Gulf of Mexico Science

Volume 33
Number 2 *Number 2*

Article 7

2016

Long-Term Movements of an Adult Male Kemp's Ridley Sea Turtle (*Lepidochelys kempii*) in the Northwestern Gulf of Mexico

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DOI: 10.18785/goms.3302.07

Recommended Citation

Hughes, C. L. and A. M. Landry Jr. 2016. Long-Term Movements of an Adult Male Kemp's Ridley Sea Turtle (*Lepidochelys kempii*) in the Northwestern Gulf of Mexico. Gulf of Mexico Science 33 (2).
Retrieved from https://aquila.usm.edu/goms/vol33/iss2/7

SHORT PAPERS AND NOTES

Gulf of Mexico Science, 2016(2), pp. 206–213

LONG-TERM MOVEMENTS OF AN ADULT MALE KEMP'S RIDLEY SEA TURTLE (*LEPIDOCHELYS KEMPII*) IN THE NORTHWESTERN GULF OF MEXICO—Despite recent insights into the spatial ecology of juvenile (Morreale and Standora, 2005; Renaud and Williams, 2005; Mansfield, 2006; McClellan, 2009; Seney and Landry, 2011; Lyn et al., 2012) and postnesting female Kemp's ridleys (*Lepidochelys kempii*) (Seney and Landry, 2008, 2011; Shaver and Rubio, 2008; Shaver et al., 2013, 2016), the breeding, migratory, and foraging behaviors of adult male Kemp's ridleys remain largely unknown (Shaver et al., 2005).

The current paradigm suggests that adult male Kemp's ridleys primarily reside in neritic foraging habitats near nesting beaches year round and engage in courtship and mating activities in March, immediately before the April–July nesting season (Owens, 1980; Rostal et al., 1998; Rostal, 1991, 2005; Shaver et al., 2005). Field observations of mounted pairs near known nesting beaches have occurred between October and May in Mexico (Rancho Nuevo) and in early June in Texas [Padre Island National Seashore (PAIS)], although confirmation of copulation is lacking (Pritchard and Márquez, 1973; Shaver et al., 2005). This tendency for male Kemp's ridleys to establish year-round residency near nesting beaches is behaviorally disparate from seasonal migratory movements displayed by adult female conspecifics (Seney and Landry, 2008, 2011; Shaver and Rubio, 2008; Shaver et al., 2016; Hughes and Landry, unpubl. data) and males of other species (*Lepidochelys olivacea*: Beavers and Cassano, 1996; Plotkin et al., 1996; *Caretta caretta*: Arendt et al., 2012; Casale et al., 2013; *Chelonia mydas*: Limpus, 1993; Hays et al., 2001; *Dermochelys coriacea*: James et al., 2005).

Identification of spatially and temporally defined areas frequented by adult male Kemp's ridleys for breeding, migrating, or foraging is necessary to accomplish a Priority 1 Recovery Task in the Kemp's Ridley Recovery Plan mandating protection and management of important marine habitats (National Marine Fisheries Service, 2011). Implementation of marine protected areas and other conservation measures to facilitate protection of adult males utilizing critical habitats will require a comprehensive effort to better delineate habitat boundaries, assess localized sources of mortality, and, in foraging areas, to quantify and qualify prey resources and physical site characteristics. Information on adult male Kemp's ridley migratory behavior is currently limited to a single source describing the movements of 11 individuals incidentally captured from waters near Rancho Nuevo (Shaver et al., 2005). Our analysis herein of a single adult male Kemp's ridley's long-term movements in northwestern Gulf of Mexico (GOM) waters, which recently have been identified as critical foraging (Shaver et al., 2013) and migratory (Shaver et al., 2016) habitat for adult female conspecifics, is the longest time series of information to date for a male sea turtle. This study provides valuable insight into the behavior of an individual male Kemp's ridley and has implications for the management and conservation of the species.

Materials and methods.—We attached a satellite transmitter to an adult male Kemp's ridley (maximum straight carapace length: 66.3 cm, mass: 31.2 kg) and released him 23 July 2009 on Mustang Island, TX (27°46′51.8412″N, 97°5′39.48″W; Fig. 1) after a 95-d rehabilitation period at the University of Texas Marine Science Institute's Animal Rehabilitation Keep. The gender of the turtle was determined on the basis of external morphology (Pritchard and Márquez, 1973; Bentivegna, 2002; Hays et al., 2010). The transmitter, a 480-g Sirtrack KiwiSat 101 platform terminal transmitter (PTT) activated at 0900 hr Greenwich Mean Time (0400 hr Central Daylight Time) and set to operate with a duty cycle of 6 hr on:6 hr off, was attached to this turtle following protocol established by Seney and Landry (2008).

