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Population Characteristics of Kemp's Ridley Sea Turtles in Nearshore Waters of the Upper Texas and Louisiana Coasts

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Abstract. – Entanglement netting at beachfront, tidal pass, bay, and lagoon habitats along the upper Texas and Louisiana coasts was used to characterize spatial/temporal occurrence, relative abundance, size class composition, sex ratio, and growth rate of nearshore Kemp's ridley (*Lepidochelys kempii*) assemblages in the western Gulf during 1992–98. Nine study areas from Grand Isle, Louisiana, to South Padre Island, Texas, were netted at different frequencies and/or years, with capture operations scheduled for at least 1 week per month at one or more areas. Beachfront habitats near Calcasieu Pass, Louisiana, and Sabine Pass, Texas, received 73% of the netting effort and accounted for 97% of the 429 ridleys captured during the study. Headstarted ridleys comprised 6.8% (29 individuals) of these captures, and all were netted at beachfront habitats. Overall ridley catch per unit of effort (CPUE) among all years and study areas was 0.5 ridley/km-hr. CPUEs at beachfront versus bay/pass habitats were 0.6 and 0.1, respectively. Sabine and Calcasieu Pass beachfront habitats yielded overall CPUEs of 0.7 and 0.5, respectively, while bay/pass habitats produced CPUEs ranging from 0.0 to 0.2. Annual CPUEs at Sabine Pass, the only area netted each year of the study, ranged from 0.2 to 1.1. Ridleys dominated (92%) catches at upper coast study areas. Ridley occurrence at Sabine and Calcasieu Passes was generally limited to April through September, with May through August producing 92% of the sample. December through February failed to yield ridleys at any study area. Recapture rate for 415 ridleys tagged at Sabine and Calcasieu Passes was 2.9%, with the interval ranging from 22 to 364 days. Recaptured ridleys grew at a mean rate of 0.02 cm/day or 7.3 cm/year. Ridleys ranged from 19.5 to 65.8 cm SCL, with 77% < 40 cm SCL. Adults comprised 2.3% of all captures, none of which were mature males. Sex ratio of wild ridleys was 1.3F:1M. Nearshore, neritic Gulf waters along the upper Texas and Louisiana coasts provide developmental habitat to juvenile and subadult ridleys during late spring through summer when blue crab abundance and discarded shrimp fishery bycatch are highest.

Key Words. – Reptilia; Testudines; Cheloniidae; *Lepidochelys kempii*; sea turtle; nearshore habitat; in-water capture; population characteristics; sex ratio; growth; headstarting; Louisiana; Texas

The endangered Kemp's ridley (*Lepidochelys kempii*) was once the most abundant sea turtle species in the Gulf of Mexico (Márquez, 1994). One single-day estimate of 40,000 adult females on the Rancho Nuevo, Tamaulipas, Mexico nesting beach in 1947 (Hildebrand, 1963) plus anecdotal information from green turtle (*Chelonia mydas*) fisheries in Florida and Texas and turtle landings in Louisiana's shrimp fisheries support this claim (Caldwell and Carr, 1957; Doughty, 1984; Witzell, 1994). The ridley's decline took place in large part in the western Gulf, where intense exploitation of eggs and adult females at Rancho Nuevo prior to 1966 and incidental capture of post-pelagic life stages in the shrimp fishery reduced the estimated annual number of nesters to fewer than 350 females by 1985 (TEWG, 1998).

The Kemp's ridley recovery plan (USFWS and NMFS, 1992), Márquez' (1994) synopsis of biological data for this species, and recent stock assessments (TEWG, 1998) emphasize the paucity of information on which to develop more robust population models and management strategies for the Kemp's ridley. Although much is known about ridley nesting dynamics at Rancho Nuevo [see annual reports by Burchfield et al. (1988–1998) and Márquez and coworkers (1982–1989)], critical variables associated with at-sea life history stages are poorly understood, especially for ridleys in the western Gulf. Until recently, information on occurrence of post-pelagic through adult life stages in the western Gulf was gleaned from strandings and incidental captures (Rabalais and Rabalais, 1980; Heinly, 1990; Caillouet et al., 1991, 1996; Manzella and Williams, 1992; Shaver, 1995, 1996). Additional information on ridley natural history and feeding ecology in the western Gulf was provided by Smith and List (1950), Liner (1954), Dobie et al. (1961), Hildebrand (1982), Ogren (1989), Shaver (1991), Márquez (1994), Werner (1994), and Landry and Costa (1999). Renaud et al. (1995, 1996) provided information on movement of ridleys adjacent to tidal passes in the northern Gulf as well as reproductive migrations to Rancho Nuevo.

