

Occurrence of neonate and juvenile sandbar sharks, *Carcharhinus plumbeus*, in the northeastern Gulf of Mexico

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The sandbar shark, *Carcharhinus plumbeus*, is a large, coastal species of the western north Atlantic occurring from Cape Cod, Massachusetts, to Brazil, including the Gulf of Mexico and Caribbean (Bigelow and Schroeder, 1948; Springer, 1960). Sandbar sharks are targeted by commercial fisheries and account for up to 60% of the large coastal shark landings in U.S. southern waters (NMFS, 1993). Adults are highly migratory and mostly congregate offshore. Neonate and juvenile sandbar sharks, on the other hand, are commonly found in coastal nursery areas where they feed (Medved et al., 1985) and avoid predation (Springer, 1967; Branstetter, 1990) during summer months.

The presence of neonate and juvenile sandbar sharks has been well documented in coastal areas of the eastern United States. Springer (1960) reported juvenile sandbar sharks from Cape Cod, Massachusetts, to Cape Canaveral, Florida. Juvenile sandbar sharks are abundant in Chesapeake Bay and eastern shore of Virginia in less than 10 m (Medved and Marshall, 1981; Musick et al., 1993). Castro (1993) found neonate and juvenile sharks in Bulls Bay, South Carolina. Pratt and Merson¹ determined Delaware Bay, New Jersey, as a major nursery area for neonate and juvenile sharks. Further attempts to delineate the extent of nursery areas for

sandbar sharks along the U.S. east coast continue (Damon, 1997; Pratt and Merson¹).

Juveniles are not known to occur in coastal areas of the eastern Gulf of Mexico. The direct correlation of juvenile sandbar shark survivorship and future stock size (Cortés, in press) requires delineation of sandbar shark nursery areas. Thus, if recruitment to the stock is assumed to be entirely from sharks from the U.S. east coast, then underestimates of total population size could occur and affect overall stock assessments. This paper reports on the occurrence of neonate and juvenile sandbar sharks and the potential nursery area of these sharks in coastal waters of the northeastern Gulf of Mexico.

Materials and methods

Sandbar sharks were captured from October 1992 to October 1997 as part of studies on the distribution and abundance of sharks in the eastern Gulf of Mexico. Because sampling had various objectives, the variability in sampling design and methods precluded quantification of a valid time series of abundance (e.g. CPUE) from 1992 to 1997. In general, gill nets varied in height from 1.52 to 3.04 m and ranged in length from 30.4 to 273.6 m, and mesh sizes from 6.9 to 20.3 cm stretched mesh. Each net, regardless of size, was anchored

at both ends and fished on the bottom. Longlines, which ranged in length from 76 to 335 m and consisted of 10–60 hooks, were anchored at both ends and fished so that one half fished the “midwater” and the other the “bottom.” Gangions were 0.9–1.8 m long and hooks were size 3/0 and 12/0 (Mustad). Usually menhaden (*Brevoortia* spp.) was the bait of choice.

The nets or longlines, or both, were set over a 24-h period at various times. Gill nets and longlines were checked, or checked and pulled, and sharks were removed throughout each sampling period. Surface water temperature (°C), salinity (ppt), and light transmission (cm) were measured daily at each station.

