SEFSC-FD-2022-03
doi: 10.25923/0g0m-se45
https://doi.org/10.25923/0g0m-se45

SHARK NURSERY GROUNDS AND ESSENTIAL FISH HABITAT STUDIES

Report on 2021 Field Activities in the Gulf of Mexico Shark Pupping and Nursery Survey (Gulfspan)

John K. Carlson
NOAA Fisheries
Southeast Fisheries Science Center

Andrea Kroetz
Cooperative Institute for Marine & Atmospheric Studies
University of Miami in support of
NOAA Fisheries
Southeast Fisheries Science Center

Angie Hoover
Jeremy M. Higgs
Jill M. Hendon
University of Southern Mississippi
Center for Fisheries and Development
Gulf Coast Research Laboratory
Ocean Spring, MS

Blake Hamilton
Ashley Dawdy
R. Dean Grubbs
Florida State University
Coastal and Marine Laboratory
St. Teresa, FL

Jayne M. Gardiner
Joel A. Beaver
New College of Florida
Sarasota, FL

Tonya R. Wiley
Havenworth Coastal Conservation
Palmetto, Florida

INTRODUCTION

This report describes results from the cooperative Gulf of Mexico Shark Pupping and Nursery (GULFSPAN) survey for 2021. The GULFPSAN survey began in 2003 to examine the distribution and abundance of juvenile sharks in coastal areas of the Gulf of Mexico. The ultimate intent of this survey is to continue to describe and further refine shark essential fish habitat as mandated by the Magnuson-Stevens Fishery Conservation and Management Act (US DOC 2007). NOAA Fisheries Panama City Laboratory oversees the survey and provides gillnet gear and tags. Individual collaborators are responsible for collection, storing, and compiling their data as well as writing their section of the year-end report. This year, collaborators included (from west to east): the University of Southern Mississippi Gulf Coast Research Laboratory (Mississippi Sound, Mississippi), NOAA Fisheries Panama City Laboratory (Northwest Florida), Florida State University Coastal and Marine Laboratory (Big Bend of Florida), and New College of Florida (southern Tampa Bay and Sarasota Bay, Florida).

METHODS

The survey was modeled after methods developed by Carlson and Brusher (1999). A monofilament gillnet consisting of six different stretched-mesh size panels was used for sampling in all areas by all institutions. Stretched-mesh sizes ranged from 7.6 centimeters (cm) (3.0 inches [in]) to 14.0 cm (5.5 in) in steps of 1.3 cm (0.5 in). Each panel was 3.0 meters (m) (10 feet [ft]) deep and 30.5 m (100 ft) long. Panel specifics can be found in Baremore et al. (2012). The six panels were strung together and fished as a single gear (i.e. set). Florida State University Coastal and Marine Laboratory and the New College of Florida fished experimental longline sets concurrently with gillnet sets (See Regions 3 and 4 for gear and method specifics). The survey was conducted monthly April – October in coastal bays, estuaries, and around barrier islands, covering more than 550 kilometers (km) of coastline (out to three nautical miles (nm); Figure 1).

Individual sampling strategies may have differed between institutions; however, in general, sets were chosen randomly and the gear was fished either perpendicular to shore or with the wind. All gillnet sets were made during daylight hours (07:00-18:00). For each set, mid-water temperature (degrees Celsius [°C]), salinity (PPT), and dissolved oxygen (milligrams per liter [mg l^{-1}]) were recorded using an environmental meter (YSI Inc./Xylem Inc.). Average depth (m) was calculated using gear start and end points recorded from the vessel's depth finder, and water clarity (depth of the photic zone, cm) was measured by Secchi disc. At times, not all environmental parameters were recorded due to logistics.