Unpublished survey reports from 1992 to 1998 by Landry and co-workers (see technical reports in 1992, 1993,

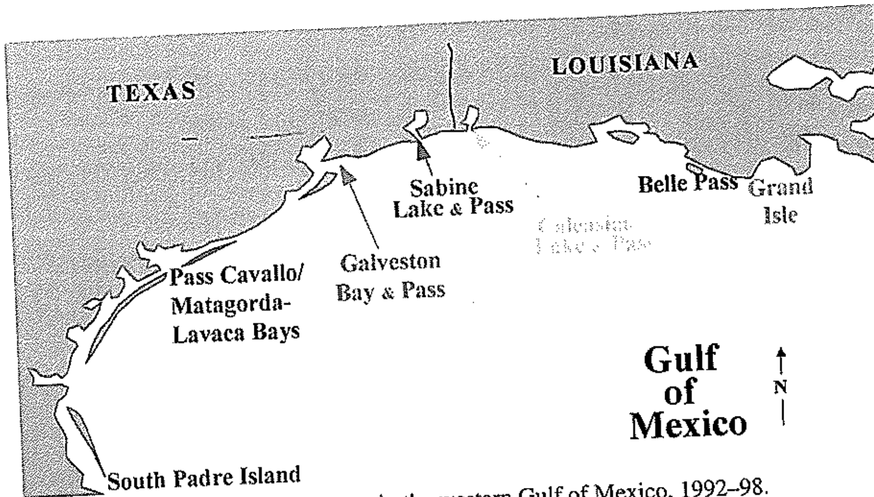

Figure 1. Kemp's ridley study areas in the western Gulf of Mexico, 1992–98.

1994, 1995, 1996) plus other research efforts (Landry and Costa, 1999) facilitated by these surveys are summarized herein to characterize spatial/temporal occurrence, relative abundance, size class composition, sex ratio, and growth rate of nearshore ridley stocks in the western Gulf.

METHODS

Study Areas. — Sea turtle capture operations were conducted at nine study areas between Grand Isle, Louisiana, and South Padre Island, Texas, from 1992–98 (Fig. 1). Study areas incorporated bay/lagoon and associated pass habitats as well as nearshore beachfront zones adjacent to jettied tidal passes between the Gulf and adjacent bays or estuaries (Table 1). Nearshore beachfront zones near jetties received the majority of capture efforts.

Beachfront study areas bordering Calcasieu Pass, Louisiana, and Sabine Pass, Texas, received 73% of the netting effort and accounted for 97% of Kemp's ridleys discussed herein (Table 2), so only they are described in detail. Other study areas, not described herein but whose survey data are presented, exhibited similar environmental characteristics to those of Calcasieu and Sabine Passes. Calcasieu Pass, a tidal outlet for the Calcasieu Lake estuary, begins immediately south of Cameron, Louisiana, and is the state's only deep-draft channel west of the Mississippi River. Sabine Pass, located 46 km west of Calcasieu Pass, extends gulfward from the Sabine Lake estuary to form the southernmost boundary between Texas and Louisiana. These passes are bordered by 5.6 km (Calcasieu Pass) to 9.6 km long jetties (Sabine Pass) that protect their 12 m deep channels. Netting operations were conducted immediately gulfward of these passes and adjacent to gently-sloping beachfront habitat with hard-sand bottoms and scattered patches of soft mud and clay. Strong current and tidal flow prevented entanglement netting in Calcasieu Pass and Sabine Pass proper.

Netting operations at seven other study areas were conducted at a variety of habitats located in bays/lagoons, within tidal passes (but outside of high current areas), and gulfward of jettied and non-jettied passes (Table 1). These study areas were considered characteristic of inshore and nearshore habitats along the coastal zone between the Mississippi River and Lower Laguna Madre System in Texas.

Sea Turtle Capture. — Kemp's ridleys were captured in 91.4 m long entanglement nets of different depths and mesh sizes (3.7 m deep with 12.7 cm bar mesh or 4.9 m deep with 25.4 cm bar mesh). Water depth among study areas ranged from 1.3 to 4 m, with this variable and current determining the net specifications required at each sampling site. Capture operations were scheduled for at least 1 week per month at one or more study areas, during which time a minimum of 3 netting days was achieved in each area. Each net day

Table 1. Total entanglement netting effort and Kemp's ridley capture statistics for western Gulf of Mexico study areas during 1992–98; CPUE = number of ridleys per km-hr.

Study Area	Habitat	Years Sampled	Netting Effort (km-hrs)	Ridleys Captured	Ridley CPUE
Grand Isle, LA	Beachfront	1995	33.88	1	0.03
Belle Passe, LA	Beachfront	1995	3.90	0	0.00
Calcasieu Lake, LA	Bay	1994	3.67	0	0.00
Calcasieu Pass, LA	Beachfront	1993-95, 1998	120.75	64	0.53
Sabine Lake, TX	Bay	1994	3.75	0	0.00
Sabine Pass, TX/LA	Beachfront	1992-98	493.33	351	0.71
Galveston Bay and Pass, TX	Bay/Pass	1993-94	52.75	5	0.09
Matagorda Bay System, TX	Bay/Pass	1996	45.45	7	0.15
South Padre Island, TX	Bay/Pass	1992-94	86.07	1	0.01
Total			843.50	429	0.51

Table 2. Monthly entanglement netting effort and Kemp's ridley capture statistics for western Gulf of Mexico study areas during 1992–98; CPUE = number of ridleys per km-hr.