Geographic location data generated by the PTT were initially processed using protocol described by Arendt et al. (2012) for mature male loggerheads (*Caretta caretta*) with one exception: the speed filter was set to 5 km hr^{-1} to render it applicable to the Kemp's ridley (Renaud, 1995). This protocol resulted in 18 substitutions and permitted retention of 98.8% of the 1,064 original observation days.

We then used Esri's ArcGIS 9.3 to visualize retained coordinates. We manually omitted discernibly spurious geolocations consisting of

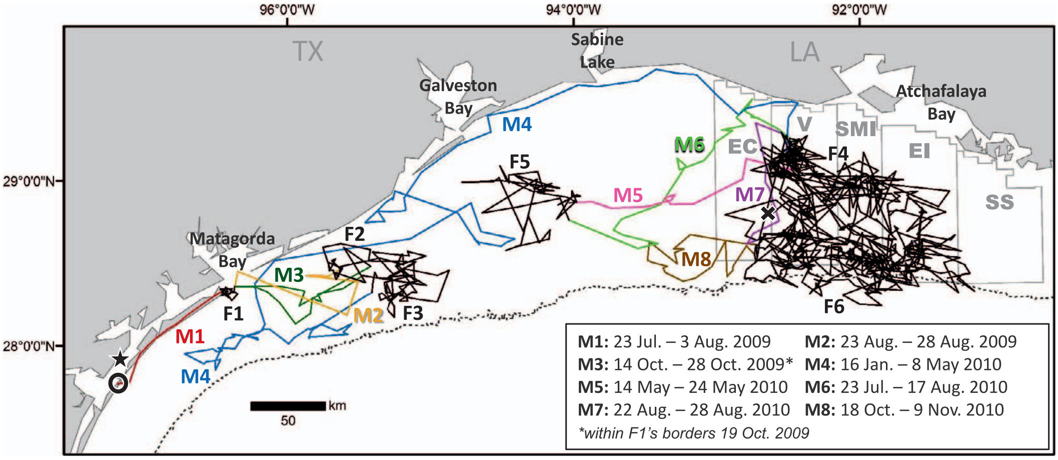

Fig. 1. Movements of an adult male Kemp's ridley sea turtle from 2009 to 2013. ★ denotes 19 April 2009 stranding location; ○ denotes 23 July 2009 release location; ✖ denotes 29 July 2013 final platform terminal transmitter (PTT) geolocation; colored lines denote migratory (M) movements; ▬ denotes foraging ground (F) movements; --- denotes 50-m isobath; ▬ denotes East Cameron (EC), Vermillion (V), South Marsh Island (SMI), Eugene Island (EI), and Ship Shoal (SS) BOEM boundary areas.

LC 0 (n = 5), LC A (n = 27), and LC B (n = 19). Geolocations retained for spatial analyses consisted of LC 3 (n = 33), LC 2 (n = 117), LC 1 (n = 209), LC 0 (n = 288), LC A (n = 200), and LC B (n = 153). We scrutinized directionality and displacement of plotted geolocations from the turtle's release site to deduce foraging vs migratory behaviors, similar to criteria used by Hawkes et al. (2011). Predominantly consecutive directional movements distinguished migratory phases (Griffin et al., 2013) from foraging behaviors, which were characterized by restricted, primarily nondirectional movements. We defined discrete foraging grounds on the basis of a minimum utilization period of 19 consecutive days (≥18 geolocations).

We used Home Range Tools (Rodgers et al., 2007) for ArcGIS to generate migratory routes to, and kernel density estimates (KDE; 50 and 90%) for, each foraging ground, with ≥44 daily locations (Millspaugh and Marzluff, 2001). Migratory phases were deemed terminated when the directional path traversed the previously established foraging zone boundary (Griffin et al., 2013). We calculated core activity areas (50% probability contour; Hooge et al., 1999) and utilization distributions (90% probability contour; Borger et al., 2006) for each foraging ground using the fixed least-squares cross-validation smoothing factor and rescaling to unit variance if the ratio of standard deviations exceeded 1.5.

We plotted official protraction diagram and leasing map boundaries, disseminated by the Bureau of Ocean Energy Management, in conjunction with retained geolocations to provide a relevant spatial reference for movements by an adult male Kemp's ridley in relation to the intense exploration, development, and extraction of profuse mineral resources in the GOM. Displayed boundary areas situated on the federal continental shelf may aid in coordinating sea turtle conservation efforts with GOM resource extraction interests.