Set soak time was defined from the time the gear entered the water to the time the gear was removed completely from the water. Haul back typically started 0.5-1.0 hours after the gear first entered the water. After haul back, the gear was moved to a different location, beginning a new

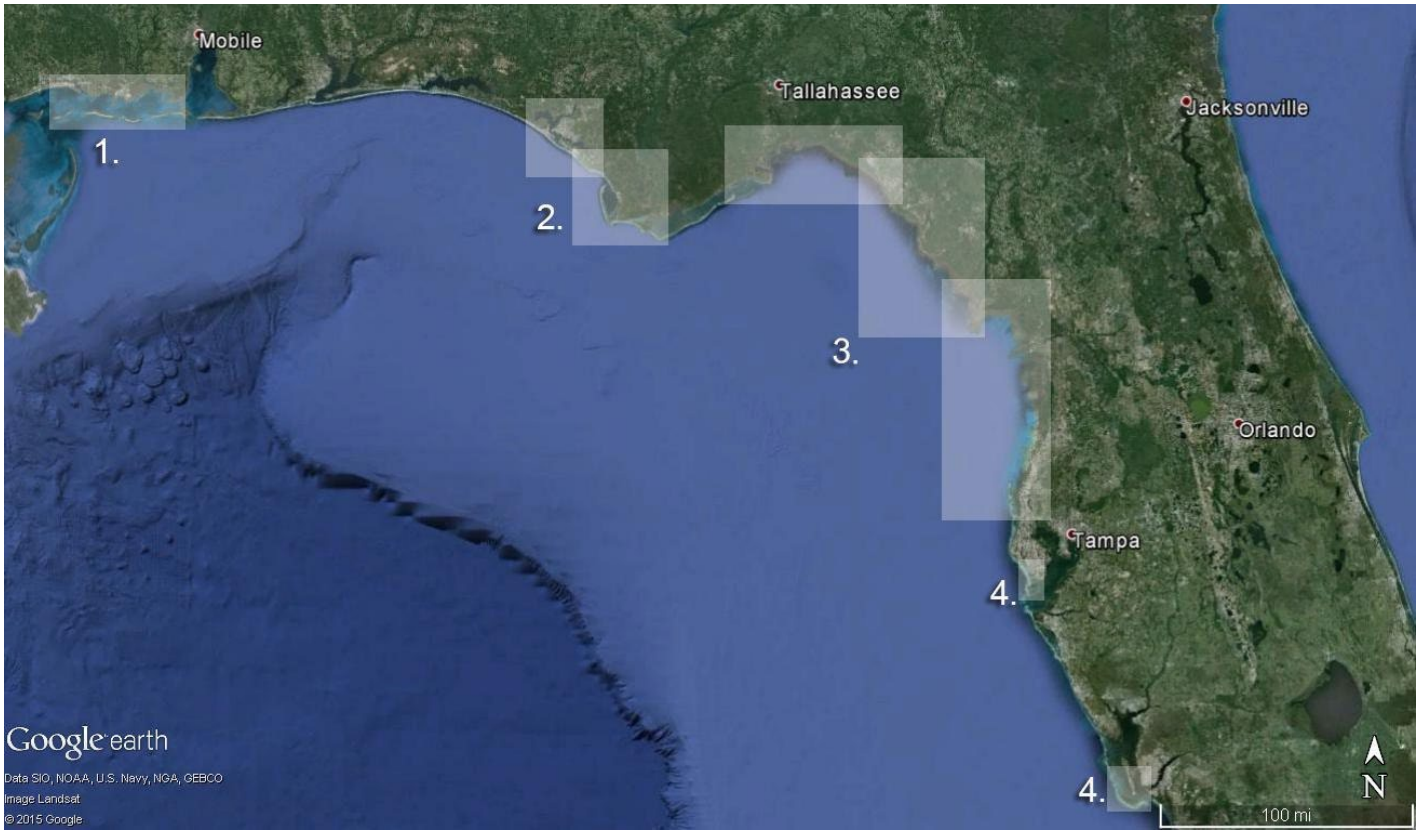
set. Catch-per-unit-effort (CPUE) was used to assess abundance of each species-life stage in each area and was defined as the number of a species-life stage caught in a geographic area divided by set soak time (standardized to gillnet hour). CPUE is presented by area and species-life stage for sharks and batoids (e.g., young-of-the-year Atlantic sharpnose shark, *Rhizoprionodon terraenovae*, in Crooked Island Sound).