Month	Netting Effort (km/h)	Ridleys Captured	Ridley CPUE
January	26.90	0	0.00
February	17.22	0	0.00
March	25.00	1	0.04
April	27.13	13	0.48
May	109.75	127	1.16
June	126.48	79	0.62
July	179.60	120	0.67
August	143.02	69	0.48
September	62.62	15	0.24
October	71.54	4	0.06
November	40.45	1	0.02
December	13.42	0	0.00
Total	843.50	429	0.51

consisted of at least a 6 hour placement of 1 to 4 nets per study area during daylight hours, with duration dependent upon sea state and weather conditions. Netting operations were conducted for at least 10 months/year during 1993–96, but were limited to March–September thereafter.

Entanglement nets were checked for sea turtles every 30–45 min or upon indications of turtle capture. Turtles were removed from nets and a blood sample immediately drawn (for sex determination via testosterone radioimmunoassay as described by Valverde [1996] using the technique of Owens and Ruiz [1980]). Ridleys were held in seawater at land-based facilities and monitored for 24 hours, after which they were measured (straight-line carapace length; SCL) to the nearest 0.1 cm and weighed to the nearest 0.01 kg. An inconel tag was applied to the trailing edge of each foreflipper and a passive integrated transponder (PIT) tag inserted into the dorsal surface of the right foreflipper. All ridleys were scanned for previously applied inconel and PIT tags prior to additional tag applications. Headstarted ridleys (Fontaine et al., 1993) and their respective year classes were identified by living tags and/or inconel tags. A laparoscopic inspection of gonads (Wood et al., 1983) was used to identify the sex of approximately 20% of all ridleys captured and to corroborate sex determined by testosterone radioimmunoassay. Ridleys were then released at their capture site.

RESULTS

Netting Effort. — Nearly 844 kilometer-hours (km-hr) of entanglement netting effort were expended toward the capture of Kemp's ridleys at 5 bay/pass and 4 beachfront study areas during 1992–98 (Table 1). Beachfront habitats adjacent to jettied passes accounted for 87.5% of this effort, with Sabine and Calcasieu Passes accounting for 58.5 and 14.3%, respectively. These two study areas received an average of 70.5 and 30.2 km-hr of netting per year, respectively, for years in which they were sampled. Sabine Pass, Calcasieu Pass, and South Padre Island were the only study areas sampled seasonally or year-around for three or more years. Within study years, the number of months in which one or more study areas was sampled ranged from 12 in 1993 to 5 in 1998. No fewer than 9 monthly netting efforts/year were expended among study areas during 1992–96. Combined monthly netting effort ranged from 13.4 km-hr in December to 179.6 km-hr in July (Table 2). Approximately 82% of the total netting effort occurred during May through October. Netting effort at a lower coast locale such as South Padre Island was typically year-around while that along the upper Texas and Louisiana coasts was limited to spring through early fall months when sea turtle abundance and prey availability were greatest (Landry and Costa, 1999).

Capture Statistics. — The 7-year study yielded 429 Kemp's ridleys captured among sampling areas, with all but 14 of these netted at beachfront habitats adjacent to Sabine and Calcasieu Passes (Table 1). Ridleys headstarted at the NMFS Galveston Laboratory and released into the Gulf after a year or less of captivity accounted for 29 (6.8%) of these captures. A total of 23,616 headstarted ridleys ranging between 24 and 54 SCL were released between 1978 and 1998 (Caillouet et al., 1997; Ben Higgins and Tim Fontaine, NMFS Galveston Laboratory, unpubl. data); see Caillouet et al. (1995) for information on release sites. All captures of headstarted ridleys occurred at Sabine and Calcasieu Pass study areas.

Annual ridley captures varied with netting effort and study area. Study areas yielding no ridleys – Belle Pass, Calcasieu Lake, and Sabine Lake - were sampled only during 1994 or 1995 and for less than 4 km-hr each. Conversely, South Padre Island received the third highest netting effort (86.1 km-hr) but yielded only 1 ridley. The low number of captures (8) in 1992 coincided with the lowest annual netting effort expended at Sabine Pass while 99 ridleys recorded a year later were caught at three study areas (Sabine Pass, Calcasieu Pass, and Galveston) and during peak annual netting effort.

