SHARK NURSERY GROUNDS AND ESSENTIAL FISH HABITAT STUDIES

GULFSPAN GULF OF MEXICO-FY06
Cooperative Gulf of Mexico States Shark Pupping and Nursery Survey

REPORT TO NOAA FISHERIES, HIGHLY MIGRATORY SPECIES OFFICE

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BACKGROUND

Identification and conservation of essential fish habitat are important components of providing adequate management and conservation for shark populations. This is of particular importance when attempting to understand the dynamics of sharks in coastal nursery areas. This report describes results from the Cooperative Gulf of Mexico Shark Pupping and Nursery Project (GULFSPAN) for 2006.

METHODS

Surveys were modeled after those developed by Carlson and Brusher (1999) to provide a direct comparison of abundance among areas. A 186-m long gill net consisting of six different mesh size panels was used for sampling in all areas. Stretched mesh sizes ranged from 7.6 cm (3.0") to 14.0 cm (5.5") in steps of 1.3 cm (0.5"). In July, an additional panel with stretched mesh 20.3 cm (8.0") was added to the survey in the panhandle of Florida. The sampling gear was randomly set within each area based on depth strata and GPS location. Nets were fished in the panhandle of Florida and Mississippi from April to October. Captured sharks were measured (precaudal, fork, total, and stretched total length), sexed, and life history stage assessed and recorded (young-of-the-year, juvenile, or adult). Sharks that were in poor condition were sacrificed for life history studies and those in good condition were tagged and released. Rays captured were measured in disc width and sexed. Because of the limited life history information for most ray species, a life history category could not always be assigned in the field. For each set of the gear, mid-water temperature (^{o}C), salinity (ppt), and dissolved oxygen (mg l^{-1}) were recorded from a YSI-85 environmental meter, average depth (m) was calculated using gear start and end points recorded from the vessel's depth finder, water clarity (depth of the photic zone, cm) was measured by secchi disc, and qualitative habitat type was (e.g., mud, sand, oyster, etc.) determined by personal observation or previously documented literature.

RESULTS

1. Panhandle of Florida

Abundance trends

Sampling sites were located in four major areas along the panhandle of Florida: St. Andrews Bay, Crooked Island Sound (Figure 1), St. Joseph Bay, the Gulf of Mexico-side of St. Vincent and St. George Islands, and Apalachicola Bay, FL (Figure 2). A total of 146 sets were made, capturing 9 species of sharks and 5 species of rays. The majority of individuals encountered were immature.

The Atlantic sharpnose shark, *Rhizoprionodon terraenovae*, a member of the small coastal management group, was the most abundant shark captured (24-89 cm FL, mean = 59.5 cm FL; Table 1a). The bonnethead shark, *Sphyrna tiburo*, was the second most abundant shark species encountered (42-86 cm FL, mean = 61.6 cm FL; Table 1d). The blacktip shark, *Carcharhinus limbatus*, was the third most abundant species captured overall and the most abundant shark captured from the large coastal management group (48-150 cm FL, mean = 80.3 cm FL; Table 1c). The remaining species captured in decreasing abundance were the spinner shark, *C. brevipinna* (47-103.5 cm FL, mean = 70.2 cm FL; Table 1i), finetooth shark, *C. isodon* (43-114 cm FL, mean = 92.6 cm TL; Table 1f), scalloped hammerhead shark, *S. lewini* (33-86 cm FL, mean = 46.6 cm TL; Table 1h), blacknose shark, *C. acronotus* (36-41 cm FL, mean = 39 cm FL; Table 1b), bull shark, *C. leucas* (150-200 cm FL, mean = 170 cm FL; Table 1e), and Florida smoothhound, *Mustelus norrisi* (37-41 cm FL, mean = 39 cm FL; Table 1g).

The cownose ray, *Rhinoptera bonasus*, was the most abundant ray captured (38-100 cm DW, mean = 74.2 cm DW; Table 2c). One of each of the other three ray species was captured: bluntnose stingray, *Dasyatis sayi* (36 cm DW; Table 2a), clearnose skate, *Raja eglanteria*, (32 cm DW; Table 2b), smooth butterfly ray, *Gymnura micrura* (34 cm DW; Table 2d), and southern stingray, *D. americana* (17 cm DW; Table 2e).

Species Essential Fish Habitat Profiles

Essential fish habitat requirements (EFH; e.g., temperature, salinity, and dissolved oxygen) for elasmobranchs collected in the panhandle of Florida were relatively similar (Tables 3-16).

As the majority of life stages of sharks collected were young-of-the-year and juveniles, areas in the panhandle of Florida remain important potential nurseries for both large and small coastal shark species (Table 3-11). In general, young-of-the-year sharks were more often collected in shallower water with higher temperature, lower salinity, and more turbid conditions compared to juveniles and adults. These small, young sharks may be selecting these habitats as a haven from larger, more active predators.

Except for the cownose ray, EFH requirements for ray species were sparse (Table 12-16). Cownose ray data suggests that adults can tolerate a much wider range of environmental factors than smaller life stages (Table 14).

Predator-prey and trophic relationships

To examine variation in diet and daily ration of the bonnethead, *S. tiburo*, sharks collected from three areas in the eastern Gulf of Mexico: northwest Florida (~29^{o}40’N, 85^{o}13’W), Anclote Key near Tampa Bay (~28^{o}10’N, 82^{o}42.5’W), and Florida Bay (~24^{o}50’N, 80^{o}48’W) from March through September, 1998-2000. In each area, diet was assessed by life stage (young-of-the-year, juveniles, adults) and quantified using five indices: percent by number (%N), percent by weight (%W), frequency of occurrence (%O), the index of relative importance expressed on a percent basis (%IRI), and %IRI based on diet category (%IRI_{DC}). Diet could not be assessed for young-of-the-year in Tampa Bay or Florida Bay owning to low sample size. Diet analysis showed an ontogenetic shift in northwest Florida and Florida Bay. Young-of-the-year from northwest Florida (n=68, 1 empty) fed on a mix of crustaceans and seagrass while juvenile (n=82, 0 empty) and adult stomachs (n=39, 1 empty) contained almost exclusively crabs. Juveniles from Florida Bay (n=72, 0 empty) shifted from feeding on a mix of crustaceans and seagrass to shrimp and cephalopods as adults (n=82, 3 empty). Crabs and seagrass made up the majority of both juvenile and adult diet in Tampa Bay (n=79, 2 empty, and n=88, 1 empty, respectively). Diets in northwest Florida and Tampa Bay were similar. The diet in Florida Bay was different from those in the other two areas, consisting of fewer crabs and more cephalopods and lobsters. Using species- and area-specific inputs, a bioenergetic model was constructed to estimate daily ration. Daily ration was significantly different by sex, life stage, and region. The bioenergetic model predicted increasing daily ration estimates with decreasing latitude and decreasing daily ration estimates with ontogeny. These results provide evidence that bonnetheads continuously exposed to warmer temperatures have elevated metabolism and require additional energy consumption to maintain growth and reproduction. Results of this study are currently in review for submission to the journal of Marine Biology (Bethea et al., in review). Colleagues at the University of Hawaii have found that heavy isotope analysis of juvenile bonnethead muscle tissue from the northeast Gulf of Mexico shows low carbon and nitrogen levels. This may indicate a food web based on seagrass. In the future, heavy isotope analysis of blue crab tissue and pH data-loggers in captive bonnetheads will be used to help determine if this shark can assimilate plant tissue.

To evaluate trophic role, the diet and feeding habits of the roundel skate, *Raja texana*, are being examined from offshore waters in the northern Gulf of Mexico. Preliminary diet was assessed by life-stage and quantified using six indices: percent by number, percent by weight, frequency of occurrence, the index of relative importance (IRI), IRI expressed on a percent basis (%IRI), and %IRI based on prey category (%IRI_{PC}). Analysis of stomachs from 31 juveniles (25 non-empty; mean DW=23.5 cm) and 46 mature individuals (39 non-empty; mean DW=32.2 cm) indicate shrimp make up 95 %IRI_{PC} of juvenile skate diet with Family Solenoceridae as the most important (22.1 %IRI). Osteichthyes (Atlantic croaker, *Micropogonias undulatus*, and *Ophidium* sp.) were also found in the diet of juvenile skates although in much smaller amounts (0.9 %IRI and 2.9 %IRI, respectively; 3.2 %IRI_{PC} overall). Mature skate diet was also predominantly shrimp (58.6 %IRI_{PC}). Crab and other crustaceans (e.g., *Squilla* sp.) were also found in the diet (2.3 and 17.4 %IRI_{PC}, respectively). Osteichthyes (all unidentifiable) made up 21 %IRI_{PC} of mature skate diets. Preliminary analysis does not indicate ontogenetic diet shifts; however, mature individuals consistently have larger and more than one prey item or type in their stomachs. Preliminary results of this study were presented at the skate symposium at the 2006 Joint Meeting of the American Society of Ichthyologists and Herpetologists and the American Elasmobranch Society (Bethea and Hale, In prep). Specimen collection for this study will continue in 2007.