Results.—The PTT transmitted location and sensor data for 1,468 d. All documented movement occurred within neritic northwestern GOM waters extending from Mustang Island, TX northeast to offshore (>10 km from the nearest shoreline) waters due south of Atchafalaya Bay, LA, within the southwestern Ship Shoal Area (Fig. 1). This turtle remained almost exclusively in waters less than 50 m in depth during both migratory and foraging phases. Migratory movements (denoted as "M") and foraging grounds (denoted as "F") described herein are followed by a numerical designation denoting sequence of occurrence (migration) or initial use (foraging ground).

Eight distinct migratory phases, ranging in duration from 6 to 113 d (mean = 26.5, SD ± 35.7), were made by the turtle in transitioning to or among foraging sites (Fig. 1). Directed movements were initiated in January (n = 1),

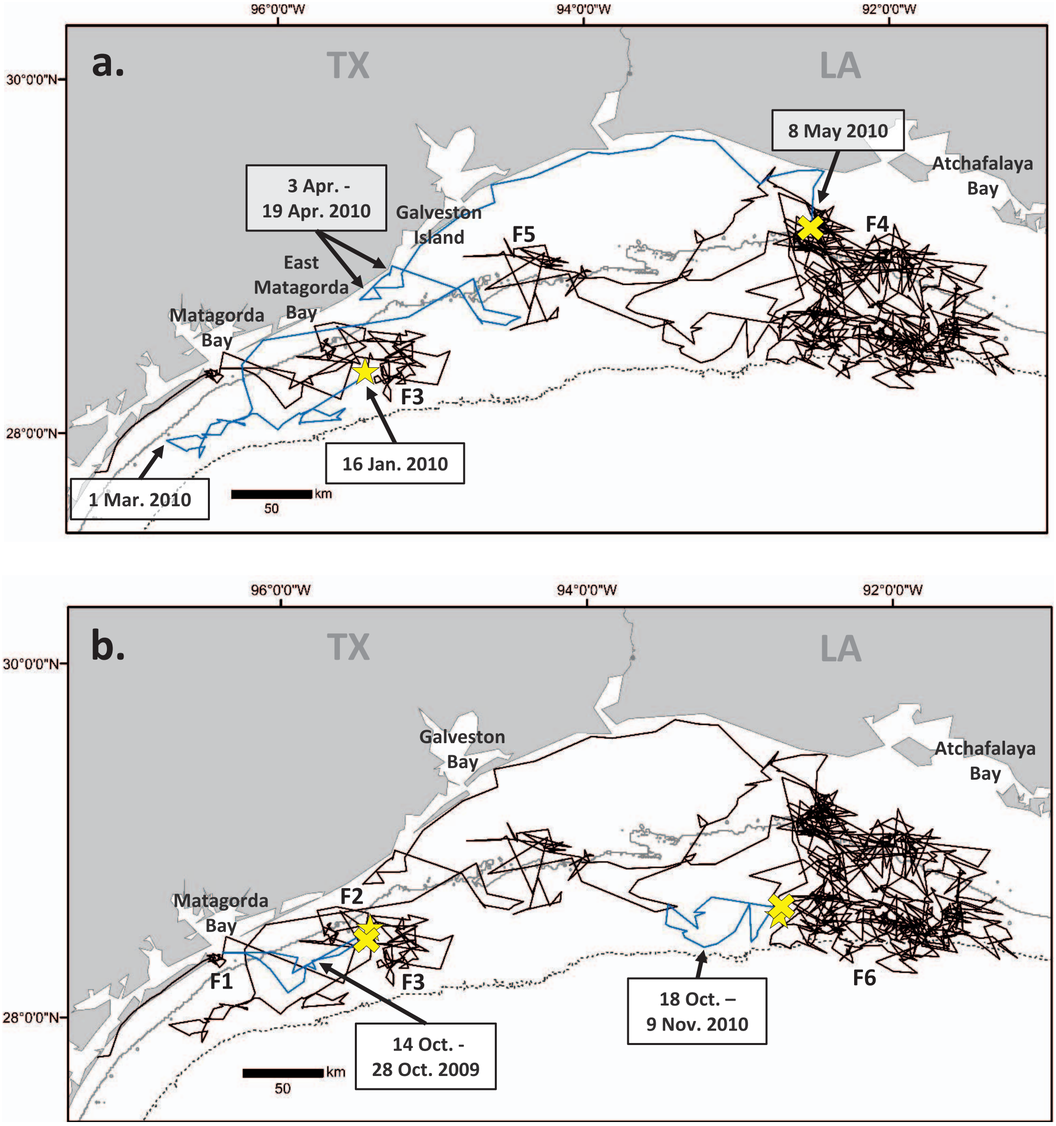

Fig. 2. Extended (a) and circuitous (b) migratory movements of an adult male Kemp's ridley sea turtle. ▬ denotes (a) extended migration 16 January–8 May 2010 and (b) circuits 14 October–28 October 2009 and 18 October–9 November 2010; ▬ denotes remainder of track 23 July 2009–29 July 2013; ☆ denotes migration start; ✖ denotes migration end; ▬ denotes 20-m isobath; --- denotes 50-m isobath.

