Developmental Biology and Ecology of Kemp's Ridley Turtles, *Lepidochelys kempi*, in the Eastern Gulf of Mexico

Jeffrey R. Schmid[1,2,3]

and

William J. Barichivich[3,4]

[1]U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center, Miami, FL 33149

[2]Archie Carr Center for Sea Turtle Research and [3]Department of Wildlife Ecology and Conservation, University of Florida, Gainesville, FL 32611

[4]U.S. Geological Survey, Biological Resources Division, Florida-Caribbean Science Center, Gainesville, Florida 32653

Presented at Kemp's mini-symposium at the 19th Annual Symposium of Sea Turtle Biology and Conservation in South Padre Island, TX.

HISTORIC REVIEW OF RESEARCH EFFORTS

For the past century, the coastal waters of the eastern Gulf of Mexico (Fig. 1) have been pivotal in our understanding, or lack thereof, of the Kemp's ridley turtle, *Lepidochelys kempi.* Garman (1880) established the species from a pair of turtles sent by Richard Kemp from Key West, Florida, and applied the common name "Kemp's Gulf Turtle". After 60 years of taxonomic rearrangement, Carr (1942) applied the common name "ridley" and identified Florida Bay as its center of abundance based upon his observations and communications with local residents. The occurrence of immature *L. kempi* was well known among the fishermen from the Cedar Keys to Key West (Carr, 1942) but the natal origin and reproductive habits of this species were unknown. There were also collections of a "large female" and a juvenile from Mississippi Sound in the north-central Gulf (Smith and List, 1955). Mexican fishermen along the northern Yucatan Peninsula reported a rare type of turtle that Carr (1957) believed to be a ridley. A confirmed record for *kempi* exists for Isla de Mujeres off the northeastern tip of the peninsula (Smith and Taylor, 1950). These turtles were commonly called "bastard turtles" in all areas of the eastern Gulf and it was believed that they were a hybrid from pairs of loggerhead, *Caretta caretta*, hawksbill, *Eretmochelys imbricata*, or green turtles, *Chelonia mydas.*

In 1955, Carr and Caldwell (1956) performed tagging experiments with "Atlantic ridley" turtles captured in the turtle fishery of west-central Florida and provided the first scientific data on size range, carapace morphometrics, and local movements for this species. They also reported fishermen's observations on the seasonal occurrence of turtles, the habitats of the fishing grounds, and presence of ovarian follicles in larger ridley turtles. Six years later scientists discovered a film of Kemp's ridley turtles nesting near Rancho Nuevo on the central-east coast of Mexico (Carr, 1963; Hildebrand, 1963). Consequently, research efforts during the 60s and 70s focused on the rapidly declining number of "Kemp's ridley" females at the nesting beach (Pritchard and Márquez M., 1973). The only source of information for Kemp's ridley turtles in the eastern Gulf during this period were records of captures in commercial fisheries (Fig. 2). A female tagged at the nesting beach in the western Gulf was recaptured by a shrimp trawler several months later between the Dry Tortugas and Marquesas Keys (Sweat, 1969). Gillnet fishermen reported captures of Kemp's ridley turtles in the nearshore waters around Sanibel Island and shrimp trawlers reported occasional captures offshore of southwest Florida (LeBuff, 1990). A few turtles captured by trawlers in the vicinity of Mississippi Sound and Mobile Bay were tagged and later recaptured in this region or to the west (Carr, 1980). A locality known as Big Gulley, located east of the entrance to Mobile Bay, was identified as an area where trawlers captured significant numbers of Kemp's ridley turtles (Carr, 1980; Ogren, 1989). By the late-70s, it was apparent that commercial fishing operations, primarily shrimp trawling, were a major source of mortality for marine turtles and research efforts were concentrated on reducing their incidental capture in fishing gear (Magnuson et al., 1990).

In 1984, the National Marine Fisheries Service initiated long-term tagging studies to characterize the aggregations of Kemp's ridley turtles occurring in the coastal waters of western Florida (Fig. 3). There were also limited tagging efforts with trawl-caught turtles in the northern Gulf which again demonstrated a westward movement from Mississippi Sound (Ogren, 1989). Rudloe et al. (1991) documented the length frequency distribution, variation in size classes by season and depth, bottom type preferences, and local movements of animals incidentally captured in the fisheries of western Apalachee Bay. Entanglement nets from the former turtle fishery were used to capture marine turtles east of the Cedar Keys in order to determine their species composition, population structure, and seasonal occurrence in these nearshore waters (Schmid and Ogren, 1990, 1992). These fishery-independent efforts provided additional data on the length frequency distribution, seasonal and annual size distributions, morphometrics, growth, population estimates, and diet of Kemp's ridley turtles in this region (Schmid, 1998).

Over the past few years, research efforts have filled gaps in the distribution of Kemp's ridley turtles in the eastern Gulf and sought to characterize the coastal habitats utilized by this species. A fishery-independent gillnet survey for sharks indicated that Kemp's ridley turtles were distributed along the entire west coast of Florida (Manire and Foote, 1996). Recently established studies have confirmed presence of Kemp's ridley turtles within Deadman Bay in northwestern Florida (Barichivich, 1998) and the Ten Thousand Islands (Witzell and Schmid, unpubl. data) and Florida Bay (B. Schroeder, pers. comm.) in southwestern Florida. Current efforts include documenting the feeding ecology of this species in the Deadman Bay-Big Bend region (Barichivich, 1998) and characterizing its habitat associations near the Cedar Keys (Schmid, 1994). The following account is a synopsis of the biological and ecological data available for Kemp's ridley turtles in the eastern Gulf of Mexico. Information is provided on their geographic and temporal size distributions, seasonal occurrence, local movements, growth rates, physiology, and habitats.

GEOGRAPHIC SIZE DISTRIBUTION

Ogren (1989) described the life history of the Kemp's ridley turtle as a juvenile epipelagic stage (< 20 cm SCL), a coastal-benthic subadult stage (20-60 cm SCL), and a coastal-benthic adult stage (≥ 60 cm SCL). A clinal size pattern has been suggested for Kemp's ridley turtles along the Atlantic seaboard, but a similar pattern has not been observed for turtles in the eastern Gulf of Mexico (Carr, 1980; Ogren, 1989). There were indications that larger turtles occur in deeper waters of the northeastern Gulf (Rudloe et al., 1991). However, a comparison of the mean sizes and size class compositions from recent tagging studies in northwestern and west-central Florida does suggest an increasing north-south size gradient in the eastern Gulf (Fig. 4). Sixty-six percent of the turtles captured in Apalachicola-Apalachee Bays and 75% if those captured in the Big Bend region (Barichivich, unpubl. data) were early to mid-subadults (20-40 cm), compared to only 24% in the Cedar Keys (Schmid, 1998). The northeastern Gulf has been identified as a potential ejection point for Kemp's ridley turtles that have completed their epipelagic development (Collard and Ogren, 1990) and these length-frequency distributions appear to support this supposition.