Overall ridley catch per unit effort (CPUE) among years and study areas was 0.5 ridleys/km-hr (Table 1). CPUEs at beachfront versus bay/pass habitats were 0.6 and 0.1, respectively. Sabine and Calcasieu Pass beachfront stations yielded overall CPUEs of 0.7 and 0.5, respectively, while bay/pass counterparts produced CPUEs ranging from 0.0 to 0.2. Upper coast beachfront habitats at Sabine and Calcasieu Passes also were similar in their catch composition (ridleys: 93.4 to 95.5%; loggerheads [*Caretta caretta*]: 3.0 to 3.7%; greens: 1.5 to 2.4%; and hawksbills [*Eretmochelys imbricata*]: 0.5% [Sabine Pass only]). This assemblage differed from that at pass/bay habitat within the southernmost study area, South Padre Island, where greens represented 97% of sea turtles taken (97 greens, 2 loggerheads, and 1 Kemp's ridley).

Ridley CPUE at Sabine and Calcasieu Passes varied among years (Fig. 2). Annual CPUEs at Sabine Pass, the only area netted all years of this study, ranged from 0.2 in 1992 to 1.1 during 1994 and 1997. Years immediately prior and subsequent to CPUE peak years at Sabine Pass yielded

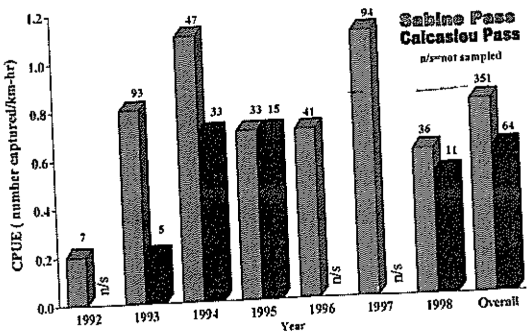

Figure 2. Annual catch per unit effort statistics for Kemp's ridley sea turtles ($n = 415$) at Sabine and Calcasieu Pass study areas during 1992–98. Numbers atop histogram bars denote number of ridleys captured.

similar but reduced CPUEs ranging from 0.6 to 0.8. The 4 years during which Calcasieu Pass was netted produced only one annual CPUE equal to that at Sabine Pass (1997, 0.7); however, its other yearly CPUEs were, on average, only 0.2 less than those at its western counterpart and never matched by other study areas.

Ridley occurrence at Sabine and Calcasieu Passes was generally limited to April through September. CPUEs during these months ranged from 0.2 to 1.2 (Table 2), with May through August producing 92% of the ridleys taken and monthly overall CPUEs ≥ 0.5. This seasonal pattern was most evident at Sabine Pass where nearly 54% of all monthly CPUEs during May through August were ≥ 1.0, with only 1 of 26 months failing to yield any ridleys. January, February, and December, months of coolest water temperatures and reduced netting effort, failed to yield ridleys at any study area (Table 2).

Tag and Recapture Statistics. — Only 12 (2.89%) of 415 ridleys tagged at Sabine and Calcasieu Pass study areas were recaptured. Duration between tagging and recapture events ranged from 22 to 364 days and averaged 182.9 days. Six recaptures occurred within the same netting year animals were originally tagged. Mean growth rate for recaptured ridleys was 0.02 cm/day, with individual rates ranging from 0.003 to 0.05 cm/day or 1.1 to 18.25 cm/yr. Two other ridleys, both adult females measuring 64.0 and 64.6 cm SCL, originally tagged on the Rancho Nuevo nesting beach in May 1994 were recaptured at Sabine Pass and Calcasieu Pass, respectively, during July 1995.

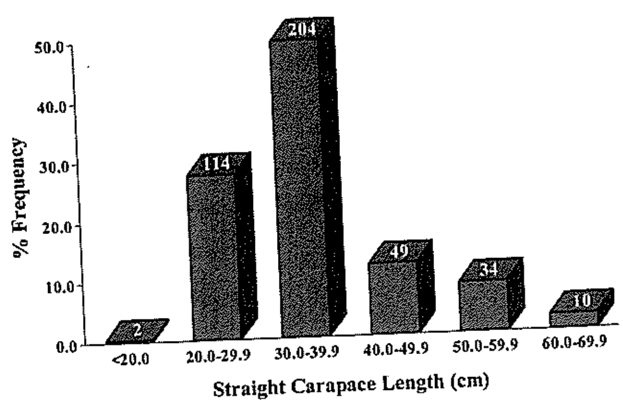

Figure 3. Carapace length frequency for all Kemp's ridley sea turtles measured ($n = 413$) from western Gulf of Mexico study areas during 1992–98. Numbers atop histogram bars denote number of ridleys measured.

