag on right costal scute 4, outlined in a circle (A), and a tag scar on the right fore-flipper, outlined in a square (B). Photographs by Ted Dillinger. (Color version is available online.)

provided by citizens (Meylan et al. 1990b, 1990c; Palmatier 1993; Bowen et al. 1994; Johnson et al. 1999; Foote and Mueller 2002; Hegna et al. 2006; Williams et al. 2006). Note that metal tags applied to head-starts as yearlings are typically missing at nesting; living tags were not applied to head-starts from the earliest year classes and, even if present, living tags can be difficult to see due to sand or algae on the carapace (Shaver and Caillouet 2015) (Fig. S2).

The head-started Kemp's ridley that nested on South Walton Beach in 2015 was approximately 50 km northwest of Panama City, where hundreds of head-started turtles were subjects in TED testing trials. Based on living tag location, this turtle was from either the 1989 or 1999 year-class. Although about 100 turtles from the 1989 year-class were involved in TED testing, without a PIT or metal tag it is impossible to know if this turtle was one of them. Sixty of the 118 (50.8%) Kemp's ridley nests recorded in the United States outside of Texas between 1989 and 2014 were also in the vicinity of Panama City (from Alabama eastward through Franklin County, Florida) (Fig. 1). The location of this head-start nest and concentration of Kemp's ridley nests in the vicinity of the TED testing site suggest a possible linkage between head-starting and nesting in this region.

We hypothesize that the TED testing location in Panama City, Florida could influence Kemp's ridley nest distribution. Nesting by head-started Kemp's near their imprinting or release locations has been documented in Texas (Shaver and Caillouet 2015). Releases provided head-started turtles with their first exposure to Gulf waters outside of captivity, as did TED testing acclimation and trials in Panama City. This first experience at sea, after 1–3 yrs in captivity, could have affected future nest site selection. Natal homing is important in nesting beach selection for sea turtles (Meylan et al. 1990a; Bowen et al. 1992, 1998; Bowen and Karl 2007) and may occur through imprinting (Owens et al. 1982) and orientation and navigation in relation to the earth's magnetic field (Lohmann et al. 2001, 2008, 2012, 2013; Putman and Lohmann 2008) or influences of surface circulation (Putman et al. 2010, 2013). Sea turtles developing in the egg, entering the surf for the first time, and swimming away from the nesting beach (or any combination) may imprint on the inclination angle or total intensity of the magnetic field and use this information to return to their natal beach to reproduce years later (Fuxjager et al. 2011, 2014; Brothers and Lohmann 2015). Experiences drifting as hatchlings in ocean currents may also directly influence adult sea turtle migrations (Scott et al. 2014). However, because head-started turtles were not allowed to swim away from their imprinting sites as hatchlings, magnetic imprinting and natal homing could have been disrupted for some (Bowen et al. 1994; Zug et al. 1997), and they may have used these or other cues to return to their rearing, TED testing, or release locations.

It is possible that the head-start nest documented from South Walton Beach was an isolated record and instead reflects a natural range expansion. Such a range expansion might be expected, as the Kemp's ridley nesting population increased after the mid-1980s, with the nesting in northeastern GOM being an increasing number of outliers. Near-shore waters of northeastern GOM are used by many migrating and foraging Kemp's ridleys that nest in Texas and Mexico (Shaver and Rubio 2008; Shaver et al. 2013, 2016), and some individuals may have begun to nest in the vicinity of these foraging sites, thereby reducing the energetic burdens of long-distance migration (Alerstam et al. 2003). However, Bowen et al. (1994) stated that only 1 or 2 colonization events occur per generation and, therefore, colonization could not explain the number of new nesting records during only a few years.

It may never be known whether Kemp's ridleys that nested in the United States outside of Texas in the past were head-started individuals. However, in the future, examining all Kemp's ridley nesters for the 4 types of tags that were used to mark head-started individuals would help document the expansion of head-start nesters. If more head-started nesters are observed and their year-class identified, critical information on the effects of head-starting and a better understanding of site fidelity in Kemp's ridleys could be gained. More research is needed to investigate the hypothesis that release or experimentation sites for captive-reared turtles may influence their future nest site selection. Such findings could have important ramifications for marine water experimentation and release site selection for turtles that have been reared in captivity. Sea turtles are no longer head-started in the United States, but hatchlings are reared in captivity in the United States and in other countries for experimentation and fisheries by-catch reduction device certification tests. These individuals are typically released when those experiments or tests are completed. In the United States, release sites are currently selected based on the presence of similar life stages and sizes for that species. However, if release or experimentation sites influence future nest site selection, and release or experimentation sites are distant from nesting beaches for the species or subpopulation, this could place turtles into nesting habitats that are not conducive to survival and thus reduce their contribution to species recovery. Such actions could have important conservation implications and warrant re-evaluation of this strategy for release of captive-reared sea turtles in the future (Hazard et al. 2015; Nagy et al. 2015).