Alternatively, the size-related distribution in the northeastern Gulf may be the result of gear bias associated with each of the studies. Commercial shrimp trawls were the primary collection method in the Florida panhandle, but any capture selectivity by this method has not been addressed. Large-mesh entanglement nets are known to favor the capture of larger turtles (Carr and Caldwell, 1956; Schmid and Ogren, 1992), while small mesh nets favor the capture of smaller turtles (Barichivich, pers. obs). Fishery-independent strike netting was the most commonly employed method in the Big Bend region. Mesh size of the nets deployed in this study was decreased from 25 cm bar to 10 cm bar as smaller turtles were observed swimming through the larger webbing (Barichivich, 1998). Similar observations have been made with the large-mesh strike net used in surveys at the Ten Thousand Islands (Witzell and Schmid, unpubl. data). The Cedar Keys study was based on fishery-independent captures, but with anchored entanglement nets of 25-30 cm bar mesh. Attempts were made to fish a 10 cm bar net in this latter study, but resulted in a drastic increase in the capture of stingrays (Ogren, pers. comm.). Thus, there is a trade-off between the mesh size used to capture turtles and the bycatch associated with the net.

TEMPORAL SIZE DISTRIBUTION

A temporal difference in size distributions was noted for Kemp's ridley turtles in west-central Florida (Schmid, 1998). All but one of the turtles examined by Carr and Caldwell in the mid-1950s were greater than 40 cm and 8% of the specimens were greater than 60 cm (Fig. 4). By comparison, 24% of the turtles captured from 1986 to 1995 were 20-40 cm and 76% were 40-60 cm. Similar measurements were recorded and gear bias was ruled out as both studies utilized large-mesh tangle nets. However, Carr and Caldwell relied upon captures from the commercial fishery and larger turtles may have been preferentially landed given their higher market value. Interestingly, some Cedar Keys turtle fishermen referred to smaller turtles as "housekeepers" which were customarily released to "tend the house" of the larger turtles (Schmid, pers. obs.). This anecdote may explain the lack of smaller size classes in the turtle fishery and suggests the fishermen may have been practicing the first conservation efforts on this species.

Conversely, the temporal difference in size distribution could be indicative of a demographic shift in the Kemp's ridley population which has resulted from the exploitation and subsequent protection of the nesting beach over the past five decades (Schmid, 1998). Prior to the mid-1970s, captures of adult-size (60+ cm) Kemp's ridley turtles, primarily females, were reported in the eastern Gulf (Garman, 1880; Smith and List, 1955; Carr and Caldwell, 1956; Carr, 1980; LeBuff, 1990). These reports correspond to a period of rapid decline in the once abundant west Gulf nesting aggregation (USFWS and NMFS, 1992). Recent tagging studies in the eastern Gulf have not recorded captures of wild Kemp's ridley turtles greater than 60 cm (Rudloe et al., 1991; Schmid, 1998; Barichivich, 1998; Witzell and Schmid, unpubl. data), although strandings of adult-size turtles have been reported (Teas, 1993) and nesting females have been observed on the Florida gulf coast (Meylan et al., 1990; Anonymous, 1994). Protection of the nesting beach over the last 30 years has increased hatchling production and presumably recruitment of post-pelagic turtles to the coastal waters (Ogren, 1989). This may account for the higher frequency of subadult Kemp's ridley turtles captured in the eastern Gulf during recent years but there are no quantitative data to demonstrate an increase in their abundance.

SEASONAL OCCURRENCE

Kemp's ridley turtles were typically captured in the nearshore waters of the northeastern Gulf from April to November (Carr and Caldwell, 1956; Schmid and Ogren, 1990, 1992). Recent investigations indicate that turtles occur in these coastal waters when water temperatures are above 20° C (Schmid, 1998) and sightings or captures have been reported in December and March (Barichivich, 1998, pers. obs.). Ogren (1989) proposed an offshore emigration in winter based upon the capture of turtles in deeper waters during December, January, and February (Rudloe et al., 1991). Kemp's ridley turtles may be moving to warmer waters offshore or may travel southward along the west coast of Florida. Tag recoveries (Henwood and Ogren, 1987; Schmid, 1995) and satellite telemetry (Renuad, 1995; Gitschlag, 1996) have demonstrated a seasonal migration for their Atlantic siblings. However, there are no tag recoveries that indicate seasonal movements in the eastern Gulf (Schmid, 1998). Recently established surveys in the Ten Thousand Islands region are inconclusive as to whether

Kemp's ridley turtles overwinter along the southwestern Florida coast, although significant numbers of sightings were recorded in December and January (Witzell and Schmid, unpubl. data).

LOCAL MOVEMENTS

Kemp's ridley turtles have been recaptured at sites of initial capture within a relatively short period of time, indicating fidelity to specific areas during their seasonal occurrence in coastal waters. Carr and Caldwell (1956) noted that a turtle released in the Cedar Keys traveled approximately 35 km to the original capture site at the Withlacoochee-Crystal River fishing grounds within 43 days. Short-term fidelity has also been observed in Apalachicola-Apalachee Bays (Rudloe et al., 1991) and the Big Bend region (Barichivich, 1998). Additionally, multiple recaptures within a netting season have been recorded at the latter locality (Table 1a). Recaptures between netting seasons and multiannual recaptures in the Cedar Keys (Table 1b) demonstrate that some turtles remigrate to capture sites in this area (Schmid, 1998). The aggregations of Kemp's ridley turtles in the Florida panhandle appear transitory, as all recaptures have been recorded in the same season and year, whereas aggregations in west-central Florida appear more residential (Schmid and Ogren, 1990). Furthermore, short-term recaptures indicate that Kemp's ridley turtles may establish restricted foraging ranges in the coastal waters of the eastern Gulf and long-term recaptures suggest that some turtles return to previously utilized areas over a period of years.