May (n = 1), July (n = 2), August (n = 2), and October (n = 2) on routes situated a mean distance of 46.2 km from shore (SD ± 39.1, range = 0–136.0 km) in waters averaging 22.6 m in depth (SD ± 13.8, range = above sea level to 44.9 m) and 23.3°C sea surface temperature (SD ± 5.7, range = 14.1–31.6°C). Mean speed of movement, which ranged from 0 to 3.3 km hr^{-1}, was 0.5 km hr^{-1} (SD ± 0.5). Nearshore (≤10 km from the nearest shoreline) migrations were principally composed of sequential linear trajectories that paralleled the coastline (Fig. 1). However, offshore migrations, although consistently advancing and, thus, predominantly void of spatially restricted nondirectional movements indicative of foraging behavior, intermittently incorporated circuitous swimming patterns (Figs. 2a, b).

Six distinct foraging grounds were identified in nearshore or offshore waters ranging from the southern reaches of Matagorda Peninsula in Texas east to Louisiana's southwestern Ship

Table 1. Physical characteristics and use of foraging sites by an adult male Kemp's ridley sea turtle in the northwestern Gulf of Mexico from 2009 to 2013. KDE: kernel density estimate; 50%: core activity area; 90%: utilization distribution; SST: sea surface temperature.

			KDE			Site characterization		
Foraging site	Duration of foraging (d)	Mean swim speed (km hr^{-1})	No. accepted daily locations	50% (km^2)	90% (km^2)	Mean depth (m)	Mean distance from shore (km)	Mean SST (°C)
F1	20	0.2 (SD ± 0.2)	19	N/A[a]	N/A[a]	3.6 (SD ± 4.1)	2.4 (SD ± 2.7)	29.5 (SD ± 1.0)
F2	44	0.5 (SD ± 0.5)	35	354.5	1,147.9	23.3 (SD ± 5.7)	29.4 (SD ± 10.8)	28.8 (SD ± 0.9)
F3	77	0.4 (SD ± 0.3)	51	677.3	2,139.2	34.9 (SD ± 3.8)	54.2 (SD ± 9.1)	21.6 (SD ± 2.6)
F4	462	0.5 (SD ± 0.4)	328	1,702.9	6,087.0	22.6 (SD ± 8.4)	54.6 (SD ± 16.3)	25.9 (SD ± 4.1)
F5	58	0.6 (SD ± 0.4)	40	880.5	3,020.6	19.6 (SD ± 4.9)	61.1 (SD ± 17.4)	29.0 (SD ± 0.9)
F6	455	0.3 (SD ± 0.3)	355	1,348.4	4,195.6	41.7 (SD ± 7.3)	98.2 (SD ± 12.6)	22.5 (SD ± 3.7)
Mean	186	0.4	138	992.7	3,318.1	31.0	71.3	24.5
SD	211.9	0.4	158.2	536.3	1,912.1	12.6	28.7	4.3
Range	20 to 462	0 to 4.3	19 to 355	354.5 to 1,702.9	1,147.9 to 6,087.0	ASL[2b] to 66.3	0 to 128.0	15.9 to 31.7

[a] Excluded from calculations because of an insufficient number of geolocations.

[b] Filtering criteria permitted inclusion of depths ≤1.0 m above sea level (ASL).

Shoal Area (Fig. 1). Integrating foraging ground data (n = 828 geolocations) over the monitoring period permitted generation of a set of parameters characteristic of the physical environment utilized by this individual during nonmigratory phases, as well as calculation of core foraging activity areas and utilization distributions for five of the six foraging grounds (Table 1, Fig. 3). Residency intervals at discrete sites before directed movement between foraging locations ranged from 1 to 177 d (mean = 79.7 d, SD ± 63.3). However, comprehensive assessments regarding site utilization over the entire tracking period required pooling data pertaining to recurrent use of previously exploited foraging grounds (n = 3). Mean foraging site residency for pooled data was 186 d (SD ± 211.9, range = 20–462 d).

Discussion.—Insufficient sample size (n = 1) and the inability to identify short- and long-term repercussions associated with the stranding and rehabilitation of this turtle (i.e., postrelease fitness, habituation, etc.) limited our ability to draw conclusions on behaviors characteristic of adult male Kemp's ridleys. Nonetheless, this prolonged monitoring of a wild male that survived to maturity without previous human intervention (based on absence of tags or tag scars) contributes to our inadequate knowledge of adult male Kemp's ridley migratory behaviors and foraging ground locations, and provides insight into a possible breeding ground location.