Telemetry

Acoustic array

In March 2006, an array of stationary underwater acoustic receivers (VEMCO Ltd. VR1) was placed in Crooked Island Sound, FL, for a third and final season of data collection on age-1 Atlantic sharpnose sharks, *R. terraenovae*. The array consists of 12 acoustic receivers and is used to continuously monitor movements of individuals from May through October in an area of ~30 km^2. HOBO data loggers (Onset Computer Corp. UA-002-64) were attached to four VR receivers throughout the bay. HOBO data loggers monitor temperature and light intensity every 30 minutes. The data collected by this system are currently being used in a broad range of studies to help better understand the role of elasmobranchs within the estuary, study changes in habitat use through time, examine intra- and inter-specific relationships (e.g. predator-prey, competition, and group dynamics), and determine how anthropogenic (e.g., water use patterns and habitat alteration) and natural disturbances (e.g., hurricanes and red tide) impact resource use.

Analysis of data from 2004 and 2005 indicate that of the 45 sharks monitored, 3 died, 6 left the bay after only a few days and never returned, and 36 moved freely in and out of the bay (Figure 3). Of those 36 animals, 31% stayed less than 1 week, 56% stayed up to 2 weeks, and 13% stayed longer than 2 weeks (all time periods measured immediately after release). Of sharks that left the bay within 1 week of release, 50% returned at some point during the summer. Of those that left with in 2 weeks of release, 44% returned. These results are different than those previously obtained for blacktip sharks from a similar sized bay (Heupel et al., 2004) where sharks spent over 100 days in residence in that system. Our results contradict commonly held theory that sharks remain in distinct coastal areas throughout summer months.

Pop-off satellite archival tags

To examine the short- and long-term location, movement, and better define habitat use, bull sharks, *Carcharhinus leucas*, were outfitted with satellite pop-up archival transmitting (PAT) tags along the gulf coast of Florida. Sharks were captured with gillnets or longlines, the tag attached to the dorsal musculature below the base of the dorsal fin with a large nylon anchor, length estimated and released. Tags were programmed to deploy after a period of 90 days. To date, 10 bull sharks (5 in 2005 and 5 in 2006) were fitted with satellite pop-up archival transmitting (PAT) tags along the northern Gulf of Mexico coast of Florida. These tags were deployed in July/August and released at various times during the fall.

Data analyzed to date indicates bull sharks made excursions to up to 15 m of depth during the day and night (Figure 4). However, the majority of the time individuals were recorded in shallow, turbid water less than 5 m deep (Figure 5). Geolocation data suggest that sharks did not move far from their capture location during the time period sampled (up to 3 months). These results suggest that bull sharks may be spending large blocks of time in shallow coastal waters, where they are likely to interact with fishers and bathers. Further analysis will be performed to extend our knowledge of EFH for this species. New Mark 10 PAT tags (Wildlife Computers, Inc.) will be deployed in 2007 that record conductivity to better determine when sharks are using river mouths and in high salinity areas.

Tag Recapture Data

Two basic types of tags are used in the panhandle of Florida: 1) a dart tag (7, 10, and 18 cm long; Floy Tag Manufacturing), placed in the flesh at the base of the first dorsal fin, and 2) a roto-tag (4.5 cm long; Premier Tags), punched through the cartilage of the first dorsal fin. Until recently, the 18 cm dart tags were provided by NOAA Fisheries Narragansett Lab. This report does not reflect sharks recaptured with those tags. In 2006, 500 sharks were tagged by NOAA Fisheries Panama City Laboratory.

Tag recapture data was collected for 9 sharks. Of those, 6 were Atlantic sharpnose, *R. terraenovae*, 2 were finetooth, *C. isodon*, and 1 was a spinner shark, *C. brevipinna*. Data on these sharks were returned by recreational anglers using hook and line, GULFSPAN surveys using gillnet, and commercial fishermen (Table 17). The shark at liberty the longest was a female finetooth shark. She was tagged on April 6, 2004, on the gulf-side of St. Vincent Island, FL, and recaptured 814 days later on June 29, 2006, 9 miles south of Biloxi, MS. The shark that traveled the longest distance was a female Atlantic sharpnose shark. She was tagged in Crooked Island Sound, FL, and recaptured 50 miles south of Venice, LA, traveling almost 400 km (Table 17).

2. Mississippi

Catch rates

A total of 40 sets at 11 sampling stations were performed in Mississippi coastal waters (Figure 6). A total of 109 sharks were collected, representing six species, 73 % of which were immature. Atlantic sharpnose, *R. terraenovae* (44.7-100.0 cm, TL), was the most abundant species caught followed by finetooth, *C. isodon* (56.9-133.60 cm, TL), blacktip, *C. limbatus* (95.2-138.5 cm, TL), bull, *C. leucas* (94.0-150.0 cm, TL), bonnethead, *S. tiburo* (78.1-95.9 cm, TL), and spinner shark, *C. brevipinna* (74.6-79.5 cm, TL). Six rays were collected representing three species, cownose ray, *R. bonasus* (30.0-87.5 cm, DW), Atlantic stingray, *D. sabina* (25.5-27.5 cm, DW), and southern stingray, *D. americana* (40.7 cm, DW).

Similar to 2005, Round Island was the most productive location (4.1 ± 1.7 sharks net hr^{-1}), followed by Horn Island (3.7 ± 0.8 sharks net hr^{-1}), Cat Island (1.7 ± 1.0 sharks net $hr^{-1)}$, Davis Bayou (0.5 ± 0.3 sharks net hr^{-1}), and Deer Island (0.0 sharks net hr^{-1}; Table 2). Monthly nominal catch rates typically peak during the summer and decline during the fall months; however, catch rates in 2006 were relatively constant from April (2.67 sharks net hr^{-1}) to August (3.2 sharks net hr^{-1}), followed by a noticeably decline in September (0.71 sharks net hr^{-1}) and an unusual peak in October (3.8 ± 3.8 sharks net hr^{-1}) . The unknown effects of Hurricane Katrina combined with a severe drought experienced during 2006 may have contributed to this change in seasonal catch rates.

For all combined life stages, Atlantic sharpnose, finetooth, spinner, bull shark, and cownose rays were most abundant off Round Island while blacktip and Atlantic sharpnose sharks, and southern stingrays were most frequently caught off Horn Island. Bonnethead sharks and Atlantic stingrays were collected in waters north of Cat Island. The bull shark was the only species collected from Davis Bayou (Tables 18-19).

Species Essential Fish Habitat Profiles

Information on essential fish habitat requirements (e.g., temperature, salinity, etc.) for the six shark and three rays species were relatively similar (Tables 20-26), however, there were a few interesting observations. The majority of sharks collected in this study were immature, indicating that the Mississippi Sound may be an important nursery area for several shark species. In general, juvenile and young-of-the-year life stages appeared to prefer the shallow, warmer, lower salinity, and more turbid waters compared to adults (Tables 20-25). These small sharks may be selecting shallow water habitats, and as a result these waters are warmer and typically have more of a freshwater influence, which lowers both salinity and turbidity.

The bull shark was the only species encountered at Davis Bayou. This is likely due to the preference of low salinity by young-of-the-year and juvenile life stages. Spinner sharks were only collected during the fall, a pattern observed for a number of years (Hoffmayer, unpub data), indicating a preference for cooler water temperature (Table 25). The Atlantic stingray, southern stingray, and cownose ray are common within the waters of the Mississippi Sound. All rays were collected at the barrier islands (Horn, Cat, and Round) in waters with relatively high salinity, warm water temperature, and similar bottom type (Table 26).

Tag Recapture Data

A total of 71 sharks were tagged and released in Mississippi coastal waters during 2006. The Atlantic sharpnose, *R. terraenovae* (n=33), and finetooth shark, *C. isodon* (n=18), were the most abundant species tagged. Other species tagged include blacktip, *C. limbatus* (n=5), bonnethead, *S. tiburo* (n=5), spinner, *C. brevipinna* (n=3), and bull shark, *C. leucas* (n=2) as well as the cownose ray, *R. bonasus* (n=2), Atlantic stingray, *D. sabina* (n=2), and southern stingray, *D. americana* (n=1).

Tag recapture data was collected on one shark using University of Southern Mississippi tags. An Atlantic sharpnose shark was recaptured 598 days after and 31.4 km from where it was originally tagged.

3. Louisiana

Southeastern Louisiana was hit by Hurricanes Katrina and Rita in 2005, causing severe damage to the coastal zone surrounding the Mississippi River. Research could not be completed in the sampling areas in Louisiana in 2006 as several marinas and launching facilities were still unavailable.