GROWTH RATES

Little information is available on the growth of wild, subadult Kemp's ridley turtles. A mean growth rate of 5.1±3.1 cm/yr was calculated for turtles collected in the northeastern Gulf by Schmid (1998) and Barichivich (1998). However, sixty-one percent of the growth rates were derived from recapture intervals of less than 180 days duration and extrapolating annual growth rates from short-term recaptures will amplify any errors associated with the measurements. Error was minimized in both studies as all measurements were performed by a single person (JRS or WJB, respectively) using the same techniques and similar types of equipment. Nonetheless, increasing the amount of time elapsed between initial capture and recapture increased the precision of the mean growth rate estimate (Table 2a). Mean growth rate within netting seasons was significantly greater (χ^2=5.23, d.f.=1, p=0.022) than between seasons (Table 2b), but all within season growth rates were calculated from recapture intervals less than 180 days and may have been overestimated owing to extrapolation. Growth rates by 10 cm size classes appear polyphasic (Table 2c), as has been suggested with skeletochronological age estimates for Kemp's ridley turtles (Zug et al., 1997; Chaloupka and Zug, 1997). However, there was not a significant difference in growth rates between the size classes (F=0.96, p=0.42) and there was also a high degree of variability associated with the estimates.

PHYSIOLOGY

Plasma corticosterone, glucose, and testosterone concentrations have been used to investigate the stress response and sex ratio of Kemp's ridley turtles captured in west-central Florida (Gregory and Schmid, in review). Mean plasma corticosterone and glucose concentrations increased significantly after 60 min of captivity, but no significant difference was observed for mean testosterone concentrations (Fig. 5). There was considerable variation in testosterone concentrations over time, as approximately half of the turtles demonstrated an increase in plasma testosterone while the others demonstrated a decrease. The results of this study demonstrate that immature Kemp's ridley turtles respond to handling stress with elevated levels of glucocorticoids and hyperglycemia. Furthermore, initial corticosterone concentrations of Kemp's ridley turtles were almost 6 fold higher than those recorded for loggerhead turtles collected at the same time and location (Gregory et al., 1996), which may have implications concerning the behavior and stress-induced mortality of both species.

Initial testosterone concentrations were used to determine the sex of individual Kemp's ridley turtles using the criteria of Coyne and Landry (unpub. data). Fifty-nine percent of the Cedar Keys turtles were classified as female, 33% as male, and 8% as indeterminant (Fig. 6). The resulting sex ratio of 1.8F:1.0M was not significantly different from 1:1 ($X^2 = 2.78$, d.f. = 1, p = 0.0956). A similar sex ratio (2F:1M, *n*=12) was reported for Kemp's ridley turtles collected in the Big Bend region (Campbell and Sulak, 1997). Predicted males with carapace lengths 38-45 cm SCL exhibited elevated levels of testosterone (Fig. 6), which may indicate that the testes of males are maturing within this size range. Carr and Caldwell (1956) observed follicles the size of "b-b shot" in butchered Kemp's ridley females as small as 18-23 kg (51-55 cm converted SCL; Schmid, 1998). This observation indicates that the ovaries of females are maturing prior to 50 cm SCL. Owens (1997) has identified the period of gonadal maturation as the subadult stage of marine turtle development and Coyne and Landry (unpub. data) have suggested redefining the size classes of Kemp's ridley turtles using physiological data. Gregory and Schmid (in review) concured with these authors and suggested the following modifications to Ogren's (1989) size classes: pelagic juvenile (< 20 cm), coastal-benthic juvenile (20-39 cm), coastal-benthic subadult (40-59 cm), and coastal-benthic adult (> 60 cm).

HABITAT ANALYSES

The mangrove-bordered coast of southern Florida, particularly Florida Bay, was first identified as the preferred habitat of Kemp's ridley turtles (Carr, 1940). Carr and Caldwell (1956) later noted that this species was also captured on the seagrass (*Thalassia* and *Syringodium*) flats of western Florida and speculated that Kemp's ridley turtles were feeding on crabs and other invertebrates in the channels cutting through the grassbeds. In recent years, research efforts in the eastern Gulf have focused on characterizing the bottom types and prey items of Kemp's ridley turtles. Ogren (1989) broadly described the habitat of subadult turtles as the shallow seagrass beds and mud bottom bays of coastal marshes, particularly in association with portunid crab distribution.

Schmid (1998) identified an oyster bar complex east of the Cedar Keys as important developmental habitat and noted the occurrence of both stone crab (*Menippe*) and blue crab (*Callinectes*) in fecal specimens collected during tagging operations. Recent analyses of Kemp's ridley habitat associations in the Cedar Keys suggest turtles were preferentially utilizing hard bottom communities surrounding the oyster reef. Barichivich (1998) collected fecal samples from Kemp's ridley turtles captured in the channels bisecting the shallow grass flats of Deadman Bay and preliminary examination indicated that spider crabs (*Libnia* sp.) were present in all samples while blue and stone crabs occurred in only a few samples. A cursory comparison of these two areas suggests a possible ontogenetic shift in utilization of benthic habitats and corresponding prey items by coastal-benthic juvenile and subadult turtles.

CONCLUSIONS

The eastern Gulf of Mexico has been recognized as an important developmental area for Kemp's ridley turtles, but more information is required to adequately conserve and manage this endangered species (Thompson et al., 1990; Magnuson et al., 1990; USFWS and NMFS, 1992). Long-term and concurrent tagging studies are needed to provide more data on site fidelity and growth rates in this region. Additionally, the capture methodology for these studies should be standardized, or at least kept constant within a study, in order to monitor trends in the population structure of in-water aggregations of Kemp's ridley turtles (Turtle Expert Working Group, 1998). Satellite telemetry is needed to identify migration routes and overwintering areas in the eastern Gulf. Characterization of Kemp's ridley turtle habitat has been identified as a priority (Thompson et al., 1990; USFWS and NMFS, 1992), but research to date is limited in scope and geographic coverage. These efforts must be expanded in order to identify and protect the developmental habitats that are critical to the survival of this species.

ACKNOWLEDGMENTS

The authors thank Karen Bjorndal, Alan Bolten, Larry Ogren, Kenneth Sulak, and Wayne Witzell for their support of much of the research efforts reported in this review. We also thank the many research assistants and student volunteers who contributed their time to data collection. Funding for these projects was provided by the National Marine Fisheries Service Panama City and Miami Laboratories, the U.S. Geological Survey Biological Resources Division, and NMFS grants to the Archie Carr Center for Sea Turtle Research.

LITERATURE CITED

Anonymous. 1994. Kemp's ridley nests in Florida. Mar. Turtle Newsl. 67:16.

Barichivich, W. J. 1998. Feeding ecology and habitat affinities of Kemp's ridley sea turtles (*Lepidochelys kempi*) in the Big Bend, Florida. Annual report, December, 1998. Panama City, Florida: National Marine Fisheries Service, 18 pp.

Campbell, C. L. and Sulak, K. J. 1997. Characterization of Kemp's ridley sea turtles in the Florida Big Bend area during 1995 & 1996. Final report, February, 1997. Panama City, Florida: National Marine Fisheries Service, 17 pp.

Carr, A. F., Jr. 1942. Notes on sea turtles. Proc. New England Zoöl. Club 21:1-16.