The male's mean foraging ground core utilization area (50% KDE: 992.7 ± 536.3 km^2; Table 1, Fig. 3) fell within the range of means (660.8–1,389 km^2) identified for adult female conspecifics sourced from nesting beaches in both Texas and Mexico (Seney and Landry, 2011; Shaver et al., 2013; Hughes and Landry, unpubl. data). The majority of stated females also established foraging grounds within the U.S. GOM, particularly in Louisiana waters proximate to this male's F4 and F6 sites. Conversely, the turtle's mean foraging area size (i.e., 50% contour) was appreciably larger than that associated with seven males monitored by Shaver et al. (2005) that appeared to reside in the vicinity of Rancho Nuevo year round (mean home range: 95 km^2).

The reason for the turtle's long-term inhabitation (29 August 2010–29 July 2013) of foraging

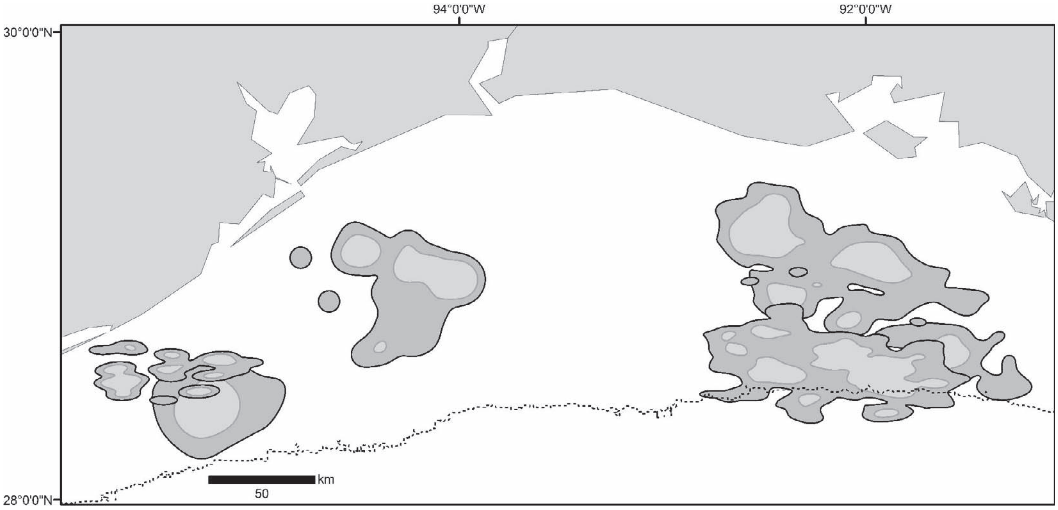

Fig. 3. Core foraging activity areas [50% kernel density estimate (KDE); light gray] and utilization distributions (90% KDE; dark gray) for foraging grounds (n = 5) utilized by an adult male Kemp's ridley sea turtle from 2009 to 2013. Geolocations associated with this individual's recurrent use of three discrete sites (F2, F4, F6) were coalesced to generate a single KDE; comprehensive site utilization durations ranged from 44 to 462 d. --- denotes 50-m isobath.

grounds offshore Louisiana is uncertain. The remigration interval for adult male Kemp's ridleys is unknown. However, studies suggest that male sea turtles of other species breed more frequently than female conspecifics (*Caretta caretta*: Hays et al., 2014; *Chelonia mydas*: Limpus, 1993), and female Kemp's ridleys are known to remigrate biennially (NMFS et al., 2011). Nonetheless, the turtle's prolonged foraging period is consistent with a similar extended residency period (>4 yr) in northwestern GOM waters documented for a wild Kemp's ridley satellite tagged after nesting at PAIS in 2011 (D. J. Shaver, pers. comm.). Research by Gallaway et al. (2016) indicates that mean female remigration intervals have steadily increased since 2008 to >3 yr for Texas' nesters, potentially due to a reduction in primary prey resources concurrent with an increased neritic-stage population utilizing northern GOM feeding grounds. Additionally, the long-term ramifications of the 20 April 2010 Deepwater Horizon oil spill on both sea turtles and prey resources within these important foraging grounds remain unclear. Exposure to environmental toxins and a reduction in prey availability both have the potential to negatively alter an individual's physiological status and, thus, ability to devote nutritional reserves to reproduction. Causative factors resulting in longer female breeding periodicity could negatively affect male remigration intervals as well.

Male Kemp's ridleys exhibit seasonal reproductive behaviors in confluence with the relatively precise seasonality displayed by nesting female conspecifics (Owens, 1980; Rostal et al., 1998; Rostal, 2005). Thus, movements spanning prenesting (March) and early nesting (April) periods during each of the 4 yr this male was tracked are of particular interest.