4. Florida Big Bend Area

GULFSPAN was expanded in 2006 to include the Florida Museum of Natural History. Funds were provided to initially sample in the Florida-Cedar Key Area north to Apalachee Bay. Elasmobranch distribution and abundance in this area is still relatively unknown. Regrettably, the principal investigator became ill and hospitalized early in the season and sampling could only be performed once. However, with funds provided in 2006, sampling will begin in April 2007 prior to a time when funds are usually allocated.

STOCK ASSESSMENT

Fishery-independent estimates of relative abundance are presently limited but can be the best estimator of the status of shark stocks. Data collected as part of the GULFSPAN project has been and will be incorporated into stock assessment models (Cortés, 2002; Cortés et al., 2002; Carlson and Bethea, 2005; Hoffmayer and Parsons, 2005). Because surveys in this project are designed to target juvenile sharks, estimates of juvenile abundance provide promising alternatives to traditional hind-casting models and improve the ability to assess current and future shark stock size and strength. In addition, catch rate information for juvenile sharks is critical in developing age-structured stock assessment models.

Data from Mississippi and panhandle of Florida will be used in the upcoming small coastal SEDAR in 2007.

CONCLUSIONS

New information on habitat preferences and essential fish habitat is emerging as this study concludes its fourth year. No juvenile sandbar sharks, *C. plumbeus*, were encountered this year. Atlantic sharpnose, *R. terraenovae*, blacktip, *C. limbatus*, and bonnethead, *S. tiburo*, as well as cownose rays, *R. bonasus*, continue to be found throughout all areas. Interestingly, Mississippi waters showed unexpected fluctuations in catch rates over the season. This may be due to Hurricane Katrina and the drought experienced this year. Evidence from habitat association tables still indicates that bull sharks inhabit the most diverse environmental conditions. They were captured in salinities ranging from 16.8 ppt (in Mississippi) to 33.9 ppt (in panhandle of Florida). Bull sharks were found over a variety of habitats; however, the areas of highest abundance were those adjacent to freshwater inflow.

Again this year, sampling in the panhandle of Florida occurred just inside Sikes Cut in Apalachicola Bay, FL. Sets made in these locations were few; however, presence/absence data continues to show that fewer elasmobranchs and potential prey species were caught inside the bay as opposed to the gulf-side of St. Vincent Island. This may be due to habitat structure and prey availability. Salinity inside Apalachicola Bay is low due to freshwater outflow from the Apalachicola River and bottom type is mostly shallow water over oyster beds and mud. The gulf-side of St. Vincent Island is a mix of clay, sand, and mud over a limestone bottom (Livingston, 1984) and several potential prey species are collected there throughout the year (Bethea and Carlson, unpubl data). Only one set was made on the gulf-side of St. George Island due to weather and time restraints. These areas will continue to be covered in the coming year.

Information critical to Essential Fish Habitat continues to develop regarding trophic relationships and feeding habitats in elasmobranchs. While preliminary, results show that roundel skates feed mostly on shrimp and crab species regardless of predator size. Similar to Atlantic sharpnose sharks, bonnethead sharks have very different diets depending on area. Bonnethead sharks in the north and eastern Gulf of Mexico feed heavily on decapod crabs while those in the southeastern gulf take more lobster and cephalopods. Variations in diet composition between areas are likely due to differences in habitat structure and availability of potential prey species. These variations could affect growth. Additionally, bonnethead sharks in throughout the eastern Gulf of Mexico have large amounts of plant material in their diet – something that has not been documented in any other species of shark. Whether or not plant material provides this species of shark with any nutritional value is still to be determined.

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Table 1. Summary of CPUE (number of sharks/net/hour) for sharks by life history stage and major area sampled in the panhandle of Florida for FY-06. Means (standard deviations) are presented. Young-of-the-year includes neonate life stage. Specimens with an undetermined life stage are included in total CPUE calculation. Species are listed alphabetically by common name.

(a) Atlantic sharpnose shark, *Rhizoprionodon terraenovae*

Life stage	St. Andrew Bay	Crooked Island Sound	St. Joseph Bay	Apalachicola Bay	Gulf-side of St. Vincent Island
Young-of-the-year	--	1.62 (2.79)	1.23 (2.64)	--	0.72 (2.69)
Juveniles	0.03 (0.17)	1.10 (1.81)	2.39 (4.98)	2.50 (3.54)	0.26 (0.92)
Adults	0.03 (0.17)	1.52 (2.14)	2.03 (2.75)	1.00 (1.41)	3.37 (5.61)
All	0.05 (0.24)	4.25 (4.03)	5.74 (7.43)	3.50 (4.95)	4.39 (6.29)

(b) Blacknose shark, *Carcharhinus acronotus*

Life stage	St. Andrew Bay	Crooked Island Sound	St. Joseph Bay	Apalachicola Bay	Gulf-side of St. Vincent Island
Young-of-the-year	--	0.15 (0.51)	0.05 (0.32)	--	--
Juveniles	--	--	--	--	--
Adults	--	--	--	--	--
All	--	0.15 (0.51)	0.05 (0.32)	--	--

(c) Blacktip shark, *Carcharhinus limbatus*

Life stage	St. Andrew Bay	Crooked Island Sound	St. Joseph Bay	Apalachicola Bay	Gulf-side of St. Vincent Island
Young-of-the-year	--	0.06 (0.44)	0.03 (0.16)	--	0.52 (2.09)
Juveniles	--	0.30 (0.62)	0.40 (1.00)	--	1.20 (1.07)
Adults	0.09 (0.29)	0.02 (0.15)	0.05 (0.22)	--	0.11 (0.26)
All	0.09 (0.29)	0.38 (0.82)	0.48 (1.19)	--	1.83 (3.57)

(d) Bonnethead shark, *Sphyrna tiburo*

Life stage	St. Andrew Bay	Crooked Island Sound	St. Joseph Bay	Apalachicola Bay	Gulf-side of St. Vincent Island
Young-of-the-year	--	0.07 (0.33)	0.01 (0.08)	--	--
Juveniles	0.03 (0.17)	1.00 (2.50)	0.80 (1.77)	--	0.02 (0.10)
Adults	0.06 (0.34)	0.20 (0.77)	0.95 (3.81)	0.50 (0.71)	0.33 (0.70)
All	0.09 (0.38)	1.38 (3.23)	1.76 (5.30)	0.50 (0.71)	0.35 (0.73)

(e) Bull shark, *Carcharhinus leucas*

Life stage	St. Andrew Bay	Crooked Island Sound	St. Joseph Bay	Apalachicola Bay	Gulf-side of St. Vincent Island
Young-of-the-year	--	--	--	--	--
Juveniles	--	--	0.01 (0.08)	--	0.02 (0.10)
Adults	--	--	0.01 (0.08)	--	--
All	--	--	0.02 (0.16)	--	0.02 (0.10)

(f) Finetooth shark, *Carcharhinus isodon*

Life stage	St. Andrew Bay	Crooked Island Sound	St. Joseph Bay	Apalachicola Bay	Gulf-side of St. Vincent Island
Young-of-the-year	--	0.06 (0.32)	--	--	--
Juveniles	0.03 (0.17)	0.02 (0.15)	0.01 (0.08)	--	0.33 (0.68)
Adults	--	0.02 (0.15)	--	--	0.50 (0.83)
All	0.03 (0.17)	0.10 (0.37)	0.01 (0.08)	--	0.80 (1.15)

(g) Florida smoothhound, *Mustelus norrisi*

Life stage	St. Andrew Bay	Crooked Island Sound	St. Joseph Bay	Apalachicola Bay	Gulf-side of St. Vincent Island
Young-of-the-year	--	--	0.01 (0.08)	--	--
Juveniles	--	--	--	--	--
Adults	--	--	--	--	--
All	--	--	0.01 (0.08)	0.50 (0.71)	--

(h) Scalloped hammerhead shark, *Sphyrna lewini*

Life stage	St. Andrew Bay	Crooked Island Sound	St. Joseph Bay	Apalachicola Bay	Gulf-side of St. Vincent Island
Young-of-the-year	--	0.27 (0.64)	0.01 (0.08)	--	0.20 (0.49)
Juveniles	--	0.03 (0.22)	0.03 (0.16)	--	0.02 (0.10)
Adults	--	--		--	--
All	--	0.30 (0.69)	0.04 (0.17)	--	0.22 (0.52)

(i) Spinner shark, *Carcharhinus brevipinna*

Life stage	St. Andrew Bay	Crooked Island Sound	St. Joseph Bay	Apalachicola Bay	Gulf-side of St. Vincent Island
Young-of-the-year	--	0.09 (0.46)	0.28 (1.30)	--	0.13 (0.38)
Juveniles	--	0.05 (0.26)	0.04 (0.17)	--	0.72 (1.66)
Adults	--	--	--	--	
All	--	0.14 (0.52)	0.31 (1.30)	--	0.85 (1.91)

Table 2. Summary of CPUE (number of rays/net/hour) for rays by major area sampled in the panhandle of Florida for FY-06. Means (standard deviations) are presented. Young-of-the-year includes neonate life stage. Specimens with an undetermined life stage are included in total CPUE calculation. Species are listed alphabetically by common name.