Carr, A. 1957. Notes on the zoogeography of the Atlantic sea turtles of the genus *Lepidochelys*. Rev. Biol. Trop. 5:45-61.

Carr, A. 1963. Panspecific reproductive convergence in *Lepidochelys kempi*. Ergeb. Biol. 26:298-303.

Carr, A. 1980. Some problems of sea turtle ecology. Am. Zool. 20:489-498.

Carr, A. F. and Caldwell, D. K. 1956. The ecology and migrations of sea turtles: 1. Results of field work in Florida, 1955. Am. Mus. Nov. 1793:23 p.

Chaloupka, M. and Zug, G. R. 1997. A polyphasic growth function for the endangered Kemp's ridley sea turtle, *Lepidochelys kempii*. Fish. Bull. 95:849-856.

Collard, S. B. and Ogren, L. H. 1990. Dispersal scenarios for pelagic post-hatchling sea turtles. Bull. Mar. Sci. 47:233-243.

Garman, S. 1880. On certain species of Chelonioidæ. Bull. Mus. Comp. Zoöl. 6:123-126.

Gitschlag, G. M. 1996. Migration and diving behavior of Kemp's ridley (Garman) sea turtles along the U.S. southeastern Atlantic coast. J. Exp. Mar. Bio. Eco. 205:115-135.

Gregory, L.F., Gross, T.S., Bolten, A.B., Bjorndal, K.A., and Guillette, L.J. 1996. Plasma corticosterone concentrations associated with acute captivity stress in wild loggerhead sea turtles (*Caretta caretta*). Gen. Comp. Endorcrinol. 104:312-320.

Gregory, L. F. and Schmid, J. R. In review. Stress responses and sex ratio of wild Kemp's ridley sea turtles (*Lepidochelys kempi*) in the northeastern Gulf of Mexico. Gen. Comp. Endorcrinol.

Henwood, T. A. and Ogren, L. H. 1987. Distribution and migrations of immature Kemp's ridley turtles (*Lepidochelys kempi*) and green turtles (*Chelonia mydas*) off Florida, Georgia, and South Carolina. Northeast Gulf Sci. 9:153-159.

Hildebrand, H. H. 1963. Hallazgo del area de anidacion de la tortuga marina "lora" *Lepidochelys kempi* (Garman) en la costa occidental del Golfo de Mexico. Cienca 22:105-112.

LeBuff, C. R., Jr. 1990. The Loggerhead Turtle in the Eastern Gulf of Mexico. Sanibel, Florida:Caretta Research, Inc., 216 pp.

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 Turtles: Causes and Prevention. Washington:National Academy Press, 259 pp.

Manire, C. A. and Foote, J. J. 1995. Capture and tag-and-release of juvenile turtles caught in gill nets in nearshore habitat of the eastern Gulf of Mexico during fishery-independent shark studies. *In:* Keinath, J. A., Barnard, D.

E., Musick, J. A., and Bell, B. A. (Compilers), Proceedings of the Fifteenth Annual Symposium on Sea Turtle Biology and Conservation. NOAA Tech. Memo. NMFS-SEFSC-387:182-186.

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

Ogren, L. H. 1989. Distribution of juvenile and subadult Kemp's ridley turtles: preliminary results from the 1984-1987 surveys. *In:* Caillouet, Jr., C. W. and Landry, Jr., A. M. (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, TAMU-SG-89-105:116-123.

Owens, D.W. 1997. Hormones in the life history of sea turtles. *In:* Lutz, P. L. and Musick, J. A. (Eds.)The Biology of Sea Turtles. Boca Raton, Florida: CRC Press, pp. 315-41.

Pritchard, P. C. H. and Márquez M., R. 1973. Kemp's ridley turtle or Atlantic ridley, *Lepidochelys kempi*. IUCN Monograph 2:1-30.

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

Rudloe, A., Rudloe, J., and Ogren, L. 1991. Occurrence of immature Kemp's ridley turtles, *Lepidochelys kempi*, in coastal waters of northwest Florida. Northeast Gulf Sci. 12:49-53.

Schmid, J. R. 1994. A GIS model for the analysis of marine turtle habitat associations. *In:* Bjorndal, K. A., Bolten, A. B., Johnson, D. A., and Eliazar, P. J. (Compilers), Proceedings of the Fourteenth Annual Symposium on Sea Turtle Biology and Conservation. NOAA Tech. Memo. NMFS-SEFSC-351:279-282.

Schmid, J. R. 1995. Marine turtle populations on the east-central coast of Florida: results of tagging studies at Cape Canaveral, Florida, 1986-1991. Fish. Bull., U.S. 93:139-151.

Schmid, J. R. 1998. Marine turtle populations on the west-central coast of Florida: results of tagging studies at the Cedar Keys, Florida, 1986-1995. Fish. Bull. 96:589-602.

Schmid, J. R. and Ogren, L. H. 1990. Results of a tagging study at Cedar Key, Florida, with comments on Kemp's ridley distribution in the southeastern U.S. *In:* Richardson, T. I., Richardson, J. I., and Donnelly, M. (Compilers), Proceedings of the Tenth Annual Workshop on Sea Turtle Biology and Conservation. NOAA Tech. Memo. NMFS-SEFC-278:129-130.

Schmid, J. R. and Ogren, L. H. 1992. Subadult Kemp's ridley sea turtles in the southeastern U.S.: results of long-term tagging studies. *In:* Salmon, M. and Wyneken, J. (Compilers), Proceedings of the Eleventh Annual Workshop on Sea Turtle Biology and Conservation. NOAA Tech. Memo. NMFS-SEFSC-32:102-103.

Smith, P. W. and List, J. C. 1955. Notes on Mississippi amphibians and reptiles. Am. Midl. Nat. 53:115-125.

Smith, H. M. and Taylor, E. H. 1950. An annotated checklist and key to the reptiles of Mexico exclusive of the snakes. Smithson. Inst. U.S. Nat. Mus. Bull., Bulletin 199, 253 pp.

Sweat, D. E. 1969. Capture of a tagged ridley turtle. Quart. J. Fl. Acad. Sci. 31:47-48.

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 Tech. Memo. NMFS-SEFSC-315, 43 pp.

Turtle Expert Working Group. 1998. An assessment of the Kemp's ridley (*Lepidochelys kempii*) and loggerhead (*Caretta caretta*) sea turtle populations in the western North Atlantic. NOAA Tech. Memo. 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*). Washington: National Marine Fisheries Service, 40 pp.

Zug, G. R., Kalb, H. J., and Luzar S. J. 1997. Age and growth on wild Kemp's ridley sea turtles *Lepidochelys kempii* from skeletochronological data. Conserv. Biol. 80:261-268.