Elasmobranchs were measured (pre-caudal length (PCL), fork length (FL), and stretch total length (STL), in cm for sharks; disc-width (DW) in cm for batoids; sexed, assigned a life stage, and, if in good condition, tagged externally on the first dorsal fin with either a Roto-tag (Premier 1 Supplies), a plastic-headed streamer dart-tag (sharks <120 cm STL; ©Floy Tag & Mfg., Inc.), a metal-headed streamer dart tag (sharks ≥120 cm STL; ©Floy Tag & Mfg., Inc.), or a plastic coated cinch-loop tag through the spiracle (batoids only; ©Floy Tag & Mfg., Inc.), and released. Elasmobranchs in poor condition were sacrificed for life history studies.

Neonates were defined as having an open umbilical scar and young-of-the-year were defined as having a closed, but visible, umbilical scar. Mature individuals were defined based on macro-analysis or published accounts of 50% size-at-maturity. Captured teleosts were measured (FL and/or STL in cm) and released.

Regions Sampled in the 2019 GULFSPAN Survey

Region 1: Mississippi Sound; Region 2: St. Andrew Bay to St. Vincent Island, Florida; Region 3: The Big Bend of Florida – St. George Sound to Anclote Key, Florida; Region 4: Southern Tampa Bay, Florida and Sarasota Bay, Florida.



RESULTS

REGION 1: MISSISSIPPI SOUND, MISSISSIPPI (UNIVERSITY OF SOUTHERN MISSISSIPPI GULF COAST RESEARCH LABORATORY)

The coastal waters of the Mississippi Sound were divided into three regions (east, central, west). Each region was allotted seven random stations generated in either the 2 - 2.9 meter (inshore) or the 3-10 meter (offshore) depth zone based on proportion of depth present in the region (Figure 1). Three stations from at least two regions were sampled monthly (April to October). Sampling was conducted using a 183 x 3 meter gill net with six, 30.5 meter panels of varying mesh sizes (7.6, 8.9, 10.2, 11.4, 12.7, and 14.0 cm stretch length). After the anchored gear fished for one hour, fish and invertebrates were removed from the net, identified to species and quantified. Sharks and rays were measured [sharks: stretch total length (STL), fork length (FL), and pre-caudal length (PCL); rays: disc width (DW)], weighed (kg), and a sex was determined prior to release at the capture site. Sharks in poor condition were saved for life history studies. At each station the depth (m) was determined using a depth finder (Garmin), water clarity was measured using a Secchi disc (cm), and bottom water parameters [temperature (°C), salinity, dissolved oxygen (mg l^{-1})] were determined using a YSI-Professional Plus multi-parameter meter (Yellow Springs Instruments). Sampled stations were grouped into one of six regions (west offshore, central offshore, east offshore, west inshore, central inshore, east inshore) for catch analysis.

Results

A total of 21 gill net sets were conducted in the Mississippi Sound between April and October, 2021 (Figure 2). This resulted in the capture of 44 sharks of four species and 15 rays of three species (Table 1). Thirteen species of teleost were also encountered during the sampling events (Table 1).

Abundance Trends

The Atlantic sharpnose sharks, *Rhizoprionodon terraenovae*, (n=16; females: 47.4 – 48.5 cm FL, mean = 48.0 cm FL; males: 46.5 – 89.0 cm FL, mean = 57.3 cm FL), was the most abundant species encountered, and made up 36.4% of the shark catch. All three life stages (young of the year, juvenile, adult) were encountered which is typical for this species in the region. The bull shark, *Carcharhinus leucas,* (n=12; females: 63.2 – 94.3 cm FL, mean = 78.8 cm FL; males: 59.6 – 103.4 cm FL, mean = 78.5 cm FL; 3 unknown), was the second most abundant species (27.3%).

Only juveniles were encountered. This is a very high rate of catch for bull sharks as compared to previous years. The finetooth shark, *Carcharhinus isodon*, (n=10; female: 47.4 – 66.0 cm FL, mean = 53.4 cm FL; male: 46.0 – 60.0 cm FL, mean = 52.0 cm FL) was the third most abundant species (22.7%). Only juvenile finetooth were caught. The blacktip shark, *Carcharhinus limbatus*, (n=6; females: 51.4 – 76.0 cm FL, mean = 66.4 cm FL; males: 53.2 – 116.8 cm FL, mean

= 78.9 cm FL), was encountered the least and made up 13.6% of the catch. All three life stages of this species were encountered.