Size Composition. — Ridleys captured at all study areas combined ($n = 429$; Table 2) ranged from 19.5 to 65.8 cm SCL, with nearly 77% of these < 40 cm SCL (Fig. 3). Carapace length frequency distributions of yearly catches displayed a consistent dominance by smaller cohorts that were taken primarily during May through September. Annual mean carapace length for ridleys netted at Sabine and Calcasieu Passes ranged from 32.9 to 39.9 cm to produce an overall average SCL of 33.5 cm. Only 10 ridleys (2.3%) were adults (≥ 60 cm SCL), whose capture was typically restricted to May or September.

Sex Ratio. — Sex was determined for 235 of the 429 ridleys captured at all study areas combined during 1992–97 using a plasma testosterone concentration technique (Coyne and Landry, 2000). Wild ridleys ($n = 215$; 122 females, 93 males) exhibited a 1.3F:1M ratio while headstarted ridleys ($n = 20$; 18 females, 2 males) had a 9F:1M ratio. Overall sex ratio was 1.4F:1M. No adult males were taken.

DISCUSSION

Despite repeated calls for better information on at-sea post-pelagic or benthic stages of Kemp's ridleys (Magnuson et al., 1990; USFWS and NMFS, 1992; TEWG, 1998), only the current study and that by Shaver (1995) have deployed directed capture techniques (i.e., targeting sea turtles) to characterize in-water population dynamics of nearshore sea turtle stocks in the western Gulf, where most ridleys occur (Márquez, 1994). Shaver (1995) used entanglement netting to describe relative abundance, temporal patterns, and growth of sea turtles at the Mansfield Channel and other locations within the south Texas Laguna Madre System. Shaver captured no ridleys during her 3+ year study, thus providing evidence supported by the current in-water study and historical stranding surveys, that the ridley's use of nearshore habitats in the western Gulf is generally restricted to more northerly environs. This premise is discussed in more detail below.

Spatial and temporal results provided by the current in-water survey of ridleys are similar to trends summarized from sea turtle stranding records for the western Gulf (Rabalais and Rabalais, 1980; Heinly, 1990; Caillouet et al., 1991, 1996; Manzella and Williams, 1992; Teas, 1993; Shaver, 1995). These data sets suggest nearshore ridley assemblages are dominated by ≤ 40 cm SCL animals that aggregate and strand near tidal passes along the upper Texas and Louisiana coasts during spring through early fall. Similar trends were reported by Cannon et al. (1994) who found that hook and line captures of ridleys by pier fishers in Texas during 1980–92 were mainly comprised of 28 to 38 cm SCL individuals taken along the upper coast. These workers noted hook and line captures peaked in August when declining blue crab abundance precipitated a shift to mullet and shrimp used as bait by fishers. The disparity in ridley CPUEs from the upper (this study) and lower Texas coasts (Shaver, 1995), plus inferences drawn from the hook and line study (Cannon et al., 1994), are similar to Manzella and Williams' (1992) findings of stranding peaks on upper and middle Texas coasts and a virtual absence of carcasses along the lower coast. These findings are indicative that juvenile ridleys occur more frequently in more northerly neritic habitats of the western Gulf of Mexico.

Elevated ridley CPUEs at beachfront habitat adjacent to Sabine and Calcasieu Passes during late spring through late summer coincided with two factors rendering the nearshore zone attractive to post-pelagic, benthic-foraging ridleys. The late spring and early summer migration of egg-laden blue crabs, the ridley's preferred prey, from bays into shallow Gulf waters for spawning purposes (More, 1969) provided abundant foraging opportunities within beachfront habitats. These waters out to 36.6 m also receive 80% of the western Gulf shrimping effort (Caillouet et al., 1991) and a rich food source in the form of discarded bycatch. Food habit studies conducted by Shaver (1991) and Werner (1994) and summarized in Márquez' (1994) synopsis of Kemp's ridley biology all reported crabs as the principal food item in ridley stomachs, while the first two investigators found evidence that shrimp bycatch plays an important role in this species' diet. An energy subsidy such as that provided by shrimp bycatch should be considered a prime factor, along with crab abundance, influencing ridley distribution patterns off the Texas and Louisiana coasts.