Table 1. Records of multiple recapture for Kemp's ridley turtles in the eastern Gulf of Mexico.

Location and tag code	Initial SCL (cm)	Date tagged	Dates of recapture	Days at large
a) Deadman Bay				
SSN 948-949	32.0	Jun. 11, 1998	Jul. 30, 1998, Aug. 18, 1998, & Sept. 8, 1998	49 19 21
XXA 834	21.8	Jun. 26, 1998	Aug. 18, 1998 & Dec. 1, 1998	53 105
XXA 819	22.4	Aug. 13, 1998	Aug. 18, 1998 & Dec. 3, 1998	5 107
b) Cedar Keys				
BBA 044-045	37.1	Sept. 4, 1991	Oct. 3, 1991 & May 27, 1992	30 237
BBA 179-180	35.6	Jul. 12, 1990	Jun. 19, 1991 & Jun. 11, 1992	332 357
BBA 062-063	34.3	Oct. 3, 1991	Sept. 20, 1992 & May 29, 1994	353 617
Tags lost[1]	(39.8)	1991	Sept. 19, 1993 & Aug. 5, 1995	- 685

[1] Turtle had lost flipper tags on both recapture events, but was identified on the last by a PIT tag applied in 1993. Year of initial tagging was determined from a year-class marking in the marginal scutes.

Table 2. Mean annual growth rates for Kemp's ridley turtles in the northeastern Gulf of Mexico by (a) recapture interval, (b) netting season, and (c) size class (standard deviations given in parentheses). Turtles were assigned to size classes by mean of initial and recapture SCL.

Data Treatments	*n*	Mean SCL growth rate (cm/yr)	Range of growth rates (cm/yr)
a) Recapture Interval			
All recaptures	33	5.1 (3.1)	1.2 - 13.0
Recaptures > 90 days	19	4.2 (2.6)	1.2 - 12.3
Recaptures > 180 days	13	3.6 (1.2)	1.2 - 5.4
b) Netting Season			
Within season	20	6.1 (3.6)	1.7 - 13.0
Between seasons	10	3.3 (1.1)	1.2 - 4.7
c) Size Class			
20.0 - 29.9 cm	5	3.7 (2.3)	1.2 - 6.5
30.0 - 39.9 cm	11	4.7 (2.8)	1.2 - 9.4
40.0 - 49.9 cm	13	6.2 (3.7)	2.9 - 13.0
50.0 - 59.9 cm	4	4.6 (2.5)	2.2 - 7.9

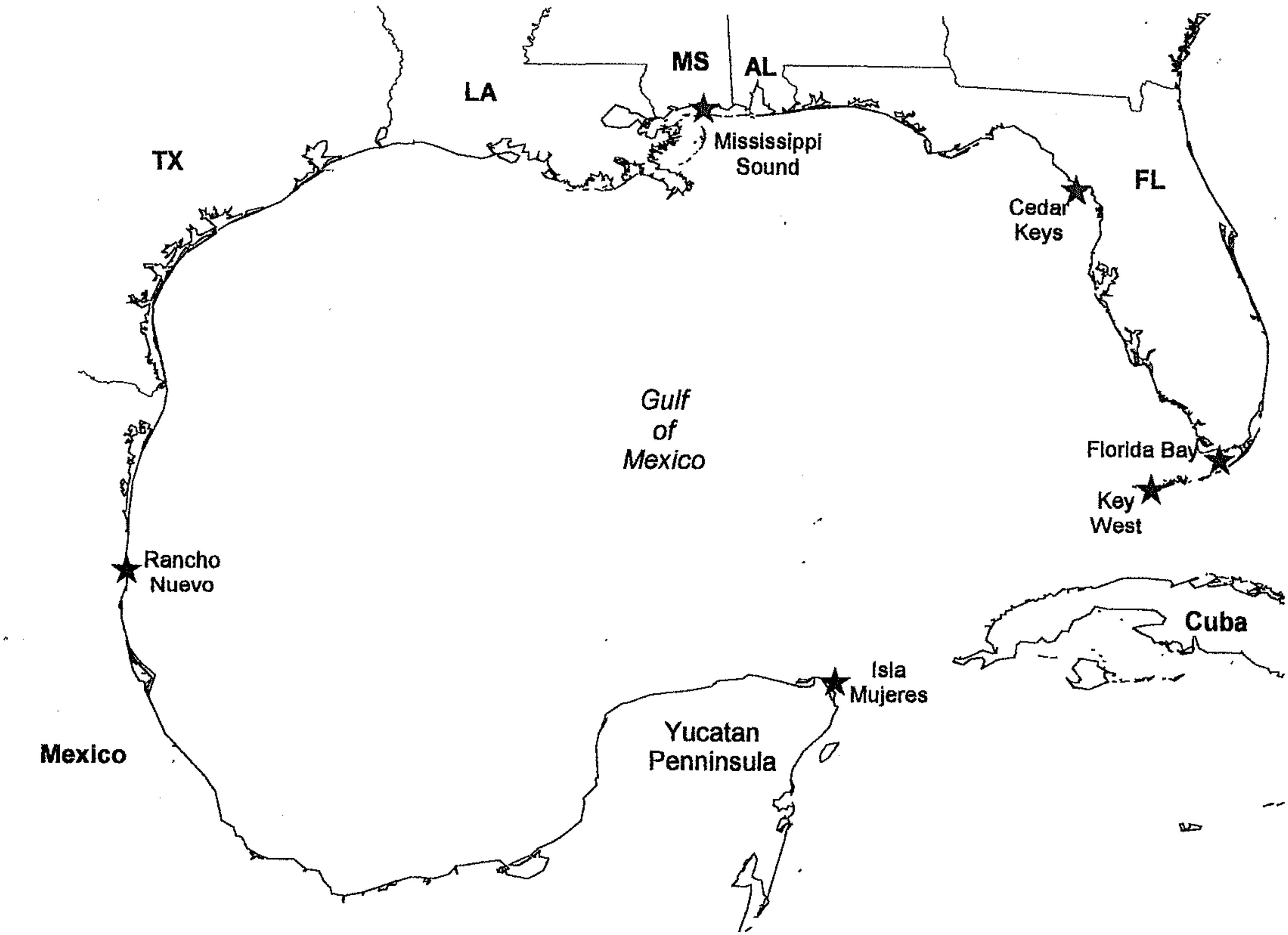

Figure 1) Locations (stars) of historic records for Kemp's ridley turtles in the Gulf of Mexico.