(a) Bluntnose stingray, *Dasyatis sayi*

Life stage	St. Andrew Bay	Crooked Island Sound	St. Joseph Bay	Apalachicola Bay	Gulf-side of St. Vincent Island
Young-of-the-year	--	--	--	--	--
Juveniles	--	--	--	--	--
Adults	--	--	--	--	--
All	--	0.02 (0.15)	--	--	--

(b) Clearnose skate, *Raja eglanteria*

Life stage	St. Andrew Bay	Crooked Island Sound	St. Joseph Bay	Apalachicola Bay	Gulf-side of St. Vincent Island
Young-of-the-year	-	-	-	-	-
Juveniles	-	-	-	-	0.04 (0.21)
Adults	-	-	-	-	-
All	-	-	-	-	0.04 (0.21)

(c) Cownose ray, *Rhinoptera bonasus*

Life stage	St. Andrew Bay	Crooked Island Sound	St. Joseph Bay	Apalachicola Bay	Gulf-side of St. Vincent Island
Young-of-the-year	0.41 (1.83)	--	0.06 (0.32)	--	--
Juveniles	--	0.02 (0.16)	0.01 (0.08)	--	--
Adults	--	0.04 (0.18)	0.36 (1.39)	--	0.39 (0.99)
All	0.41 (1.83)	0.06 (0.22)	0.44 (1.42)	--	0.39 (0.99)

(d) Smooth butterfly ray, *Gymnura micrura*

Life stage	St. Andrew Bay	Crooked Island Sound	St. Joseph Bay	Apalachicola Bay	Gulf-side of St. Vincent Island
Young-of-the-year	-	-	-	-	-
Juveniles	-	-	-	-	-
Adults	-	-	-	-	-
All	-	0.02 (0.15)	-	-	-

(e) Southern stingray, *Dasyatis americana*

Life stage	St. Andrew Bay	Crooked Island Sound	St. Joseph Bay	Apalachicola Bay	Gulf-side of St. Vincent Island
Young-of-the-year	-	-	-	-	-
Juveniles	-	0.02 (0.16)	-	-	-
Adults	-	-	-	-	-
All	-	0.02 (0.16)	-	-	-

Table 3. Summary of the habitat associations for the Atlantic sharpnose shark, *Rhizoprionodon terraenovae*, by life stage in the panhandle of Florida for FY-06. Young-of-the-year includes neonate life stage. Means (ranges) are presented. Bottom type is presented in descending predominance unless otherwise stated.

Life stage	Temperature (°C)	Salinity (ppt)	Depth (m)	Water clarity (cm)	Dissolved oxygen (mg l^{-1})	Bottom type
Young-of-the-year	21.8-31.0 (27.9)	29.0-36.4 (33.8)	1.4-9.8 (4.6)	60-600 (280.0)	2.7-6.9 (5.3)	Mud/Sand/ Seagrass
Juveniles	21.8-31.7 (27.9)	29.0-37.2 (33.9)	1.65-9.8 (4.6)	75-600 (283)	2.7-6.8 (5.3)	Sand/Seagrass/ Mud
Adults	21.8-31.0 (27.8)	29.0-37.2 (33.9)	1.7-9.8 (4.7)	40-625 (278)	2.7-6.9 (5.3)	Mud/Sand/ Shell/Seagrass

Table 4. Summary of the habitat associations for the blacknose shark, *Carcharhinus acronotus*, by life stage in the panhandle of Florida for FY-06. Young-of-the-year includes neonate life stage. Means (ranges) are presented. Bottom type is presented in descending predominance unless otherwise stated.

Life stage	Temperature (°C)	Salinity (ppt)	Depth (m)	Water clarity (cm)	Dissolved oxygen (mg l^{-1})	Bottom type
Young-of-the-year	30.3-31.7 (30.9)	33.4-34.7 (34.2)	1.9-3.6 (2.7)	160-310 (253)	5.13-5.87 (5.6)	Mud/ Sand/ Seagrass
Juveniles	- -	- -	- -	- -	- -	-
Adults	- -	- -	- -	- -	- -	-

Table 5. Summary of the habitat associations for the blacktip shark, *Carcharhinus limbatus*, by life stage in the panhandle of Florida for FY-06. Young-of-the-year includes neonate life stage. Means (ranges) are presented. Bottom type is presented in descending predominance unless otherwise stated.

Life stage	Temperature (°C)	Salinity (ppt)	Depth (m)	Water clarity (cm)	Dissolved oxygen (mg l^{-1})	Bottom type
Young-of-the-year	26.4-31.0 (29.0)	32.0-34.6 (33.4)	3.8-6.9 (5.0)	80-425 (266)	3.8-5.8 (5.1)	Mud/Sand
Juveniles	21.9-31.0 (28.4)	31.6-36.8 (34.0)	3.2-9.0 (5.2)	60-625 (270)	3.8-7.2 (5.4)	Mud/Sand/ Shell
Adults	23.8-30.9 (28.7)	20.0-36.4 (33.4)	1.4-9.0 (4.9)	60-625 (270)	3.8-5.5 (5.0)	Mud/Seagrass/ Sand

Table 6. Summary of the habitat associations for the bonnethead shark, *Sphyrna tiburo*, by life stage in the panhandle of Florida for FY-06. Young-of-the-year includes neonate life stage. Means (ranges) are presented. Bottom type is presented in descending predominance unless otherwise stated.

Life stage	Temperature (°C)	Salinity (ppt)	Depth (m)	Water clarity (cm)	Dissolved oxygen (mg l^{-1})	Bottom type
Young-of-the-year	21.2-31.0 (27.9)	32.2-34.5 (33.6)	4.0-5.4 (4.6)	250-385 (294)	5.4-6.9 (5.9)	Mud/Sand
Juveniles	21.8-31.7 (28.2)	29.0-37.2 (33.8)	1.7-9.0 (4.4)	40-500 (264)	2.9-6.8 (5.3)	Mud/Sand/ Seagrass
Adults	21.8-30.6 (27.6)	30.6-36.8 (34.0)	1.7-8.6 (4.3)	40-500 (264)	2.9-6.8 (5.3)	Mud/Sand/ Seagrass

Table 7. Summary of the habitat associations for the bull shark, *Carcharhinus leucas*, by life stage in the panhandle of Florida for FY-06. Means (ranges) are presented for juveniles. Raw data are presented for adults.

Life stage	Temperature (°C)	Salinity (ppt)	Depth (m)	Water clarity (cm)	Dissolved oxygen (mg l^{-1})	Bottom type
Young-of-the-year	- -	- -	- -	- -	- -	-
Juveniles	29.8-30.9 (30.4)	33.8-33.9 (33.85)	7.2-7.25 (7.23)	310-450 (380)	5.2-5.4 (5.3)	Mud
Adults	29.9 -	33.8 -	7.25 -	310 -	5.2 -	Mud

Table 8. Summary of the habitat associations for the finetooth shark, *Carcharhinus isodon*, by life stage in the panhandle of Florida for FY-06. Young-of-the-year includes neonate life stage. Means (ranges) are presented. Bottom type is presented in descending predominance unless otherwise stated.

Life stage	Temperature (°C)	Salinity (ppt)	Depth (m)	Water clarity (cm)	Dissolved oxygen (mg l^{-1})	Bottom type
Young-of-the-year	30.5-31.7 (30.9)	34.4 (34.4)	2.9-4.5 (3.8)	160 (160)	5.9-6.1 (6.0)	Mud/Sand
Juveniles	24.4-30.9 (28.3)	32.6-35.2 (34.4)	3.4-7.9 (4.8)	40-450 (158)	3.8-6.0 (5.1)	Mud/Sand
Adults	23.8-30.7 (27.8)	30.0-36.4 (34.1)	2.0-7.9 (4.5)	55-250 (123)	4.8-5.5 (5.2)	Mud/Sand

Table 9. Summary of the habitat associations for the Florida smoothhound, *Mustelus norrisi*, by life stage in the panhandle of Florida for FY-06. Young-of-the-year includes neonate life stage. Raw data are presented. Bottom type is presented in descending predominance unless otherwise stated.

Life stage	Temperature (°C)	Salinity (ppt)	Depth (m)	Water clarity (cm)	Dissolved oxygen (mg l^{-1})	Bottom type
Young-of-the-year	-	36	1.7	240	-	Mud/Oyster
Juveniles	28.8	35.0	4.8	260	-	Sand/Seagrass
Adults	- -	- -	- -	- -	- -	-

Table 10. Summary of the habitat associations for the scalloped hammerhead shark, *Sphyrna lewini*, by life stage in the panhandle of Florida for FY-06. Young-of-the-year includes neonate life. Means (ranges) are presented. Values without ranges are raw data. Bottom type is presented in descending predominance unless otherwise stated.