Eight months postrelease, the turtle traversed coastal waters between Matagorda Bay (mid-March) and Follets Island (early April) at a moderate rate of speed (0.5 ± 0.4 km hr^{-1}), then remained in nearshore waters just south of Galveston Island until 19 April (Fig. 2a). This nearshore environment has been identified as an internesting corridor annually frequented in May and June by female Kemp's ridleys after nesting on upper Texas coast (UTC) beaches (Seney and Landry, 2008, 2011; Hughes and Landry, unpubl. data).

We suggest that this turtle's movements within this internesting corridor during the breeding period were consistent with the behavior of a reproductively active male searching for suitable mates. On 20 April, just before the 24 April 2010 documented start of Kemp's ridley nesting in Texas (Shaver, 2011), the turtle initiated linearly directed movements along the 2-m depth contour at an increased rate of speed (0.8 ± 0.7 km hr^{-1}) to feeding grounds off Louisiana (Fig. 2a). This migration from Texas nearshore waters, and speculated breeding grounds, to a known Kemp's ridley foraging hot spot (Seney and Landry, 2008, 2011; Shaver et al., 2013) is temporally consistent with the estimated conclusion of the breeding period on the basis of studies of seasonal dynamics of reproductive hormones (Rostal, 2007) and studies that have shown that male sea turtles leave breeding grounds when females begin nesting (*Lepidochelys olivacea*: Plotkin et al., 1996; *Caretta caretta*: Hays et al., 2010; Arendt et al., 2012).

If nearshore waters adjacent to the UTC function as breeding grounds for the small number of Kemp's ridleys nesting annually on associated beaches, conjecture that is supported by movements of this turtle during March and April 2010, then serious consideration must be given to expansion of a Texas Parks and Wildlife Department (TPWD) regulation instituted in 2000 for protection of conspecifics nesting on lower Texas coast beaches (Lewison et al., 2003; Shaver and Rubio, 2008). The TPWD regulation currently prohibits shrimp trawling, a principal source of anthropogenic mortality for the Kemp's ridley (Moore et al., 2008; National Marine Fisheries Service, 2011), within 8 km of the shoreline along North Padre Island, South Padre Island, and Boca Chica Beach annually from 1 December through mid-May. Extension of the marine environment affected by this regulation northward to incorporate waters adjacent to the UTC would reduce the potential for fisheries-associated mortality of conspecifics annually congregating for reproductive purposes, thus consequentially supporting the potential proliferation of Kemp's ridleys at the northernmost extent of their known nesting range.

The ecological niche of adult male Kemp's ridley sea turtles is poorly understood. Additional long-term monitoring of male Kemp's ridleys associated with both highly productive and small-scale rookeries in Texas and Mexico is needed to fill significant gaps in our understanding of the ecological requirements of this critical population component during breeding, migratory, and foraging phases. Such data will permit development and implementation of inclusive conservation strategies in support of a Priority 1 Recovery Task in the Kemp's Ridley Recovery Plan that mandates the protection and management of important marine foraging and breeding habitats utilized by this species.

Acknowledgments.—This work is a result of a research program sponsored in part by the Texas Sea Grant College Program, supported by the National Oceanic and Atmospheric Administration Office, Department of Commerce, under grant #NA06OAR4170076. Additional funding was generously provided by the Texas General Land Office, SEATURTLE.ORG, and Help Endangered Animals-Ridley Turtles (HEART). Research herein was completed by CLH under the guidance of AML in partial fulfillment of an M.S. degree from Texas A&M University. The authors thank T. Amos for providing this ridley for research and T. Metz for managing PTT attachment. E. Seney contributed invaluable guidance in satellite telemetry research methodology; M. Arendt and D. Griffin provided counsel on telemetry data analysis. Research was permitted by the U.S. Fish and Wildlife Service (TE776123-1) and TPWD (Scientific Permit SPR-0590-094).

Literature Cited

Arendt, M. D., A. L. Segars, J. I. Byrd, J. Boynton, J. A. Schwenter, J. D. Whitaker, and L. Parker. 2012. Migration, distribution, and diving behavior of adult male loggerhead sea turtles (*Caretta caretta*) following dispersal from a major breeding aggregation in the western North Atlantic. Mar. Biol. 159(1):113–125.

Beavers, S. C., and E. R. Cassano. 1996. Movements and dive behavior of a male sea turtle (*Lepidochelys olivacea*) in the eastern tropical Pacific. J. Herpetol. 30(1):97–104.