The majority of the shark catch (n=41, 90% of those indicated for maturity) was of juvenile or young of the year stature, which is consistent with previous years, and implies that the Mississippi Sound is an important habitat for area for these species as they mature.

Of the ray species encountered, the cownose ray, *Rhinoptera bonasus,* (n=7; female 75.5 – 82.2 cm DW, mean = 78.0 cm DW; male: 76.0 – 81.4 cm DW, mean = 78.0 cm DW) and the Brazilian cownose ray, *Rhinoptera brasiliensis,* (n=7; female 79.2 -97.3 cm DW; mean = 88.3 cm DW; male: 71.3 – 79.7 cm DW, mean = 75.9 cm DW), were the most abundant species encountered (46.7% each). Additionally, a bluntnose stingray, *Hypanus say*, (n=1; male: 44.8 cm DW) was caught. All rays we mature in stature.

Catch-per-unit-effort by area

Sampling in the west offshore region took place north of Cat Island, and mid-Sound south of Bay St. Louis (Figure 2). This region is heavily influenced by Pearl River drainage and is characterized by a sand, silt, or mud bottom. Catch per unit effort (CPUE) was 0.20 elasmobranchs per net hour (see Figure 3 for individual station CPUEs). Elasmobranch catch occurred only at the June station conducted mid-Sound. This station resulted in the encounter of two juvenile bull sharks (CPUE was 0.20 sharks per net hour) (Table 2). The stations conducted in May, and August, all north of Cat Island, yielded no elasmobranchs. The station conducted in April yielded no catch at all (water parameters were normal).

Sampling in the central offshore region took place north of west Ship Island in May, in Dog Keys Pass (between Horn and Ship islands) in June, south of Biloxi in August, and north of Horn Island in September. This region has little riverine influence and is characterized by sand, silt, or mud bottom with sparse grass beds present at the islands. The CPUE was 0.51 elasmobranchs per net hour (see Figure 3 for individual station CPUEs). Three species were caught in this region: a juvenile finetooth shark (0.17 sharks per net hour), an adult blacktip (0.18 sharks per net hour), and a juvenile bull shark (0.17 sharks per net hour) (Table 2). The stations conducted in May and June yielded no elasmobranchs.

The east offshore region included one mid-Sound station south of Pascagoula in April, one station north of Petit Bois Island in July, and one station north of the east end of Horn Island in October. This region has moderate influence from the Pascagoula River and is characterized by mud, silt, and sand bottom, and sparse artificial reef structure. This region had a CPUE of 4.52 elasmobranchs per net hour (see Figure 3 for individual station CPUEs) consisting of two elasmobranch species. Juvenile Atlantic sharpnose sharks were caught in the greatest abundance (1.82 sharks per net hour), followed by adult Brazilian cownose rays (1.48 rays per net hour), young of the year Atlantic sharpnose sharks (0.61 sharks per net hour), and adult Atlantic sharpnose sharks (0.62 sharks per net hour) (Table 2 and 3). The station conducted in July yielded

no elasmobranchs.

The west inshore region was sampled south of the mouth of Bay St Louis in May, southeast of the Bay in August, and east of Gulfport in September. This area is greatly influenced by the Jourdan and Wolf rivers and is characterized by mud bottom. The CPUE in this region was 0.51 elasmobranchs per net hour (see Figure 3 for individual station CPUEs). The bull shark was the only species encountered. The catch included a juvenile (0.17 sharks per net hour), and two individuals of unknown stature (0.34 sharks per net hour; Table 2).

The central inshore region was sampled south of Deer Island in June and October, and south Ocean Springs in July. This area is directly influenced by the riverine outflow from Biloxi Bay and is characterized by mud, silt, fine sand, and oyster reef bottom. This region had the highest CPUE of 7.62 elasmobranchs per net hour (see Figure 3 for individual station CPUEs). Three species were caught in this region. Juvenile finetooth sharks made up the highest CPUE at (0.98 sharks per net hour), followed by juvenile bull sharks (0.55 sharks per net hour). One juvenile Atlantic sharpnose shark (0.14 sharks per net hour) and one bull shark of unknown stature (0.09 sharks per net hour) were also caught (Table 2).