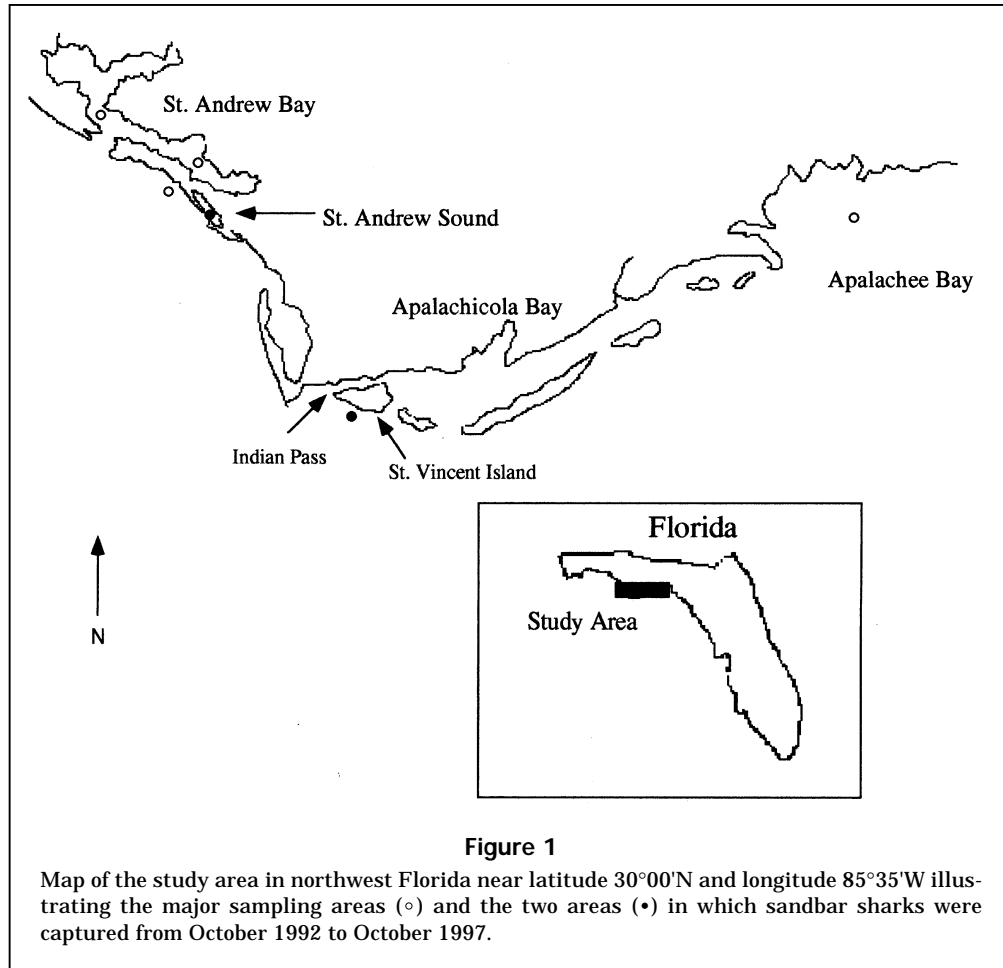
After they were caught, sharks were sexed and measured (total length, TL) to the nearest mm. Sharks that were in poor condition were euthanized for life history information; those in good condition were tagged with a multirecapture, nylon-head, dart tag (Hueter and Manire²) and released. Sampling took place April to October of each year, occasionally from November to March.

Study area

Sampling sites were located in four major areas along the northeastern portion of the Gulf, Apalachee Bay to St. Andrews Bay, Florida (Fig. 1).

¹ Pratt, H. L., and R. R. Merson. 1996. Delaware Bay sandbar shark nursery pilot study. Narragansett Laboratory, National Marine Fisheries Service, NOAA. Progress report, 23 p.

² Hueter, R. E., and C. A. Manire. 1994. By-catch and catch-release mortality of small sharks and associated fishes in the estuarine nursery grounds of Tampa Bay and Charlotte Harbor. NOAA NMFS/MARFIN Program. Project Rep. NA17FF-0378-01, 183 p.



The eastern part of this area has an irregular coastline, few beaches and enclosed bay systems, and has large amounts of submergent (*Thalassia* spp. and *Halodule* spp.) and emergent vegetation (*Spartina* spp. and *Juncus* spp.). The western part has numerous barrier islands and sand beaches and is composed of semi-enclosed bays. Tidal amplitude in the bays is highest in Apalachee Bay and generally decreases toward the west.

St. Andrew Bay consists of several embayments (average range 1.9–5.7 m deep) and has low fresh-water inflow, low turbidities, and high percentages of sand in the substrate. Salinity ranges from 13 to 32 ppt and tidal amplitude averages 0.48 m. The system exchanges water with the Gulf of Mexico through two passes, a natural pass at the east end and a man-made pass at the west end.

St. Andrew Sound is a small semi-enclosed marine lagoon with expanses of submergent vegetation. It is about 14.5 km long and 0.2–2.0 km wide and has water depths from 3.5 to 4.5 m deep (mean high tide). Salinity ranges from 25 to 36 ppt and tidal ampli-

tude averages 0.42 m. The sound exchanges water with the Gulf of Mexico through a pass (≈0.5–2.0 km wide) that was created near the center of Crooked Island by Hurricane Eloise in 1975.