Head-starting of Kemp's ridleys was an extreme management action taken in response to an extreme need (near extinction of the species). Besides the management results, head-starting also served as a unique experiment in nest-site fidelity of hatchling turtles. However, these data are lost without documentation of these head-started hatchlings as nesting adults. Initiation of examination and tagging efforts for nesting Kemp's ridleys would provide this information. Monitoring is particularly important in Alabama and the panhandle of Florida, which includes locations where the head-start nest, nest concentration, and TED testing occurred. There are challenges to this, however; magnetometers required to detect coded wire tags are expensive (currently $3750 USD), and Kemp's ridleys nest mostly during the day rather than at night when all other sea turtle species nest and are being monitored. One possible way to address these challenges is to expand the long-term nest monitoring programs already being conducted on high-density loggerhead nesting beaches within this region (Lamont et al. 2012, 2014; Lamont et al. 2014; Lamont and Houser 2014). In addition, sea turtle groups that conduct morning nest patrol efforts in the southeast United States could be trained to identify living tags, and citizen science could be used to gather information from beach-goers who opportunistically observe and photograph Kemp's nesting in the daytime.

Collection of tissue samples from Kemp's ridley nesters that are observed, and dead embryos from nests of unknown maternity, would allow for analysis of the relationship among nesting Kemp's. Kinship analysis involving mitochondrial DNA sequencing combined with nuclear DNA analysis could be used to match genotypes for nesters and offspring for unassigned nests, as is being done for Kemp's ridleys in Texas (Frey et al. 2014). Additionally, results from collected samples could be compared to those obtained from Texas (since 2002) to examine for possible lineage relationships to wild and head-started Kemp's ridleys.

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LITERATURE CITED

ALERSTAM, T., HEDENSTROM, A., AND AKESSON, S. 2003. Long-distance migration: evolution and determinants. Oikos 103: 247–260.

BOWEN, B.W., CLARK, A.M., ABREU-GROBOIS, F.A., CHAVES, A., REICHART, H.A., AND FERL, R.J. 1998. Global phylogeography of the ridley sea turtles (*Lepidochelys spp.*) as inferred from mitrochondrial DNA sequences. Genetica 101:179–189.

BOWEN, B.W., CONANT, T.A., AND HOPKINS-MURPHY, S.R. 1994. Where are they now? The Kemp's Ridley Head-start Project. Conservation Biology 8:853–856.

BOWEN, B.W. AND KARL, S.A. 2007. Population genetics and phylogeography of sea turtles. Molecular Ecology 16:4886–4907.

BOWEN, B.W., MEYLAN, A.B., ROSS, J.P., LIMPUS, C.J., BALAZS, G.H., AND AVISE, J.C. 1992. Global population structure and natural history of the green turtle (*Chelonia mydas*) in terms of matriarchal phylogeny. Evolution 46:865–881.

BROTHERS, J.R. AND LOHMANN, K.J. 2015. Evidence for geomagnetic imprinting and magnetic navigation in the natal homing of sea turtles. Current Biology 25:392–396. http://dx.doi.org/10.1016/j.cub.2014.12.035.

Caillouet, C.W., Jr. 1995. Egg and hatchling take for Kemp's Ridley Headstart Experiment. Marine Turtle Newsletter 68: 13–15.

Caillouet, C.W., Jr., Fontaine, C.T., Manzella, S.A., Williams, T.D., and Revera, D.B. 1986. Scutes reserved for living tags. Marine Turtle Newsletter 36:5–6.

Caillouet, C.W., Jr., Fontaine, C.T., Manzella-Tirpak, S.A., and Shaver, D.J. 1995. Survival of head-started Kemp's ridley sea turtles (*Lepidochelys kempii*) released into the Gulf of Mexico or adjacent bays. Chelonian Conservation and Biology 1:285–292.

Caillouet, C.W, Jr., Robertson, B.A., Fontaine, C.T., Williams, T.D., Higgins, B.M., and Revera, D.B. 1997. Distinguishing captive-reared from wild Kemp's ridleys. Marine Turtle Newsletter 77:1–6.