Life stage	Temperature (°C)	Salinity (ppt)	Depth (m)	Water clarity (cm)	Dissolved oxygen (mg l^{-1})	Bottom type
Young-of-the-year	23.8-30.8 (27.8)	32.3-36.8 (34.2)	1.9-8.6 (4.3)	40-450 (238)	2.9-6.0 (5.1)	Mud/Sand
Juveniles	23.8-29.4 (27.1)	32.3-36.4 (34.0)	4.3-9.8 (5.8)	60-440 (252)	5.4-5.5 (5.5)	Mud
Adults	- -	- -	- -	- -	- -	-

Table 11. Summary of the habitat associations for the spinner shark, *Carcharhinus brevipinna*, by life stage in the panhandle of Florida for FY-06. Young-of-the-year includes neonate life stage. Means (ranges) are presented. Bottom type is presented in descending predominance unless otherwise stated.

Life stage	Temperature (°C)	Salinity (ppt)	Depth (m)	Water clarity (cm)	Dissolved oxygen (mg l^{-1})	Bottom type
Young-of-the-year	30.3-30.9 (30.6)	33.0-34.8 (33.9)	3.8-9.0 (5.8)	74-500 (293)	3.8-6.1 (5.1)	Mud/Sand
Juveniles	27.0-30.9 (29.5)	32.0-35.2 (33.5)	3.6-8.9 (5.5)	40-450 (245)	3.8-6.3 (5.2)	Mud/Sand
Adults	- -	- -	- -	- -	- -	-

Table 12. Summary of the habitat associations for the bluntnose stingray, *Dasyatis sayi*, by life stage in the panhandle of Florida for FY-06. Raw data are presented. Bottom type is presented in descending predominance unless otherwise stated.

Life stage	Temperature (°C)	Salinity (ppt)	Depth (m)	Water clarity (cm)	Dissolved oxygen (mg l^{-1})	Bottom type
Young-of-the-year	- -	- -	- -	- -	- -	-
Juveniles	27.9	32.6	1.4	140	4.8	Mud/Seagrass
Adults	- -	- -	- -	- -	- -	-

Table 13. Summary of the habitat associations for the clearnose skate, *Raja eglanteria*, by life stage in the panhandle of Florida for FY-06. Raw data are presented. Bottom type is presented in descending predominance unless otherwise stated.

Life stage	Temperature (°C)	Salinity (ppt)	Depth (m)	Water clarity (cm)	Dissolved oxygen (mg l^{-1})	Bottom type
Young-of-the-year	- -	- -	- -	- -	- -	-
Juveniles	27.5	33.1	6.8	250	4.9	Mud
Adults	- -	- -	- -	- -	- -	-

Table 14. Summary of the habitat associations for the cownose ray, *Rhinoptera bonasus*, by life stage in the panhandle of Florida for FY-06. Young-of-the-year includes neonate life stage. Means (ranges) are presented. Bottom type is presented in descending predominance unless otherwise stated.

Life stage	Temperature (°C)	Salinity (ppt)	Depth (m)	Water clarity (cm)	Dissolved oxygen (mg l^{-1})	Bottom type
Young-of-the-year	29.9-31.1 (30.4)	31.0-33.9 (33.3)	1.5-8.6 (4.2)	150-450 (282)	4.6-5.2 (4.8)	Mud/Sand/ Seagrass
Juveniles	28.0-29.0 (28.5)	34.0-34.2 (34.1)	3.4-9.0 (5.3)	325-625 (447)	- -	Mud/Sand
Adults	20.5-28.0 (24.1)	33.8-36.4 (34.9)	1.7-9.0 (4.7)	50-625 (275)	2.9-6.9 (5.7)	Mud/Sand/ Seagrass

Table 15. Summary of the habitat associations for the smooth butterfly ray, *Gymnura micrura*, by life stage in the panhandle of Florida for FY-06. Young-of-the-year includes neonate life stage. Raw data are presented. Bottom type is presented in descending predominance unless otherwise stated.

Life stage	Temperature (°C)	Salinity (ppt)	Depth (m)	Water clarity (cm)	Dissolved oxygen (mg l^{-1})	Bottom type
Young-of-the-year	- -	33.0	3.4	280	-	Mud
Juveniles	- -	- -	- -	- -	- -	-
Adults	- -	- -	- -	- -	- -	-

Table 16. Summary of the habitat associations for the southern stingray, *Dasyatis americana*, by life stage in the panhandle of Florida for FY-06. Raw data are presented. Bottom type is presented in descending predominance unless otherwise stated.

Life stage	Temperature (°C)	Salinity (ppt)	Depth (m)	Water clarity (cm)	Dissolved oxygen (mg l^{-1})	Bottom type
Young-of-the-year	-	29.0	2.1	140	-	Mud/Seagrass
Juveniles	- -	- -	- -	- -	- -	-
Adults	- -	- -	- -	- -	- -	-

Table 17. 2006 Recapture information for sharks tagged in the panhandle of Florida for FY-06. Data are sorted by days at liberty in descending order.

Species	Sex	Mode of Recapture	Days at Liberty	Distance Moved (km), Direction	Location Tagged	Location Recaptured
Finetooth shark	F	Recreational Angler	814	309.0, NW	Gulf-side St. Vincent Island, FL	9 mi S Biloxi, MS
Atlantic sharpnose shark	M	Recreational Angler	793	<1	Crooked Island Sound, FL	Crooked Island Sound, FL
Atlantic sharpnose shark	M	GULFSPAN	719	1.6, W	Crooked Island Sound, FL	Crooked Island Sound, FL
Atlantic sharpnose shark	F	Recreational Angler	437	399.6, SW	Crooked Island Sound, FL	50 mi S of Venice, LA
Spinner shark	F	GULFSPAN	400	<1	Gulf-side St. Vincent Island, FL	Gulf-side St. Vincent Island, FL
Finetooth shark	M	Commercial Fisherman	358	333.4, SE	Gulf-side St. Vincent Island, FL	Offshore Venice, FL
Atlantic sharpnose shark	M	Recreational Angler	67	<1	St. Joe Bay, FL	St. Joe Bay, FL
Atlantic sharpnose shark	M	Recreational Angler	20	8.8, E	St. Joe Bay, FL	St. Joe Bay, FL
Atlantic sharpnose shark	F	Recreational Angler	9	<1	Apalachicola Bay, FL	Apalachicola Bay, FL

Table 18. Summary of CPUE (number of sharks/net/hour) for sharks and rays by life history stage and major area sampled in Mississippi coastal waters FY-06. Mean values are presented and numbers in parentheses represent standard deviation. Young-of-the-year includes neonates. Species are listed alphabetically by common name.

(a) Atlantic sharpnose shark, *Rhizoprionodon terraenovae*

Life stage	Round Island	Horn Island	Cat Island	Deer Island	Davis Bayou
Young-of-the-year	-	0.67(1.15)	-	-	-
Juveniles	1.07(1.06)	0.47(0.56)	0.33(0.47)	-	-
Adults	0.35(0.60)	1.33(1.53)	0.11(0.16)	-	-
All	1.46(1.66)	2.47(1.55)	0.44(0.63)	-	-

(b) Blacktip shark, *Carcharhinus limbatus*

Life stage	Round Island	Horn Island	Cat Island	Deer Island	Davis Bayou
Young-of-the-year	-	-	-	-	-
Juveniles	-	0.89(0.96)	0.11(0.16)	-	-
Adults	-	0.11(0.19)	-	-	-
All	-	1.01(1.15)	0.11(0.16	-	-

(c) Bonnethead shark, *Sphyrna tiburo*

Life stage	Round Island	Horn Island	Cat Island	Deer Island	Davis Bayou
Young-of-the-year	-	-	-	-	-
Juveniles	0.08(0.14)	-	0.22(0.32)	-	-
Adults	-	0.09(0.16)	0.33(0.47)	-	-
All	0.08(0.14)	0.09(0.16)	0.56(0.78)	-	-

(d) Bull shark, *Carcharhinus leucas*

Life stage	Round Island	Horn Island	Cat Island	Deer Island	Davis Bayou
Young-of-the-year	-	-	-	-	-
Juveniles	0.25(0.43)	0.11(0.19)	0.12(0.17)	-	0.53(0.39)
Adults	-	-	-	-	-
All	0.25(0.43)	0.11(0.19)	0.12(0.17)	-	0.53(0.39)

(e) Finetooth shark, *Carcharhinus isodon*

Life stage	Round Island	Horn Island	Cat Island	Deer Island	Davis Bayou
Young-of-the-year	1.33(1.37)	-	0.12(0.17)	-	-
Juveniles	0.52(0.33)	-	-	-	-
Adults	0.07(0.12)	0.09(0.16)	-	-	-
All	1.92(1.29)	0.09(0.16)	0.12(0.17)	-	-

(f) Spinner shark, *Carcharhinus brevipinna*

Life stage	Round Island	Horn Island	Cat Island	Deer Island	Davis Bayou
Young-of-the-year	0.21(0.36)	-	-	-	-
Juveniles	-	-	-	-	-
Adults	-	-	-	-	-
All	0.21(0.36)	-	-	-	-

Table 19. Summary of CPUE (number of rays/net/hour) for rays by major area sampled in Mississippi coastal waters FY-06. Means (standard deviations) are presented. Young-of-the-year includes neonate life stage. Specimens with an undetermined life stage are included in total CPUE calculation. Species are listed alphabetically by common name.