Indian Pass is located at the western end of the Apalachicola Bay system. This area is about 2–3 km south of St. Vincent Island in the Gulf of Mexico where the average range of water depth is 5–10 m. The bay system surrounding this area is largely a line of barrier islands fronting the intersection of the Apalachicola delta and is the only bay system in Florida in which a large river system drains. As a result of river discharge, there is little submergent vegetation due to high turbidity. Salinity fluctuates from 15 to 35 ppt and tidal range is 0.66 m.

Apalachee Bay is an open ocean bay without barrier islands separating the area from the open Gulf of Mexico. The bay is broad, shallow (average 3 m), and extends about 15 km offshore. Salinity ranges from 22 to 36 ppt and tidal amplitude averages 1.0 m. Wave energy is low and the area has large expanses of submerged vegetation.

Results

Neonate and juvenile sandbar sharks ($n=105$) were captured in two areas of the northeastern Gulf of Mexico, Indian Pass, and St. Andrew Sound. Captured sandbar sharks were 572–1640 mm TL (Fig. 2). Seventeen were determined to be neonates and young-of-the-year (mean size= 643 ± 44.5 mm TL), as indicated by the presence of an open or partially healed umbilical scar. The largest sandbar shark with a partially healed umbilical scar was 720 mm TL. Following the age-length relationship provided in Sminkey and Musick (1995) and the life history stage classification in Cortés (in press) we estimated that 52 sharks were small juveniles (about 1–3 yr old), 34 were large juveniles (about 4–9 yr old), and 2 were subadults (about 10–12 yr old). Mature adults were not caught.

Sandbar sharks were captured in all years except 1995 (Fig. 3). The number of individuals collected was highest in 1993. Small juveniles were the dominant life stage captured in 1993 and 1997 and larger juveniles in 1994. Young-of-the-year, including neonates, were caught in all years sandbar sharks were captured.

The abundance and size of sharks varied with season (Fig. 4). Sandbar sharks were not captured until April when the water temperature approached 22°C. These were mostly small juveniles ranging in size from 800 to 1200 mm TL. Neonates were first captured in June when temperatures reached 25°C and young-of-the-year continued to be caught through October.

There was a significant relationship between abundance and water temperature ($r^2=0.25$, $P=0.008$), but not with salinity or turbidity ($P \geq 0.05$). Sandbar sharks were most abundant during summer months when all size classes were caught. Few larger juveniles were caught in fall.

Discussion

Presence of neonate and juvenile sandbar sharks in the northeastern Gulf of Mexico suggests that sand-

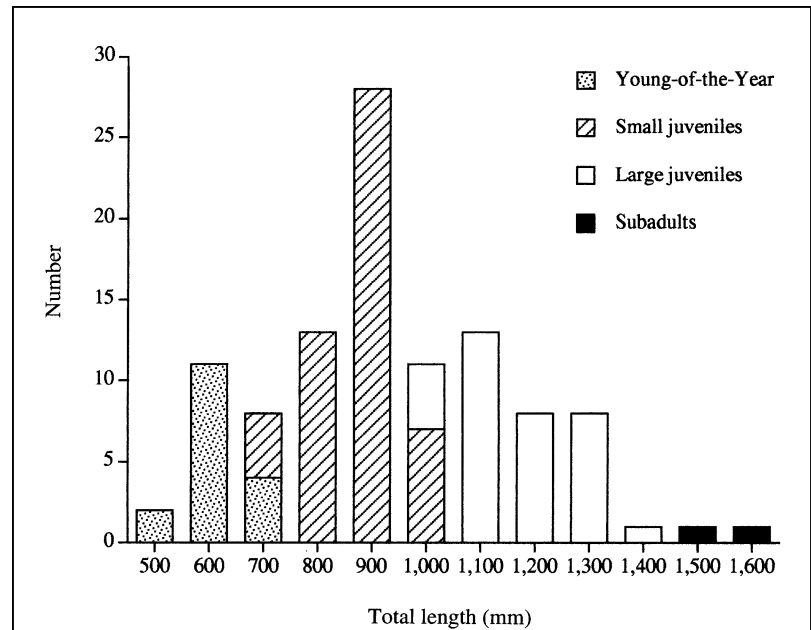


Figure 2

Length-frequency distribution of all sandbar sharks ($n=105$) by life history stage caught in gill nets and longlines from October 1992 to October 1997. Young-of-the-year includes neonates.