Bentivegna, F. 2002. Intra-Mediterranean migrations of loggerhead sea turtles (*Caretta caretta*) monitored by satellite telemetry. Mar. Biol. 141(4):795–800.

Borger, L., N. Franconi, G. de Michele, A. Gantz, F. Meschi, A. Manica, S. Lovari, and T. Coulson. 2006. Effects of sampling regime on the mean and variance of home range size estimates. J. Anim. Ecol. 75(6):1393–1405.

Casale, P., D. Freggi, A. Ciná, and M. Rocco. 2013. Spatio-temporal distribution and migration of adult male loggerhead sea turtles (*Caretta caretta*) in the Mediterranean Sea: further evidence of the importance of neritic habitats off North Africa. Mar. Biol. 160(3):703–718.

Gallaway, B. J., W. J. Gazey, T. Wibbels, E. Bevan, D. J. Shaver, and J. George. 2016. Evaluation of the status of the Kemp's ridley sea turtle following the 2010 Deepwater Horizon Oil Spill. Gulf Mex. Sci.. 33:192–205.

Griffin, D. B., S. R. Murphy, M. G. Frick, A. C. Broderick, J. W. Coker, M. S. Coyne, M. G. Dodd, M. H. Godfrey, B. J. Godley, L. A. Hawkes, T. M. Murphy, K. L. Williams, and M. J. Witt. 2013. Foraging habitats and migration corridors utilized by a recovering subpopulation of adult female

DOI: 10.18785/goms.3302.07

loggerhead sea turtles: implications for conservation. Mar. Biol. 160(12):3071–3086.

Hawkes, L. A., M. J. Witt, A. C. Broderick, J. W. Coker, M. S. Coyne, M. Dodd, M. G. Frick, M. H. Godfrey, D. B. Griffin, S. R. Murphy, T. M. Murphy, K. L. Williams, and B. J. Godley. 2011. Home on the range: spatial ecology of loggerhead turtles in Atlantic waters of the USA. Divers. Distrib. 17(4):624–640.

Hays, G. C., A. C. Broderick, F. Glen, B. J. Godley, and W. J. Nichols. 2001. The movements and submergence behaviour of male green turtles at Ascension Island. Mar. Biol. 139:395–399.

———, S. Fossette, K. A. Katselidis, G. Schofield, and M. B. Gravenor. 2010. Breeding periodicity for male sea turtles, operational sex ratios, and implications in the face of climate change. Conserv. Biol. 24(6):1636–1643.

———, A. D. Mazaris, and G. Schofield. 2014. Different male vs. female breeding periodicity helps mitigate offspring sex ratio skews in sea turtles. Front. Mar. Sci. 1(43):1–9.

Hooge, P. N., W. M. Eichenlaub, and E. K. Solomon. 1999. Using GIS to analyze animal movements in the marine environment. U.S. Geological Survey, Glacier Bay Field Station, AK. Available at: www.absc.usgs.gov/glba/gistools/anim_mov_useme.pdf.

James, M. C., S. A. Eckert, and R. A. Myers. 2005. Migratory and reproductive movements of male leatherback turtles (*Dermochelys coriacea*). Mar. Biol. 147(4):845–853.

Lewison, R. L., L. B. Crowder, and D. J. Shaver. 2003. The impact of turtle excluder devices and fisheries closures on loggerhead and Kemp's ridley strandings in the western Gulf of Mexico. Conserv. Biol. 17(4):1089–1097.

Limpus, C. J. 1993. The green turtle, *Chelonia mydas*, in Queensland: breeding males in the southern Great Barrier Reef. Wildlife Res. 20(4):513–523.

Lyn, H., A. Coleman, M. Broadway, J. Klaus, S. Finerty, D. Shannon, and M. Solangi. 2012. Displacement and site fidelity of rehabilitated immature Kemp's ridley sea turtles (*Lepidochelys kempii*). Mar. Turtle Newsl. 135:10–13.

Mansfield, K. L. 2006. Sources of mortality, movements and behavior of sea turtles in Virginia. Ph.D. diss., The College of William and Mary, Williamsburg, VA.

McClellan, C. M. 2009. Behavior, ecology, and conservation of sea turtles in the North Atlantic Ocean. Ph.D. diss., Duke Univ., Durham, NC.

Millspaugh, J. J., and J. M. Marzluff (eds.). 2001. Radio tracking and animal populations. Academic Press, San Diego, CA.

Moore, J. E., B. P. Wallace, R. L. Lewison, R. Zydelis, T. M. Cox, and L. B. Crowder. 2008. A review of marine mammal, sea turtle and seabird bycatch in USA fisheries and the role of policy in shaping management. Mar. Policy 33(3):435–451.