The attractiveness of food-rich, shallow water zones near tidal passes to neritic ridley stocks is not only apparent from our CPUE statistics but also from tracking studies conducted by Renaud et al. (1995, 1996). These workers found that 80% of radio- and sonic-tagged ridleys released immediately adjacent to Sabine and Calcasieu Passes remained within 5 km of shore and at mean depths less than 4 m. Most ridleys maintained strong site fidelity to the westward side of both passes until cold fronts forced them to migrate100 km south along the coast. While these patterns support the hypothesis that ridleys are transient inhabitants of developmental habitat within nearshore zones along the upper Texas and Louisiana coasts, they do little to explain the extremely low recapture rate recorded during our study. Conversely, these post-pelagic assemblages may have been so large that the tagged portion was but a small fraction thereof and the opportunity for recaptures extremely small. Westerly flow from the Mississippi River drainage system provides some degree of thermal stability and food-rich drift lines along the Louisiana and upper Texas coasts that, together with loop currents in the central Gulf, serve as transport mechanisms for post-pelagic ridleys in search of benthic foraging grounds. Thus, the aggregation potential at our study areas is probably greater than that outside the Mississippi River's influence. Conversely, easternmost study areas are frequently detrimentally impacted by hypoxic events associated with freshwater runoff and nutrient loading from the Mississippi River (Rabalais et al., 1998). The fact that entanglement netting operations at study areas closest to the Mississippi River – Grand Isle and Belle Pass – occurred during a severe hypoxic event in 1995, wherein prey items such as portunid crabs and bycatch species were displaced from their oxygen-deficient waters, may explain the virtual absence of ridleys at these beachfront locales.

The disparity in ridley capture success between beachfront habitats near Sabine and Calcasieu Passes and bay/lagoon and pass habitats in other study areas also merits consideration. Although various workers (Carr, 1957, 1980; Hildebrand, 1982; Manzella et al., 1988; Manzella and Williams, 1992) have reported ridleys from bays and lagoons, our study failed to verify this species' use of inshore waters in Texas and Louisiana. Some historical records are based on stranded animals that may have been swept inshore by currents and tides, thus yielding misleading documentation (Manzella and Williams, 1992). Other reports deal with stranding of headstart ridleys originally released in inshore waters (Caillouet et al., 1995). Differences in entanglement netting effort expended at beachfront versus bay/lagoon habitat also may account for disparities in capture success between respective study areas. More netting effort is required in both Sabine and Calcasieu Lakes to provide a robust characterization of whether ridleys, encountering beachfront zones, eventually venture through tidal passes into coastal bays.

The current study along with Shaver's (1995) entanglement net survey of Mansfield Pass provide strong evidence that ridleys (at least neritic, benthic-feeding immatures) prefer upper Texas/Louisiana environs to those along the lower Gulf coast. While ridleys accounted for over 95% of all turtles captured by this study from areas north of Matagorda Bay, they represented only 1% of the catch within pass and lagoon habitats adjacent to South Padre Island. Entanglement netting surveys in the latter study area during 1992–94 captured virtually nothing but green turtles (97%). Shaver's (1995) failure to capture ridleys at Mansfield Pass adds support to the assumption that algae and seagrass laden habitats along the lower Texas coast better serve herbivorous green turtles than a benthic carnivore like the ridley. A 43% recapture rate for green turtles netted at South Padre Island during the current study plus evidence of their overwintering in *Thalassia testudinum* beds in the lower Laguna Madre (Arms, 1996) indicate this species, unlike ridleys, is a year-around resident of inshore habitats, especially those in south Texas.

Our radioimmunoassays and supporting laparoscopic examinations (Coyne and Landry, 2000) provide the first sex ratio determination for live ridleys captured in the western Gulf. Previous reports on sex ratio of Gulf ridley assemblages have been based on strandings (Shaver, 1991; Stabenau et al., 1996). The 1.4F:1M ratio determined in our study differs to varying degrees from previous studies. Shaver (1991) reported a 1F:1M ratio for 81 ridleys, 42 of which were headstarted cohorts, stranding along south Texas beaches. Further inspection of Shaver's results reveals a

1F:1.8M and 1.6F:1M ratio for wild and headstarted ridleys, respectively. These results contrast sharply with our study's finding for wild (1.3F:1M) and headstarted ridleys (9F:1M). Sex ratios reported by Stabenau et al. (1996) for overall (3.2F:1M), wild (3F:1M), and headstarted cohorts (7.5F:1M) stranding along the upper Texas coast differ even more. These differences may be explained by several factors ranging from the possibility of sexually biased gonadal decay rates in stranded animals to impact of headstart management practices on population sex ratios.

In summary, the current study provides the only long-term (7-year), in-water characterization conducted to date of the spatial/temporal occurrence, population characteristics, and relative abundance of Kemp's ridleys in nearshore waters of the upper Texas and Louisiana coasts. Our entanglement netting surveys indicate these neritic waters, especially those along the upper Texas and Louisiana coasts, serve as developmental habitat for juvenile and subadult ridleys. Relative abundance and CPUE statistics are dominated by immature ridleys ≤ 40 cm SCL that occupy shallow beachfront zones from April through September. Highest ridley capture rates occur gulfward of Sabine and Calcasieu Passes, where blue crab abundance and incidental bycatch discarded by the shrimp fishery attract these young cohorts. Information collected during our study identifies Calcasieu and Sabine Pass study areas as "index habitats" where post-pelagic juvenile through subadult ridleys occur seasonally and, as such, can be monitored for long term population trends. This baseline information can be compared with data from future studies at these and other nearshore areas to assess ridley population dynamics and habitat preference in the western Gulf, thereby serving as standards to help evaluate this species' recovery and refine management strategies and conservation status.