Caillouet, C.W., Jr., Shaver, D.J., and Landry, A.M., Jr. 2015. Kemp's ridley sea turtle (*Lepidochelys kempii*) head-start and reintroduction to Padre Island National Seashore, Texas. Herpetological Conservation and Biology 10(Symp):309–377.

Fontaine, C.T., Revera, D.B., Williams, T.D., and Caillouet, C.W., Jr. 1993. Detection, verification and decoding of tags and marks in head-started Kemp's ridley sea turtles, *Lepidochelys kempii*. NOAA Tech. Memor. NMFS-SEFC-334. Miami, FL: National Marine Fisheries Service, 40 pp.

Fontaine, C.T. and Shaver, D.J. 2005. Head-starting the Kemp's ridley sea turtle, *Lepidochelys kempii*, at the NMFS Galveston Laboratory, 1978–1992: a review. Chelonian Conservation and Biology 4:838–845.

Fontaine, C.T., Williams, J.A., and Caillouet, C.W., Jr. 1991. General information about sea turtle research at the NMFS Galveston Laboratory. NOAA Tech. Memor. NMFS-SEFC-259. Galveston, TX: National Marine Fisheries Service, 9 pp.

Fontaine, C.T., Williams, T.D., and Caillouet, C.W., Jr. 1988. Scutes reserved for living tags; an update. Marine Turtle Newsletter 43:8–9.

Foote, J.J. and Mueller, T.L. 2002. Two Kemp's ridley (*Lepidochelys kempii*) nests on the Gulf coast of Sarasota County, Florida, USA. In: Mosier, A., Foley, A., and Brost, B. (Comps.). Proceedings of the 20th Annual Symposium Sea Turtle Biology and Conservation, NOAA Tech. Memor. NMFS-SEFSC-477. Miami, FL: National Marine Fisheries Service, pp. 252–253.

Frey, A., Dutton, P.H., Shaver, D.J., Shelby Walker, J., and Rubio, C. 2014. Kemp's ridley (*Lepidochelys kempii*) nesting abundance in Texas, USA: a novel approach using genetics to improve population census. Endangered Species Research 23: 63–71.

Fuxjager, M.J., Davidoff, K.R., Mangiamele, L.A., and Lohmann, K.J. 2014. The geomagnetic environment in which sea turtle eggs incubate affects subsequent magnetic navigation behaviour of hatchlings. Proceedings of the Royal Society B 281:20141218. http://dx.doi.org/10.1098/rspb.2014.1218.

Fuxjager, M.J., Eastwood, B.S., and Lohmann, K.J. 2011. Orientation of hatchling loggerhead sea turtles to regional magnetic fields along a transoceanic migratory pathway. The Journal of Experimental Biology 214:2504–2508. http://doi:10.1242/jeb.055921.

Gearhart, J., Hataway, D., Hopkins, N., and Foster, D. 2015. 2012 turtle excluder device testing and gear evaluations. NOAA Tech. Memor. NMFS-SEFSC-674. Pascagoula, MS: National Marine Fisheries Service, 29 pp.

Hazard, L.C., Morafka, D.J., and Hillard, S. 2015. Post-release dispersal and predation of head-started juvenile desert tortoises (*Gopherus agassizii*): effect of release site distance on homing behavior. Herpetological Conservation and Biology 10(Symp):504–515.

Hegna, R.H., Warren, M.J., Carter, C.J., and Stiner, J.C. 2006. *Lepidochelys kempii* (Kemp's ridley sea turtle). Herpetological Review 37:492.

Hendrickson, L.P. and Hendrickson, J.R. 1981. A new method for marking sea turtles. Marine Turtle Newsletter 19:6–7.

Jenkins, L.D. 2012. Reducing sea turtle bycatch in trawl nets: a history of NMFS turtle excluder device (TED) research. Marine Fisheries Review 74:26–44.

Johnson, S.A., Bass, A.L., Libert, B., Marshall, M., and Fulk, D. 1999. Kemp's ridley (*Lepidochelys kempii*) nesting in Florida. Florida Scientist 62:194–204.

Lamont, M.M., Carthy, R.R., and Fujisaki, I. 2012. Declining reproductive parameters highlight conservation needs of loggerhead turtles (*Caretta caretta*) in the northern Gulf of Mexico. Chelonian Conservation and Biology 11:190–196.