Morreale, S. J., and E. A. Standora. 2005. Western North Atlantic waters: crucial developmental habitat for Kemp's ridley and loggerhead sea turtles. Chelonian Conserv. Biol. 4(4):872–882.

National Marine Fisheries Service (NMFS). 2011. U.S. national bycatch report. W. A. Karp, L. L. Desfosse, and S. G. Brooke (eds.). U.S. Department of Commerce, NOAA Tech. Mem. NMFS-F/SPO-117E Silver Spring, MD.

———, U.S. Fish and Wildlife Service, and Secretaria de Medio Ambiente y Recursos Naturales (NMFS, USFWS, and SEMARNAT). 2011. Binational recovery plan for the Kemp's ridley sea turtle (*Lepidochelys kempii*). 2d rev. National Marine Fisheries Service, Silver Spring, MD.

Owens, D. W. 1980. The comparative reproductive physiology of sea turtles. Am. Zool. 20(3):549–563.

Plotkin, P. T., D. W. Owens, R. A. Byles, and R. Patterson. 1996. Departure of male olive ridley turtles (*Lepidochelys olivacea*) from a nearshore breeding ground. Herpetologica 52(1):1–7.

Pritchard, P. C. H., and M. R. Márquez. 1973. Kemp's ridley turtle or Atlantic ridley, *Lepidochelys kempi*. Unwin Brothers Limited, Surrey, U.K.

Renaud, M. L. 1995. Movements and submergence patterns of Kemp's ridley turtles (*Lepidochelys kempii*). J. Herpetol. 29(3):370–374.

———, and J. A. Williams. 2005. Kemp's ridley sea turtle movements and migrations. Chelonian Conserv. Biol. 4:808–816.

Rodgers, A. R., A. P. Carr, H. L. Beyer, L. Smith, and J. G. Kie. 2007. HRT: Home Range Tools for ArcGIS. Version 1.1. Ontario Ministry of Natural Resources, Centre for Northern Forest Ecosystem Research, Thunder Bay, Ontario, Canada.

Rostal, D. C. 1991. The reproductive behavior and physiology of the Kemp's ridley sea turtle, *Lepidochelys kempi* (Garman 1880). Ph.D. diss., Texas A&M Univ., College Station, TX.

———. 2005. Seasonal reproductive biology of the Kemp's ridley sea turtle (*Lepidochelys kempii*): comparison of captive and wild populations. Chelonian Conserv. Biol. 4(4):788–800.

———. 2007. Reproductive physiology of the ridley sea turtle, p 151–165. *In:* Biology and conservation of ridley sea turtles. P. T. Plotkin (ed.). Johns Hopkins Univ. Press, Baltimore, MD.

———, D. W. Owens, J. S. Grumbles, D. S. Mackenzie, and M. S. Amoss Jr. 1998. Seasonal reproductive cycle of the Kemp's ridley sea turtle (*Lepidochelys kempi*). Gen. Comp. Endocrinol. 109(2):232–243.

Seney, E. E., and A. M. Landry Jr. 2008. Movements of Kemp's ridley sea turtles nesting on the upper Texas coast: implications for management. Endang. Species Res. 4:73–84.

———, and ———. 2011. Movement patterns of immature and adult female Kemp's ridley sea turtles in the northwestern Gulf of Mexico. Mar. Ecol. Prog. Ser. 440:241–254.

Shaver, D. J. 2011. Texas sea turtle nesting and stranding 2010 report. U.S. Department of the Interior, Corpus Christi, TX.

———, K. M. Hart, I. Fujisaki, C. Rubio, A. R. Sartain, J. Peña, P. M. Burchfield, D. G. Gamez, and J. Ortiz.

2013. Foraging area fidelity for Kemp's ridleys in the Gulf of Mexico. Ecol. Evol. 3(7):2002–2012.

———, ———, ———, ———, A. R. Sartain-Iverson, J. Peña, D. G. Gamez, R. D. J. G. D. Miron, P. M. Burchfield, H. J. Martinez, and J. Ortiz. 2016. Migratory corridors of adult female Kemp's ridley turtles in the Gulf of Mexico. Biol. Conserv. 194:158–167.

———, and C. Rubio. 2008. Post-nesting movement of wild and head-started Kemp's ridley sea turtles *Lepidochelys kempii* in the Gulf of Mexico. Endang. Species Res. 4:43–55.

———, B. A. Schroeder, R. A. Byles, P. M. Burchfield, J. Peña, R. Márquez, and H. J. Martinez. 2005. Movements and home ranges of adult male Kemp's ridley sea turtles (*Lepidochelys kempii)* in the Gulf of Mexico investigated by satellite telemetry. Chelonian Conserv. Biol. 4(4):817–827.

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DOI: 10.18785/goms.3302.07