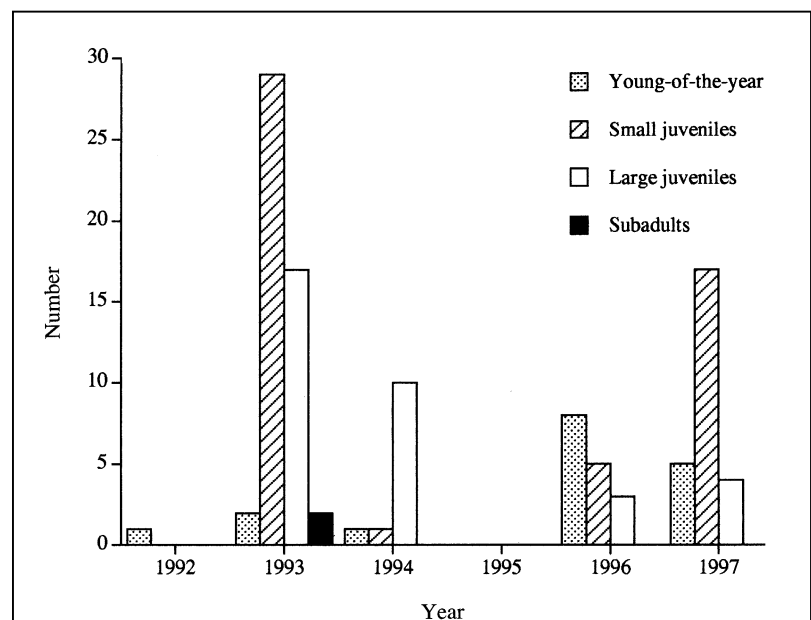
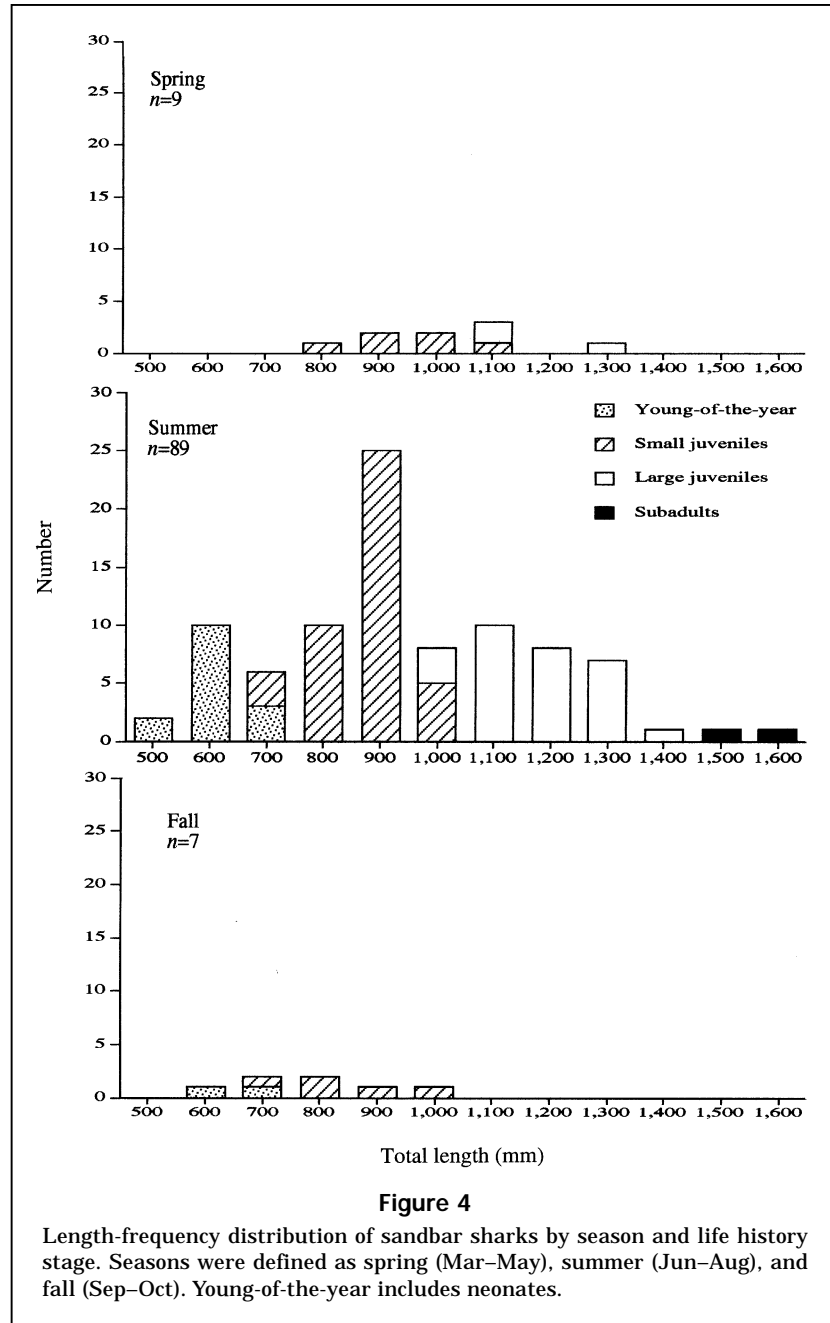