(a) Atlantic stingray, *Dasyatis sabina*

Life stage	Round Island	Horn Island	Cat Island	Deer Island	Davis Bayou
Young-of-the-year	-	-	-	-	-
Juveniles	-	-	-	-	-
Adults	-	0.11(0.19)	0.23(0.01)	-	-
All	-	0.11(0.19)	0.23(0.01)	-	-

(b) Cownose ray, *Rhinoptera bonasus*

Life stage	Round Island	Horn Island	Cat Island	Deer Island	Davis Bayou
Young-of-the-year	0.07(0.12)	-	-	-	-
Juveniles	-	-	-	-	-
Adults	0.07(0.12)	0.07(0.12)	-	-	-
All	0.14(0.24)	0.07(0.12)	-	-	-

(c) Southern stingray, *Dasyatis americana*

Life stage	Round Island	Horn Island	Cat Island	Deer Island	Davis Bayou
Young-of-the-year	-	-	-	-	-
Juveniles	-	0.06(0.12)	-	-	-
Adults	-	-	-	-	-
All	-	0.06(0.12)	-	-	-

Table 20. Summary of the habitat associations for the Atlantic sharpnose shark, *Rhizoprionodon terraenovae*, by life stage in Mississippi coastal waters FY-06. Young-of-the-year includes neonate life stage. Means are presented. Ranges are in parentheses. Bottom type is presented in descending predominance unless otherwise stated.

Life stage	Temperature (^{o}C)	Salinity (ppt)	Depth (m)	Water clarity (cm)	Dissolved oxygen (mg l^{-1})	Bottom type
Young-of-the year	30.8 -	27.8 -	6.4 -	79 -	5.1 -	Slit/Clay/ Sand
Juvenile	28.5 (23.6-32.4)	27.3 (23.5-31.4)	4.5 (2.7-6.4)	171 (79-406)	5.4 (4.9-6.0)	Slit/Clay/ Sand
Adult	26.6 (24.0-31.0)	27.5 (23.5-31.4)	4.5 (3.1-5.2)	218 (116-406)	5.9 (5.1-6.7)	Sand/Silt/ Clay

Table 21. Summary of the habitat associations for the blacktip shark, *Carcharhinus limbatus*, by life stage in Mississippi coastal waters FY-06. Young-of-the-year includes neonate life stage. Means are presented. Ranges are in parentheses. Bottom type is presented in descending predominance unless otherwise stated.

Life stage	Temperature (^{o}C)	Salinity (ppt)	Depth (m)	Water clarity (cm)	Dissolved oxygen (mg l^{-1})	Bottom type
Young-of-the year	- -	- -	- -	- -	- -	- -
Juvenile	28.3 (25.4-31.0)	26.6 (23.5-29.0)	5.3 (4.6-6.4)	206 (79-406)	5.9 (5.1-6.6)	Sand/Silt/ Clay
Adult	30.8 -	27.8 -	6.4 -	79 -	5.1 -	Slit/Clay/ Sand

Table 22. Summary of the habitat associations for the bull shark, *Carcharhinus leucas*, by life stage in Mississippi coastal waters FY-06. Young-of-the-year includes neonate life stage. Means are presented. Ranges are in parentheses. Bottom type is presented in descending predominance unless otherwise stated.

Life stage	Temperature (°C)	Salinity (ppt)	Depth (m)	Water clarity (cm)	Dissolved oxygen (mg l^{-1})	Bottom type
Young-of-the-year	- -	- -	- -	- -	- -	- -
Juvenile	27.6 (24.7-30.8)	23.6 (16.8-27.8)	3.0 (0.8-6.4)	80 (48-112)	6.4 (4.7-9.1)	Mud/Sand/Clay
Adult	- -	- -	- -	- -	- -	- -

Table 23. Summary of the habitat associations for the bonnethead shark, *Sphyrna tiburo*, by life stage in Mississippi coastal waters FY-06. Young-of-the-year includes neonate life stage. Means are presented. Ranges are in parentheses. Bottom type is presented in descending predominance unless otherwise stated.

Life stage	Temperature (°C)	Salinity (ppt)	Depth (m)	Water clarity (cm)	Dissolved oxygen (mg l^{-1})	Bottom type
Young-of-the year	- -	- -	- -	- -	- -	
Juvenile	27.8 (25.9-30.2)	25.3 (23.5-27.0)	3.8 (2.5-5.1)	122 (112-132)	5.3 (4.7-6.0)	Sand/Clay/Mud
Adult	25.7 (25.4-26.0)	26.3 (23.5-29.0)	5.1 (5.0-5.2)	269 (132-406)	5.9 (5.8-6.0)	Sand/Slit/Clay

Table 24. Summary of the habitat associations for the finetooth shark, *Carcharhinus isodon,* by life stage in Mississippi coastal waters FY-06. Young-of-the-year includes neonate life stage. Means are presented. Ranges are in parentheses. Bottom type is presented in descending predominance unless otherwise stated.

Life stage	Temperature (°C)	Salinity (ppt)	Depth (m)	Water clarity (cm)	Dissolved oxygen (mg l^{-1})	Bottom type
Young-of-the year	26.5 (24.0-30.2)	28.2 (26.3-31.4)	3.2 (2.5-4.0)	112 (107-116)	5.8 (4.7-7.5)	Sand/Silt/Clay
Juvenile	27.9 (24.0-30.2)	27.8 (25.0-31.4)	2.8 (2.5-3.1)	117 (112-122)	4.9 (4.7-5.1)	Sand/Silt/Clay
Adult	25.0 (24.0-26.0)	30.2 (29.0-31.4)	4.1 (3.1-5.2)	261 (116-406)	5.5 (5.1-5.8)	Sand/Slit/Clay

Table 25. Summary of the habitat associations for the spinner shark, *Carcharhinus brevipinna*, by life stage in Mississippi coastal waters FY-06. Young-of-the-year includes neonate life stage. Means are presented. Ranges are in parentheses. Bottom type is presented in descending predominance unless otherwise stated.

Life stage	Temperature (°C)	Salinity (ppt)	Depth (m)	Water clarity (cm)	Dissolved oxygen (mg l^{-1})	Bottom type
Young-of-the year	24.0 -	31.4 -	3.1 -	116 -	5.1 -	Silt/Sand/ Clay
Juvenile	- -	- -	- -	- -	- -	- -
Adult	- -	- -	- -	- -	- -	- -

Table 26. Summary of the habitat associations for skates and rays in Mississippi coastal waters FY-06. Means are presented. Ranges are in parentheses. Bottom type is presented in descending predominance unless otherwise stated. Species are alphabetized by common name.

Species	Temperature (°C)	Salinity (ppt)	Depth (m)	Water clarity (cm)	Dissolved oxygen (mg l^{-1})	Bottom type
Atlantic guitarfish	- -	- -	- -	- -	- -	-
Atlantic stingray	25.4 (25.4)	24.9 (23.5-26.3)	4.5 (4.0-5.0)	120.0 (107.0-132.0)	6.8 (6.0-7.5)	Sand/Slit -
Bluntnose stingray	- -	- -	- -	- -	- -	
Cownose ray	27.5 (24.0-31.0)	28.7 (26.0-31.4)	3.8 (3.1-4.6)	116.0 (116.0)	5.9 (5.1-6.7)	Sand/Slit/ Clay
Devil ray	- -	- -	- -	- -	- -	-
Roundel skate	- -	- -	- -	- -	- -	-
Smooth butterfly ray	- -	- -	- -	- -	- -	-
Southern stingray	30.8 -	27.8 -	6.4 -	79.0 -	5.1 -	Sand/Slit/ Clay
Spiny butterfly ray	- -	- -	- -	- -	- -	
Spotted eagle ray	- -	- -	- -	- -	- -	-

Figure 1. Locations of sets made in FY-06 for areas in St. Andrew Bay and Crooked Island Sound in the panhandle of Florida.