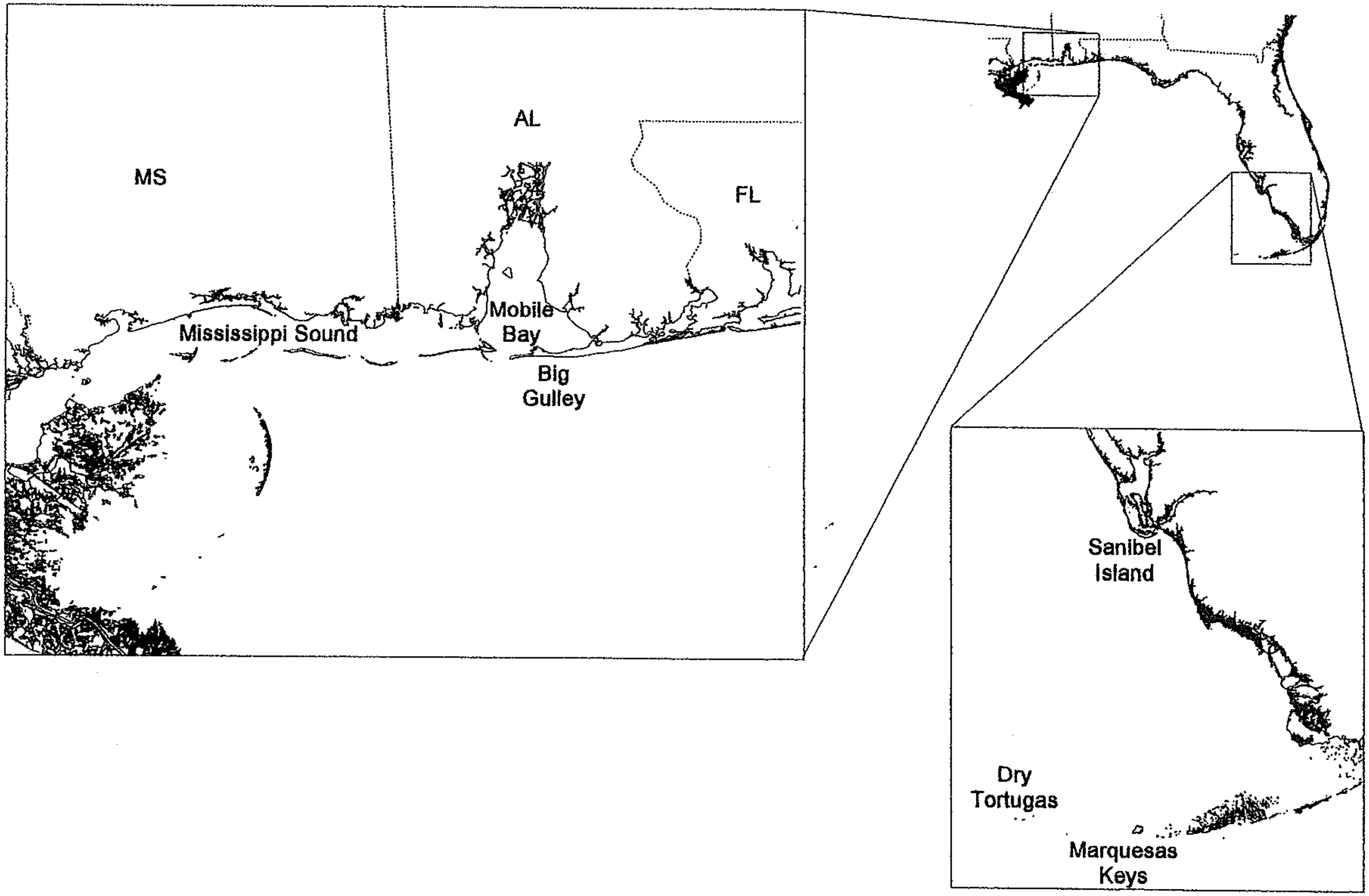

Figure 2) Locations of incidental captures of Kemp's ridley turtles in the eastern Gulf of Mexico.