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LITERATURE CITED

ARMS, S.A. 1996. Overwintering behavior and movement of immature green sea turtles in south Texas waters. M.S. Thesis, Texas A&M University, College Station.

CAILLOUET, C.W., JR., DURONSLET, J.J., LANDRY, A.M., JR., REVERA, D.B., SHAVER, D.J., STANLEY, K.M., HEINLY, R.W., AND STABENAU, E.K. 1991. Sea turtle strandings and shrimp fishing effort in the northwestern Gulf of Mexico, 1986-89. Fishery Bulletin 89:712-718.

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(4):285-292.

CAILLOUET, C.W., JR., SHAVER, D.J., TEAS, W.G., NANCE, J.M., REVERA, D.B., AND CANNON, A.C. 1996. Relationship between sea turtle stranding rates and shrimp fishing intensities in the northwestern Gulf of Mexico: 1986-1989 versus 1990-1993. Fishery Bulletin 94:237-249.

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.

CALDWELL, D.L., AND CARR, A. 1957. Status of the sea turtle fishery in Florida. Transactions of the Twenty-second North American Wildlife Conference, pp. 457-463.

CANNON, A.C., FONTAINE, C.T., WILLIAMS, T.D., REVERA, D.B., AND CAILLOUET, C.W., JR. 1994. Incidental catch of Kemp's ridley sea turtles (*Lepidochelys kempi*), by hook and line, along the Texas coast, 1980-1992. In: Schroeder, B.A. and Witherington, B.E.. (Compilers). Proceedings of the Thirteenth Annual Workshop on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-341, pp. 40-42.

CARR, A. 1957. Notes on the zoogeography of the Atlantic sea turtles of the genus *Lepidochelys*. Revista Biologica Tropical 5(1):45-61.

CARR, A. 1980. Some problems of sea turtle ecology. American Zoologist 20:489-498.

COYNE, M.S. AND LANDRY, A.M., JR. 2000. Plasma testosterone dynamics in the Kemp's ridley sea turtle. In: Abreu-Grobois, F.A., Briseno-Duenas, R., Marquez-Millan, R., and Sarti-Martinez, L. (Compilers). Proceedings of the Eighteenth International Sea Turtle Symposium. NOAA Technical Memorandum NMFS-SEFSC-436, p. 286.

DOBIE, J.L., OGREN, L.H., AND FITZPATRICK, J.F., JR. 1961. Food notes and records of the Atlantic ridley turtle (*Lepidochelys kempii*) from Louisiana. Copeia 1961(1):109-110.

DOUGHTY, R.W. 1984. Sea turtles in Texas: a forgotten commerce. Southwestern Historical Quarterly 88:43-70.

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 Technical Memorandum NMFS-SEFC-334, 40 pp.

HEINLY, R.W. 1990. Seasonal occurrence and distribution of stranded sea turtles along Texas and southwestern Louisiana coasts. M.S. Thesis, Texas A&M University, College Station.

HILDEBRAND, H.H. 1963. Hallazgo del ·rea anidaciÛn de la tortuga marina "lora", *Lepidochelys kempi* (Garman), en la costa occidental del Golfo de MÈxico (Rept., Chel.). Ciencia (Mexico) 22:105-112.

Hildebrand, H.H. 1982. A historical review of the status of sea turtle populations in the western Gulf of Mexico. In: Bjorndal, K. (Ed.). Biology and Conservation of Sea Turtles. Washington, DC: Smithsonian Institution Press, pp. 447-453.

Landry, A.M., Jr. and Costa, D. 1999. Status of sea turtle stocks in the Gulf of Mexico with emphasis on the Kemp's ridley. In: Kumpf, H., Steidinger, K., and Sherman, K. (Eds.). Gulf of Mexico Large Marine Ecosystem. Malden, MA: Blackwell Science, pp. 248-268.

Liner, E.A. 1954. The herpetofauna of Lafayette, Terrebonne, and Vermilion parishes, Louisiana. Proceedings of the Louisiana Academy of Science 17:65-85.

Magnuson, J.J., Bjorndal, K.A., DuPaul, W.D., Graham, G.L., Owens, D.W., Peterson, C.H., Pritchard, P.C.H., Richardson, J.I., Saul, G.E., and West, C.W. 1990. Decline of the sea turtle: causes and prevention. Committee on Sea Turtle Conservation, National Research Council (U.S.), National Academy Press, Washington, DC.

Manzella, S.A., Caillouet, C.W., Jr., and Fontaine, C.T. 1988. Kemp's Ridley, *Lepidochelys kempi*, sea turtle head start tag recoveries: distribution, habitat, and method of recovery. Marine Fisheries Review 50(3):24-32.