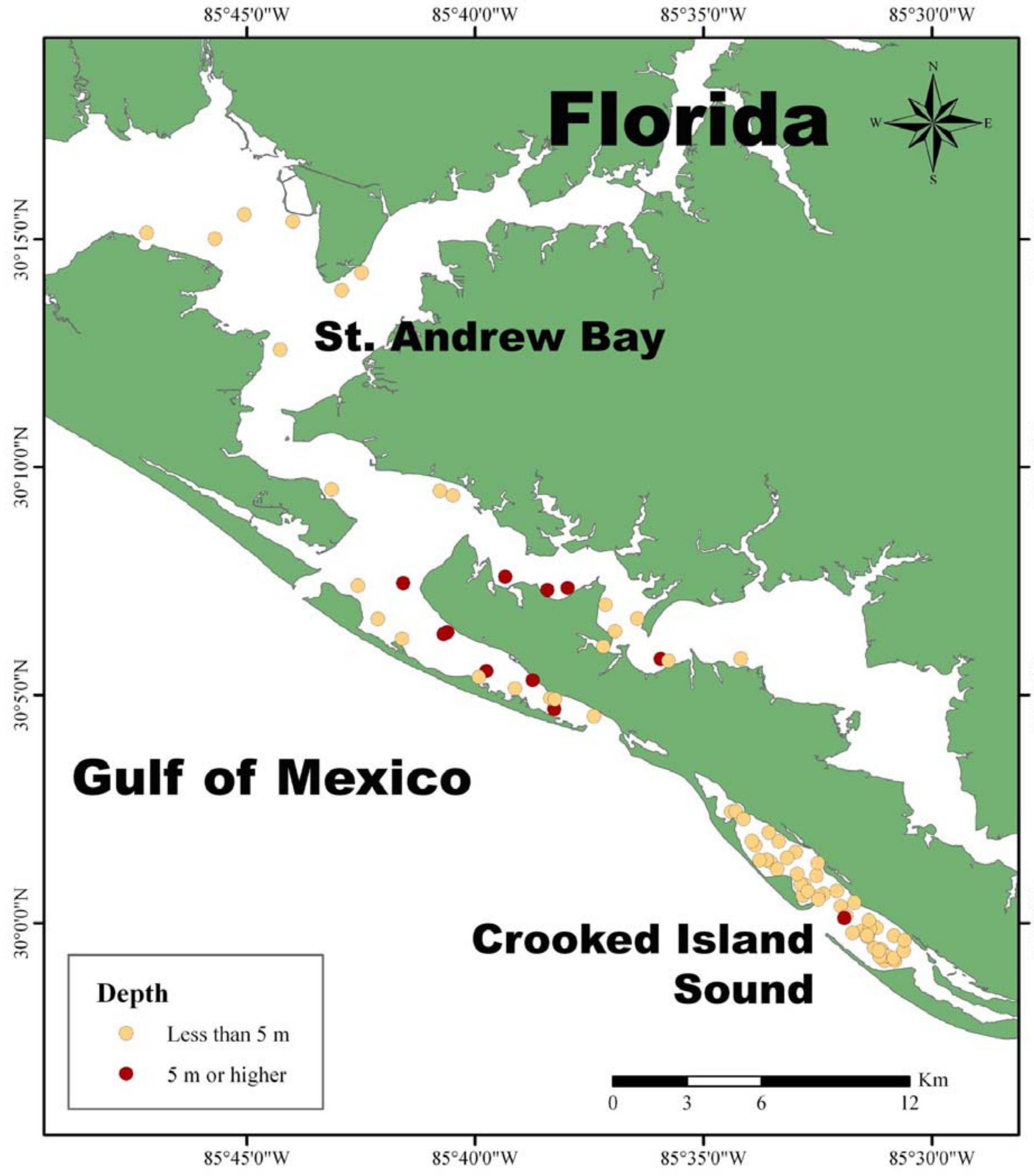

Figure 2. Locations of sets made in FY-06 for areas in St. Joseph Bay, the gulf-side of St. Vincent Island, and Apalachicola Bay in the panhandle of Florida.

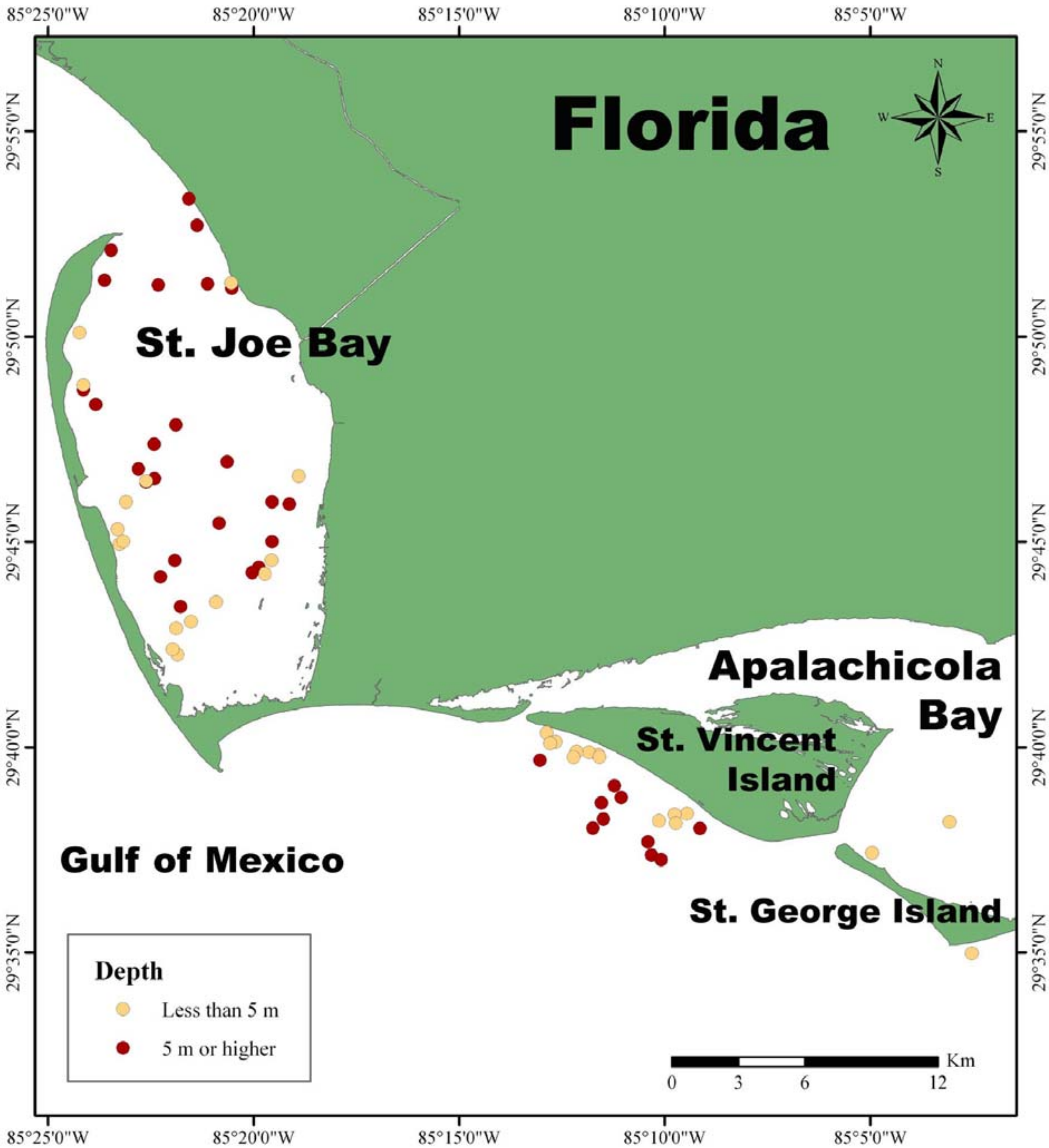

Figure 3. Presence–absence of Atlantic sharpnose sharks monitored within Crooked Island Sound, FL, during 2004 and 2005.