Lamont, M.M. and Fujisaki, I. 2014. Effects of ocean temperature on nesting phenology and fecundity of the loggerhead sea turtle (*Caretta caretta*). Journal of Herpetology 48:98–102.

Lamont, M.M. Fujisaki, I., and Carthy, R.R. 2014. Estimates of vital rates for a declining loggerhead turtle (*Caretta caretta*) subpopulation: implications for management. Marine Biology. doi:10.1007/s00227-014-2537-0.

Lamont, M.M. and Houser, C. 2014. Spatial distribution of loggerhead turtle (*Caretta caretta*) emergences along a highly dynamic beach in the northern Gulf of Mexico. Journal of Experimental Marine Biology and Ecology 453:98–107.

Lohmann, K.J., Cain, S.D., Dodge, S.A., and Lohmann, C.M.F. 2001. Regional magnetic fields as navigational markers for sea turtles. Science 294:363–366.

Lohmann, K.J., Lohmann, C.M.F., Brothers, J.R., and Putman, N.F. 2013. Natal homing and imprinting in sea turtles. In: Wyneken, J., Lohmann, K.J., and Musick, J.A. (Eds.). The Biology of Sea Turtles. Volume 3. Boca Raton, FL: CRC Press, pp. 59–77.

Lohmann, K.J., Putman, N.F., and Lohmann, C.M.F. 2008. Geomagnetic imprinting: a unifying hypothesis of long-distance natal homing in salmon and sea turtles. Proceedings of the National Academy of Sciences 105:19096–19101.

Lohmann, K.J., Putman, N.F., and Lohmann, C.M.F. 2012. The magnetic map of hatchling loggerhead sea turtles. Current Opinion in Neurobiology 22:336–342.

Meylan, A., Bowen, B.W., and Avise, J.C. 1990a. A genetic test of the natal homing versus the social facilitation models for green turtle migration. Science 248:724–727.

Meylan, A., Castaneda, P., Coogan, C., Lozon, T., and Fletemeyer, J. 1990b. First recorded nesting by Kemp's ridley in Florida, USA. Marine Turtle Newsletter 48:8–9.

Meylan, A., Castaneda, P., Coogan, C., Lozon, T., and Fletemeyer, J. 1990c. *Lepidochelys kempii* (Kemp's ridley sea turtle). Reproduction. Herpetological Review 21:19–20.

Nagy, K.A., Hillard, L.S., Tuma, M.W., and Morafka, D.J. 2015. Head-started desert tortoises (*Gopherus agassizii*): movements, survivorship and mortality causes following their release. Herpetological Conservation and Biology 10(1):203–215.

National Marine Fisheries Service (NMFS) and US Fish and Wildlife Service (US FWS). 2015. Kemp's ridley sea turtle (*Lepidochelys kempii*) 5-year review: summary and evaluation. Silver Spring, MD: National Marine Fisheries Service, 63 pp.

National Marine Fisheries Service (NMFS), US Fish and Wildlife Service (US FWS), and Secretaría de Medio

AMBIENTE Y RECURSOS NATURALES (SEMARNAT). 2011. Binational recovery plan for the Kemp's ridley sea turtle (*Lepidochelys kempii*). Second Revision. Silver Spring, MD: National Marine Fisheries Service, 156 pp. + appendices.

OWENS, D.W., GRASSMAN, M.A., AND HENDRICKSON, J.R. 1982. The imprinting hypothesis and sea turtle reproduction. Herpetologica 38:124–135.

PALMATIER, R. 1993. *Lepidochelys kempii* (Kemp's ridley), nesting. Herpetological Review 24:149–150.

PUTMAN, N.F. AND LOHMANN, K.J. 2008. Compatibility of magnetic imprinting and secular variation. Current Biology 18:R596–R597.

PUTMAN, N.F., MANSFIELD, K.L., HE, R., SHAVER, D.J., AND VERLEY, R. 2013. Predicting the distribution of oceanic-stage Kemp's ridley sea turtles. Biology Letters 9:1–5.

PUTMAN, N.F., SHAY, T.J., AND LOHMANN, K.J. 2010. Is the geographic distribution of nesting in Kemp's ridley turtle shaped by the migration needs of offspring? Integrative and Comparative Biology 50:305–314.

SCOTT, R., MARSH, R., AND HAYS, G.C. 2014. Ontogeny of long distance migration. Ecology 95:2840–2850.

SHAVER, D.J. 2005. Analysis of the Kemp's ridley imprinting and headstart project at Padre Island National Seashore, Texas, 1978–88, and subsequent Kemp's ridley nesting and stranding records on the Texas coast. Chelonian Conservation and Biology 4:846–859.