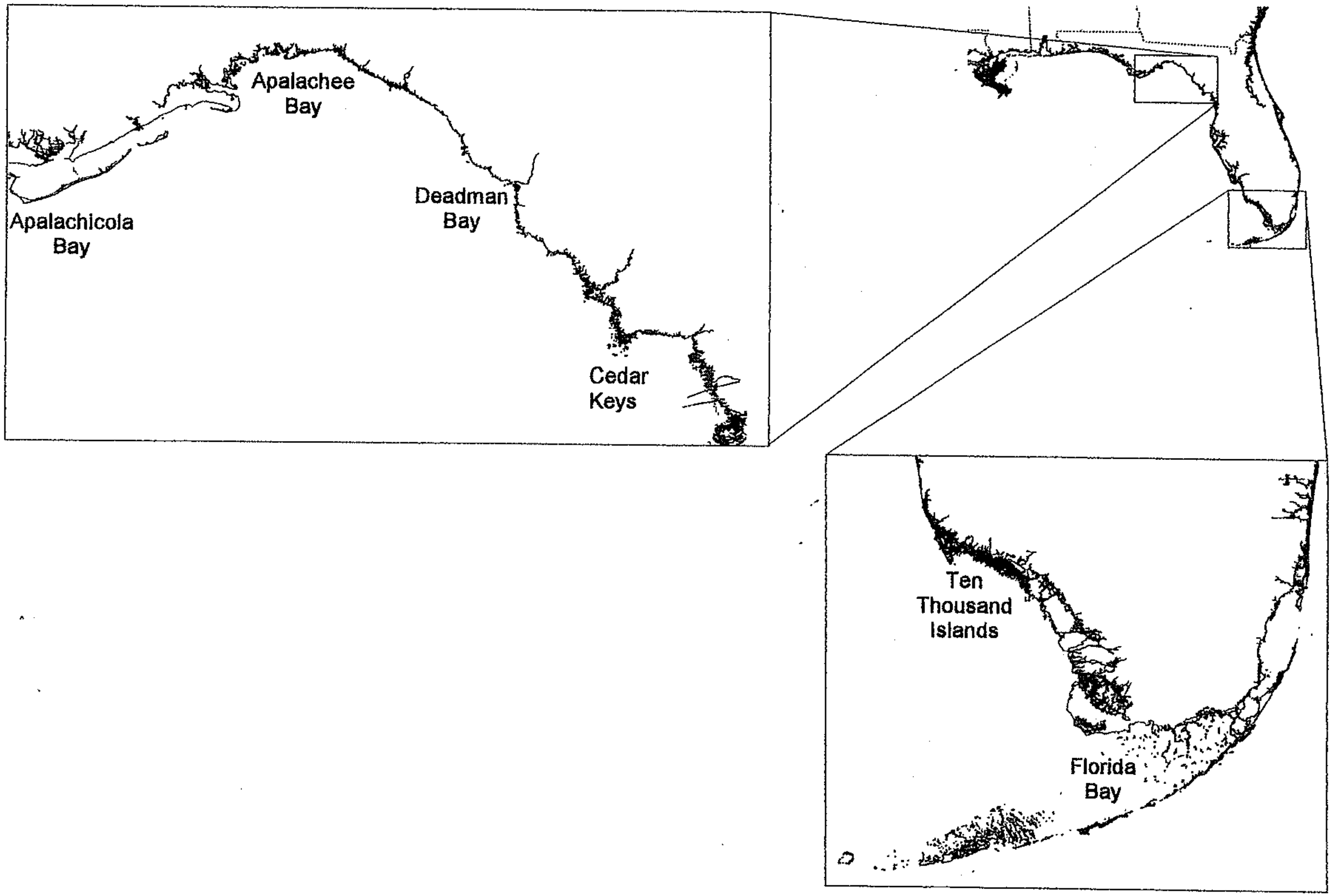

Figure 3) Locations of recent and ongoing tagging studies of Kemp's ridley turtles in the eastern Gulf of Mexico.

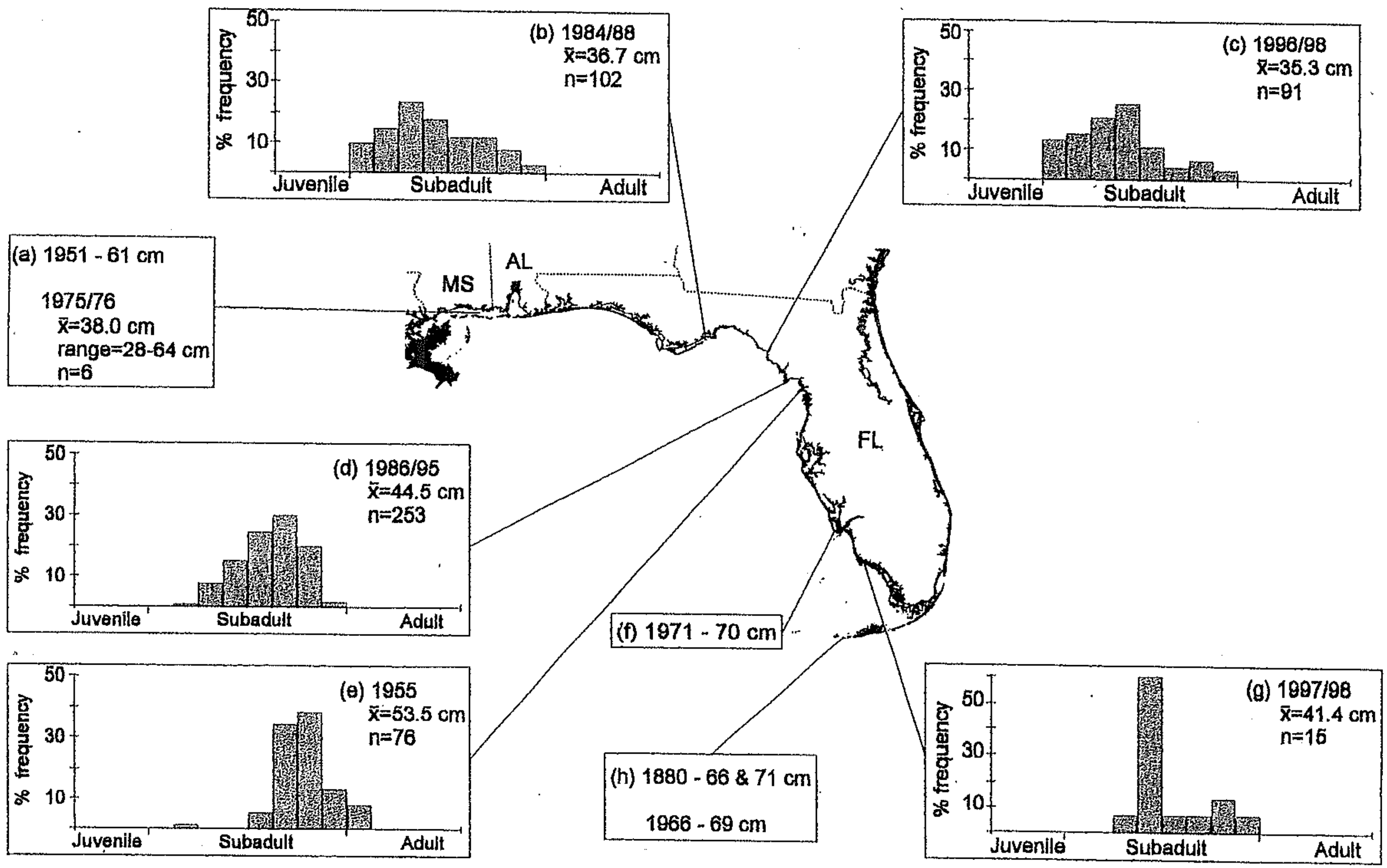

Figure 4) Length data for Kemp's ridley turtles in the eastern Gulf of Mexico: (a) Mississippi Sound (Smith and List, 1955; Carr, 1980), (b) Apalachicola-Apalachee Bays (Rudloe et al., 1991), (c) Big Bend-Deadman Bay (Sulak and Barichivich, unpubl. data), (d) Cedar Keys (Schmid, 1998), (e) Withlacoochee-Crystal Rivers (Carr and Caldwell, 1956), (f) Sanibel Island (LeBuff, 1990), (g) Ten Thousand Islands (Witzell and Schmid, unpubl. data), and (g) Key West (Garman, 1880; Sweat, 1969).