Figure 3

Overall abundance of sandbar sharks captured by year and life history stage from October 1992 to October 1997. Young-of-the-year includes neonates.

bar sharks pup in the eastern Gulf of Mexico. Springer (1960) proposed the existence of two breeding populations of sandbar sharks, one off the mid-Atlantic coast



of the United States, one in the western Gulf of Mexico. Bigelow and Schroeder (1948) captured one sandbar shark that was 747 mm TL off the Texas coast, and Springer (1960) took a few females with full-term pups near the mouth of the Mississippi River. Branstetter (1987) captured two neonates (67 and 69 cm TL) from Galveston Bay, Texas. Some evidence of possible pupping areas in the eastern Gulf of Mexico was presented by Clark and von Schmidt (1965), who captured gravid females off Sarasota, Florida, and Branstetter (1981), who reported on six gravid females from a Shark Rodeo off Pensacola, Florida. However,

no neonate or juvenile sharks have been previously reported from the eastern Gulf of Mexico.

Sandbar shark distribution in the northeastern Gulf of Mexico was limited to the mouth of the Apalachicola River, near St. Vincent Island; none were caught in three additional areas sampled and only two were captured in St. Andrew Sound. Although all areas sampled vary in environmental parameters, none of the environmental conditions measured appeared to be associated with the distribution of juvenile sandbar sharks. It is possible that sandbar sharks are attracted by the abundance of

prey and bycatch from intense commercial shrimping operations that occur in the area surveyed at the mouth of the Apalachicola River.

The absence of gravid females in the survey does not preclude the presence of a pupping and nursery area. Females may be pupping farther inshore or offshore from the sampling area, at times when sampling did not occur or sampling gear may have had reduced efficiency at capturing larger sharks. Female sharks are reported to move into Chesapeake Bay to pup when water temperatures reach 18–20°C (Grubbs, 1996), and most sampling in this study began in April when water temperatures were usually above 20°C. In addition, mature female sandbar sharks are large (>1800 mm TL; Sminkey and Musick, 1995) and it is likely that they were able to avoid the sampling gear.

Neonate sandbar sharks (<age 1) usually reside in primary nursery areas where they were born through the first summer (Pratt and Merson¹); thus it is unlikely that individuals captured in this area underwent significant migrations from another area. The paucity of tag and recapture information in the Gulf of Mexico also complicates understanding of the geographical and seasonal distribution of neonate and juvenile sandbar sharks. Future research should be focused on further delineation and annual monitoring of hypothesized nursery areas for sandbar sharks and on increasing ongoing tagging efforts.

Acknowledgments

Thanks are given to L. Trent who began determining the distribution of sharks in the northeastern Gulf of Mexico in 1992. B. Blackwell, N. Lewis, and M. Miller helped with sampling. E. Cortés and D. DeVries suggested valuable improvements on an earlier version of this manuscript. This research was funded by NOAA/National Marine Fisheries Service/Highly Migratory Species Office and the Southeast Fisheries Science Center, National Marine Fisheries Laboratory, Panama City.

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