SHAVER, D.J. AND CAILLOUET, C.W., JR. 1998. More Kemp's ridley turtles return to south Texas to nest. Marine Turtle Newsletter 82:1–5.

SHAVER, D.J. AND CAILLOUET, C.W., JR. 2015. Reintroduction of Kemp's ridley (*Lepidochelys kempii*) sea turtle to Padre Island National Seashore, Texas and its connection to head-starting. Herpetological Conservation and Biology 10(Symp):378–435.

SHAVER, D.J., HART, K., FUJISAKI, I., RUBIO, C., SARTAIN, A.R., PEÑA, J., BURCHFIELD, P.M., GOMEZ GAMEZ, D., AND ORTIZ, J. 2013. Foraging area fidelity for Kemp's ridleys in the Gulf of Mexico. Ecology and Evolution 3:2002–2012.

SHAVER, D.J., HART, K., FUJISAKI, I., RUBIO, C., SARTAIN-IVERSON, A.R., PEÑA, J., GOMEZ GAMEZ, D., DE JESUS GONZALES DIAZ MIRON, R., BURCHFIELD, P.M., MARTINEZ, H.J., AND ORTIZ, J. 2016. Migratory corridors of adult female Kemp's ridley turtles in the Gulf of Mexico. Biological Conservation 194: 158–167.

SHAVER, D.J. AND RUBIO, C. 2008. Post-nesting movement of wild and head-started Kemp's ridley sea turtles (*Lepidochelys kempii*) in the Gulf of Mexico. Endangered Species Research 4:43–55.

SHAVER, D.J. AND WIBBELS, T. 2007. Head-starting the Kemp's ridley sea turtle. In: Plotkin, P.T. (Ed.). Biology and Conservation of Ridley Sea Turtles. Baltimore, MD: The Johns Hopkins University Press, pp. 297–323.

WILLIAMS, K.L., FRICK, M.G., AND PFALLER, J.B. 2006. First report of green, *Chelonia mydas*, and Kemp's ridley, *Lepidochelys kempii*, turtle nesting on Wassaw Island, Georgia, USA. Marine Turtle Newsletter 113:8.

ZUG, G.R., KALB, H.J., AND LUZAR, S.J. 1997. Age and growth in wild Kemp's ridley sea turtles *Lepidochelys kempii* from skeletochronological data. Biological Conservation 80:261–268.

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Tonic Immobility in Newly Emerged Sea Turtle Hatchlings

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ABSTRACT. – **The ability for animals to become temporarily immobile via external stimulus is known as tonic immobility (TI) and has been widely described among different taxa. However, TI is poorly documented in turtles. We demonstrate TI in newly emerged green turtle (*Chelonia mydas*) hatchlings in relation to potential practical applications and discuss the methodology of how to induce TI. On average, combining all clutches sampled, TI induced green turtle hatchlings to remain immobile for 25 ± 12 sec; thus, we argue that in this state of immobility, researchers and conservationist can safely obtain quantitative variables (e.g., animals' weight and morphological measurements without forceful stressing or harming the animal).**

Animals have a wide variety of defensive behaviors that are adaptive in certain situations. Thanatopsis or tonic immobility (TI) is a distinctive behavior defined as a temporary loss of muscle and/or neurological function (partial paralysis) in response to a threat. The human equivalent is known as "hypnosis", which dates back to the Old Testament (Ratner 1967). This phenomenon may last for a few seconds to over several hours (Gallup 1974). Although animals in a TI state seem to be unresponsive to external stimulus, evidence indicates some animals can continue to process information about the environments that surround them (Sigman and Prestrude 1981). Recent evidence suggests that TI is not associated with any suspension of consciousness (Marx et al. 2008). Indeed, Mauk et al. (1981) noted that the lizard *Anolis carolinensis* in TI can exhibit hyperalgesia (increased sensitivity to pain).

Tonic immobility has been observed in a variety of animals including fish (Tobler 2005, Wells et al. 2005), amphibians (Toledo et al. 2010), reptiles (Gehlbach 1970; Edson and Gallup 1972; Hennig et al. 1979; Santos et al. 2010) birds (Sargeant and Eberhardt 1975), and mammals (Fraser 1960; Francq 1969; Carli 1974), and TI in invertebrates also appears to be common (as reviewed in Coutinho et al. 2013). However, as far as we know, TI has not been documented in sea turtle hatchlings.