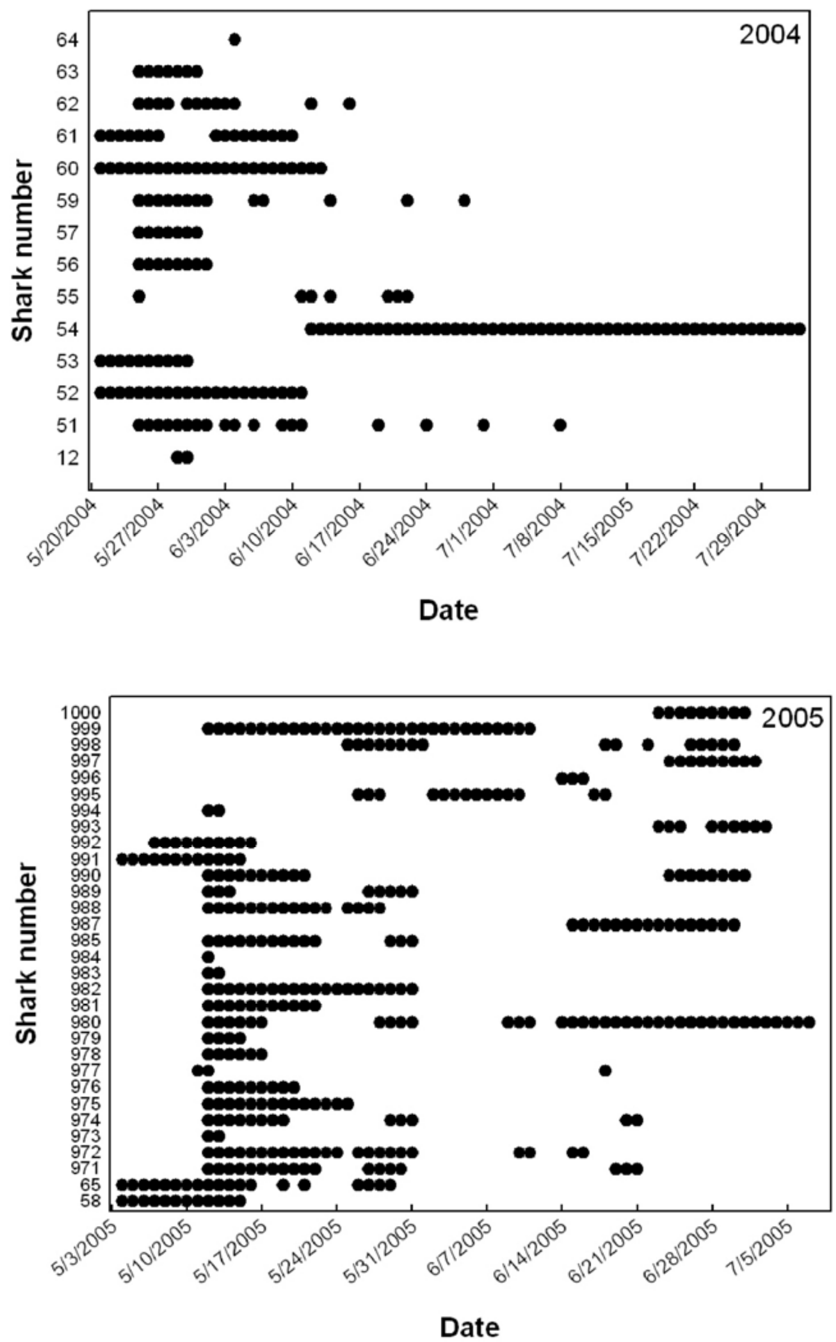

Figure 4. An example of the depth data collected on a bull shark tagged with a PAT tag. Deep dives are present, but the majority of time is spent in shallow regions.

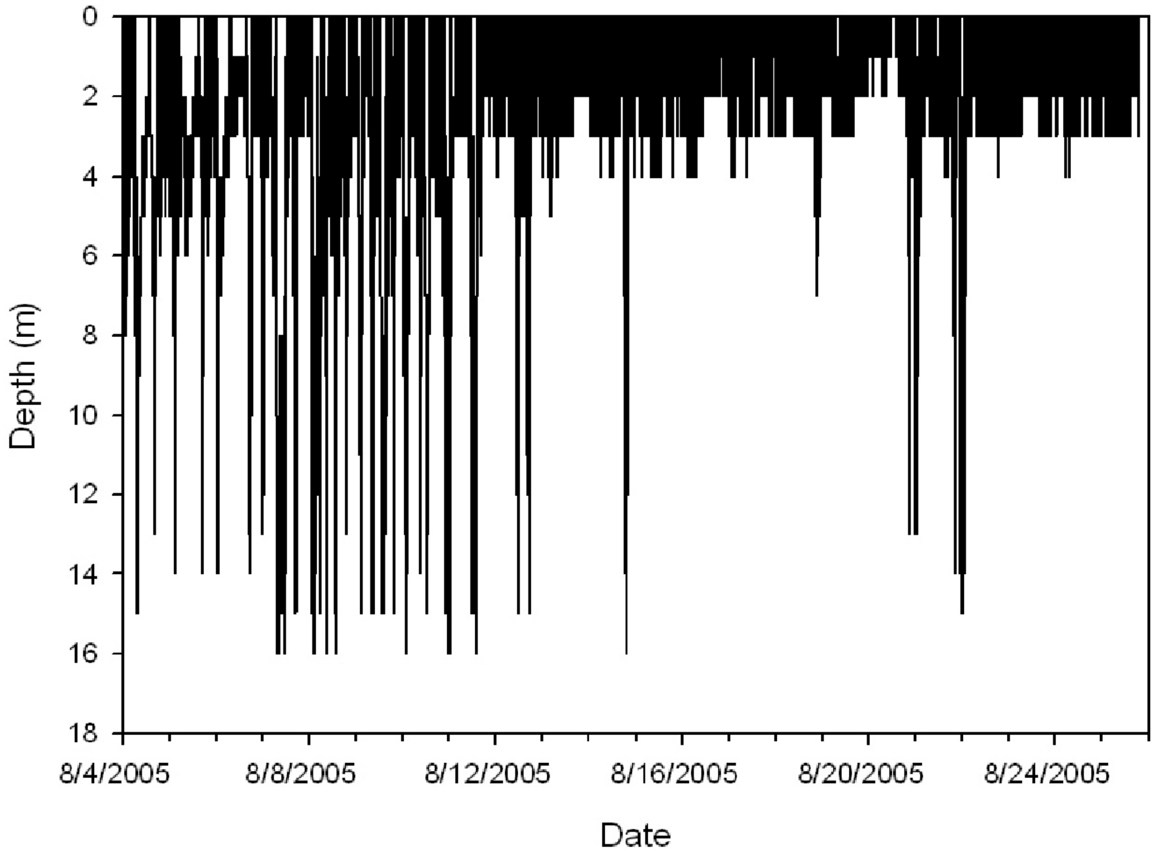

Figure 5. Data from a recovered PAT tag as an example of the depth data in relation to time of day. Open bars indicate daylight hours. The majority of time was spent in water less than 5 m deep with excursions to depth.

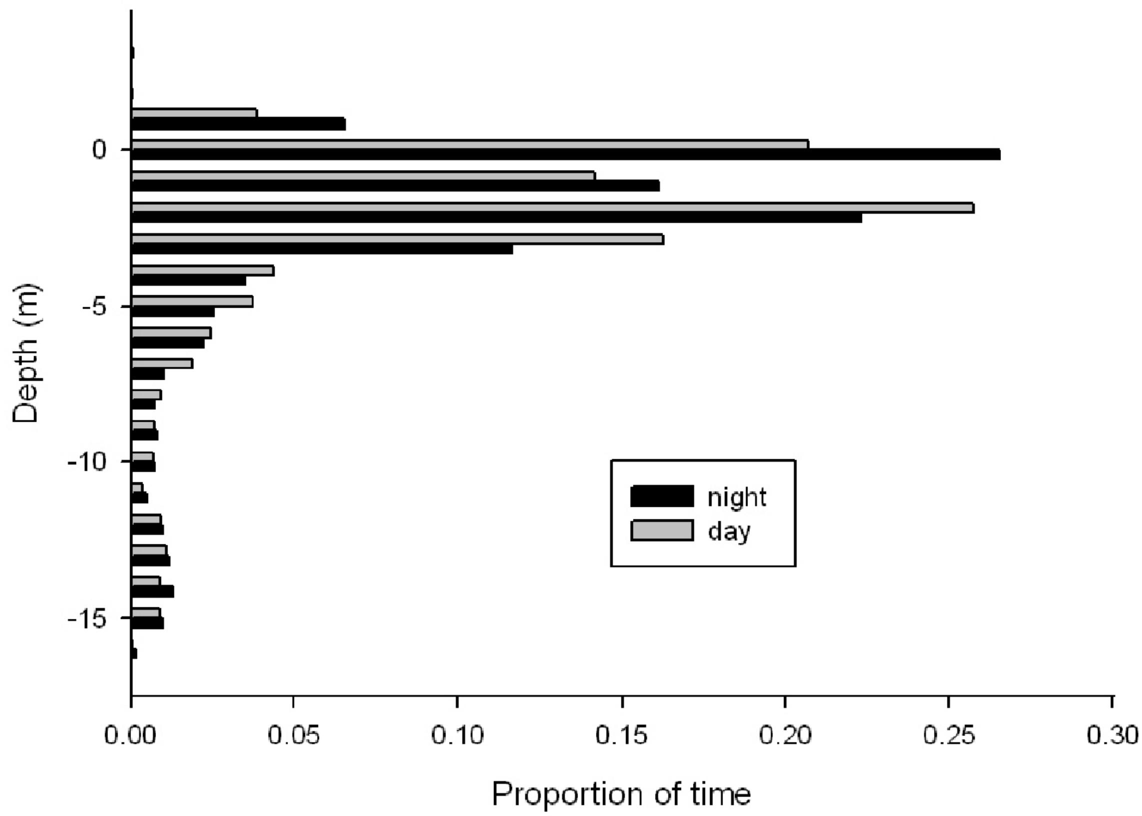

Figure 6. Locations of sets made in FY-06 for areas in Mississippi coastal waters.