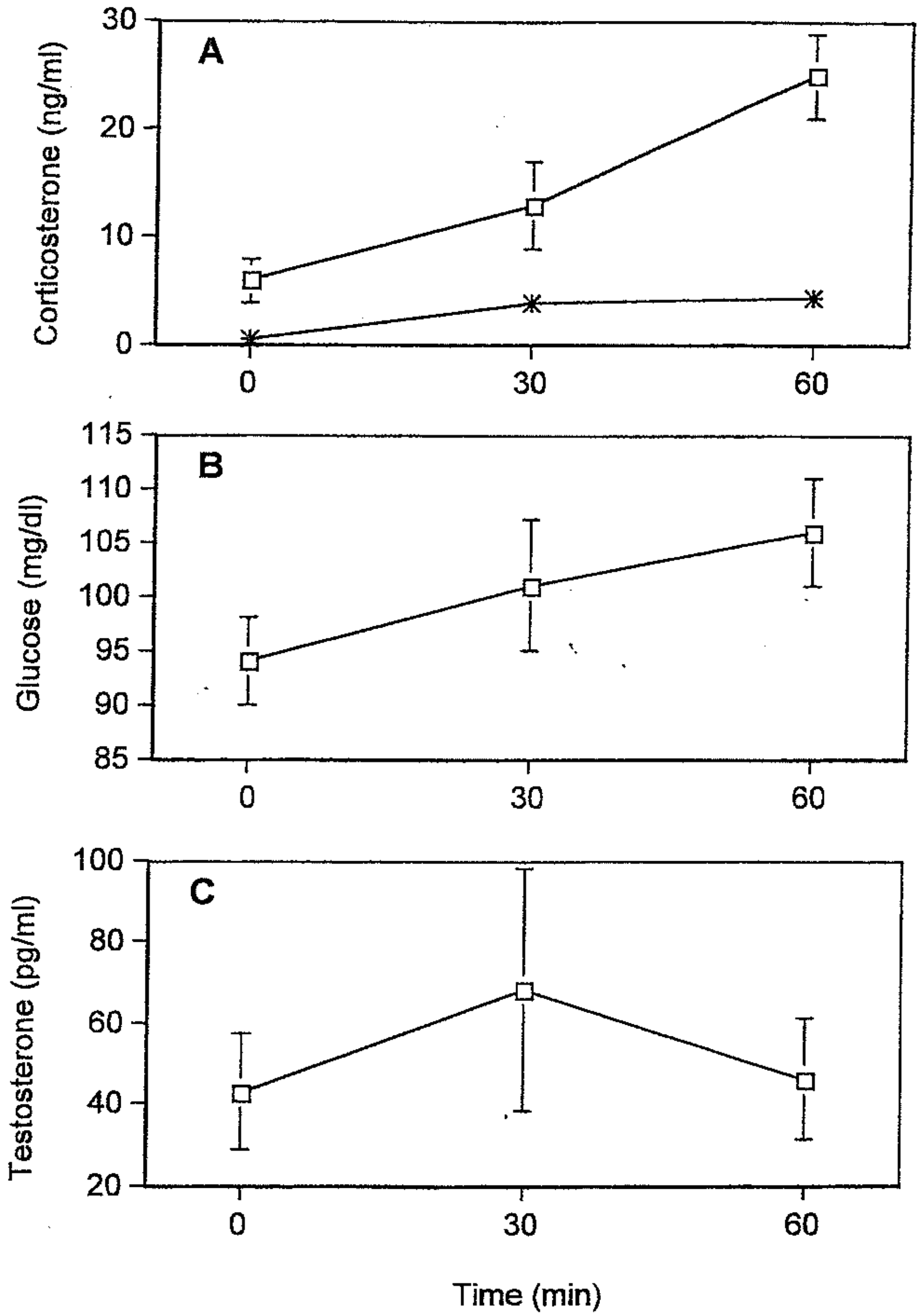

Figure 5) Mean plasma concentrations of (A) corticosterone, (B) glucose, and (C) testosterone in Kemp's ridley turtles over time (from Gregory and Schmid, in review). Asterisks indicate corticosterone concentrations for loggerhead turtles captured at the same time and place (Gregory et al., 1996).

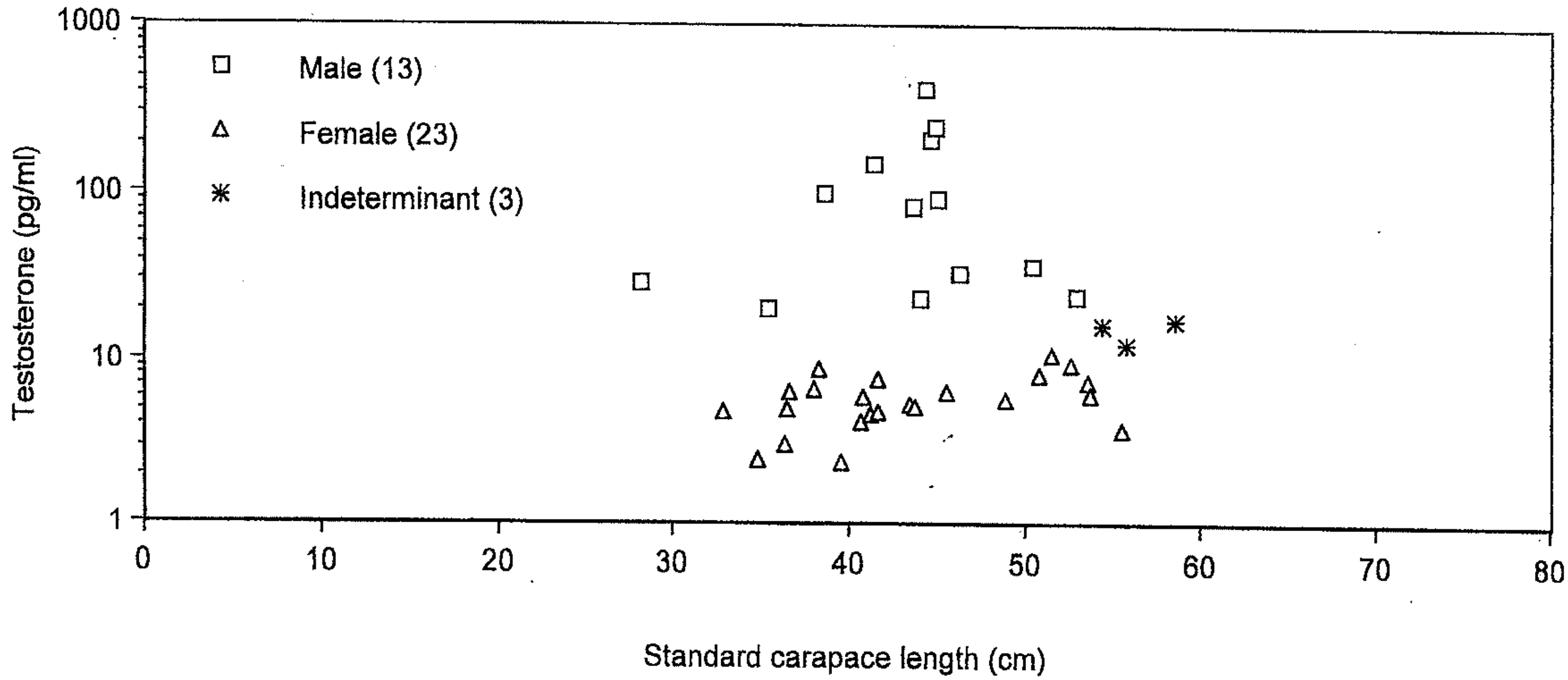

Figure 6) Initial plasma testosterone concentrations in Kemp's ridley turtles illustrating predicted sexes (from Gregory and Schmid, in review). Numbers in parentheses indicate sample sizes.