Manzella, S.A., and Williams, J.A. 1992. The distribution of Kemp's ridley sea turtles (*Lepidochelys kempi*) along the Texas coast: an atlas. NOAA Technical Report, NMFS 110, 52 pp.

Márquez-M., R. 1994. Synopsis of biological data on the Kemp's ridley turtle, *Lepidochelys kempi* (Garman, 1880). NOAA Technical Memorandum NMFS-SEFSC-343, 91 pp.

More, W.R. 1969. A contribution to the biology of the blue crab, *Callinectes sapidus* (Rathbun), in Texas with a description of the fishery. Texas Parks and Wildlife Department, Technical Series, No. 1, 31 pp.

Ogren, L.H. 1989. Distribution of juvenile and subadult Kemp's ridley turtles: preliminary results from the 1984-1987 surveys. In: Caillouet, C.W., Jr., and Landry, A.M., Jr. (Eds.). Proceedings of the First International Symposium on Kemp's Ridley Sea Turtle Biology, Conservation and Management. Texas A&M University Sea Grant College Program Publication, TAMU-SG-89-105, pp. 116-123.

Owens, D.W., and Ruiz, G.J. 1980. New methods of obtaining blood and cerebrospinal fluid from marine turtles. Herpetologica 36:17-20.

Rabalais, N.N., Turner, R.E., Wiseman, W.J., and Dortch, Q. 1998. Consequence of the 1993 Mississippi River flood in the Gulf of Mexico. Regulated Rivers-Research & Management 14(2):161-177.

Rabalais, S.C. and Rabalais, N.N. 1980. The occurrence of sea turtles on the south Texas coast. Contributions in Marine Science 23:123-129.

Renaud, M., Carpenter, J., Williams, J., Carter, D., and Williams, B. 1995. Movement of Kemp's ridley sea turtles (*Lepidochelys kempii*) near Bolivar Roads Pass and Sabine Pass, Texas and Calcasieu Pass, Louisiana. May 1994 – May 1995. Final Report, U.S. Army Corps of Engineers, Galveston and New Orleans Districts.

Renaud, M.L., Carpenter, J.A., Williams, J.A., and Landry, A.M., Jr. 1996. Kemp's ridley sea turtles (*Lepidochelys kempii*) tracked by satellite telemetry from Louisiana to nesting beach at Rancho Nuevo, Tamaulipas, Mexico. Chelonian Conservation and Biology 2:108-109.

Shaver, D.J. 1991. Feeding ecology of wild and head-started Kemp's ridley sea turtles in south Texas waters. Journal of Herpetology 25:327-334.

Shaver, D.J. 1995. Sea turtle stranding along the Texas coast again cause for concern. Marine Turtle Newsletter 70:2-4.

Shaver, D.J. 1996. Head-started Kemp's ridley turtles nest in Texas. Marine Turtle Newsletter 74:5-7.

Smith, P.W., and List, J. 1950. Notes of Mississippi amphibians and reptiles. American Midland Naturalist 53:115-125.

Stabenau, E.K., Stanley, K.S., and Landry, A.M., Jr. 1996. Sex ratios from stranded sea turtles along the upper Texas coast. Journal of Herpetology 30:427-430.

Teas, W.G. 1993. Species composition and size class distribution of marine turtle strandings on the Gulf of Mexico and southeast United States coasts, 1985–1991. NOAA Technical Memorandum NMFS-SEFSC-315, 43 pp.

Turtle Expert Working Group (TEWG). 1998. An assessment of the Kemp's ridley (*Lepidochelys kempii*) and loggerhead (*Caretta caretta*) sea turtle populations in the Western North Atlantic. NOAA Technical Memorandum NMFS-SEFSC-409, 96 pp.

U.S. Fish and Wildlife Service and National Marine Fisheries Service. 1992. Recovery Plan for the Kemp's Ridley Sea Turtle (*Lepidochelys kempii*). National Marine Fisheries Service, St. Petersburg, Florida.

Valverde, R.A. 1996. Corticosteroid dynamics in a free-ranging population of olive ridley sea turtles (*Lepidochelys olivacea* Eschscholtz, 1829) at Playa Nancite, Costa Rica as a function of their reproductive behavior. Ph.D. Thesis, Texas A&M University, College Station.

Werner, S.A. 1994. Feeding ecology of wild and head started Kemp's ridley sea turtles. M.S. Thesis, Texas A&M University, College Station.

Witzell, W.N. 1994. The U.S. commercial sea turtle landings. NOAA Technical Memorandum NMFS-SEFSC-350, 130 pp.

Wood, J.R., Wood, F.E., Critchley, K.H., Wildt, D.E., and Bush, M. 1983. Laparoscopy of the green sea turtle, *Chelonia mydas*. British Journal of Herpetology 6(9):323-327.

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