The east inshore region was sampled west of Round Island in April, south of Pascagoula in July, mid-Sound south of Grand Bay NERR in September, and east of Round Island in October. This region has high influence from the Pascagoula River and is characterized by a mud and silt bottom. The CPUE was 2.26 elasmobranchs per net hour (see Figure 3 for individual station CPUEs). This region showed the greatest diversity of six elasmobranch species. The highest CPUE was for adult cownose rays (1.11 rays per net hour). This was followed by juvenile blacktip sharks (0.45 sharks per net hour), juvenile finetooth sharks (0.35 sharks per net hour), young of the year blacktip sharks (0.30 sharks per net hour), juvenile bull sharks (0.20 sharks per net hour), and the bluntnose stingray (0.15 rays per net hour) (Table 2 and 3).

Species Habitat Profiles

Total elasmobranch catch and diversity encountered in 2021 were lower than in previous years. Descriptions of the habitat profiles are based on the water parameters at the bottom of the water column.

All life stages of Atlantic sharpnose shark were caught during the sampling period in the Mississippi Sound. This is not surprising as both male and female young of the year and juveniles, as well as adult males typically inhabit these waters. All life stages were caught in the spring and fall in the offshore east regions, and a juvenile was encountered in the fall in the offshore central region (Table 2). Water conditions for all three species were similar however, all life stages occurred in higher salinity waters (>25) and young of the year were caught in the lowest water clarity water (Table 4).

The bull shark was encountered in all regions sampled except for the offshore east (Table 2). Only juveniles were caught, and encounters were only during summer and early fall months.

This shark was caught in the widest range of salinity and water clarity values (Table 5).
The finetooth shark was caught in the inshore east, inshore central and offshore central regions (Table 2). Only juveniles were encountered, and they were only caught in the late summer and fall. Finetooth sharks were caught in a wide range of water clarity sites (Table 6).

The blacktip shark was the other species for which all life stages were encountered. All individuals were caught in the fall in the offshore central and inshore east regions. This species was found in higher water temperatures (28.5 – 29.3°C) due to the season in which they were caught (Table 7). Young of the year and juveniles were caught in the same water parameters at the inshore east stations. The adult was also caught in similar water parameters but in the offshore central region.

Rays were only caught in the east and only adults of the species were encountered (Table 3). All cownose rays were encountered in the inshore east region in April and September. This is not surprising as cownose rays are typically found closer to the coastal region than the Brazilian cownose ray. They were also found in a wide range of water clarity values (Table 8). The Brazilian cownose ray was only found at one offshore east station in the fall (Table 3) in surprisingly low dissolved oxygen waters (2.8 mg/L) (Table 9). It is not surprising that so many individuals were caught at one station as this species is known to school. One bluntnose stingray was also caught in the inshore east region in the fall (Table 3). It was in slightly higher temperature waters for the Sound as it was caught in early fall (Table 10).

Overall, 2021 sampling resulted in the capture of the four historically predominant shark species for the Mississippi Sound, however it was surprising to not encounter any sphyrnids or spinner sharks. The ray encounter was higher than normal, however this is likely due to the schooling behavior exhibited by Rhinopterid species. Of the 41 sharks for which a maturity stage was determined, 90% were of juvenile or young of the year stature. Three male, Atlantic sharpnose sharks were deemed mature which are normal inhabitants of the Sound. The one adult blacktip that was caught was a rare catch for this survey. Adult blacktips are typically encountered south of the Mississippi Sound.

Due to the sampling regime put in place in 2012, the same sites are unable to be sampled monthly. It is therefore important to note that these results are only representative of the conditions at the time of sampling and likely do not reflect the species assemblage throughout the year. As the Mississippi Sound is a very dynamic environment there are seasonal/monthly shifts in abundances and size classes.

Figure 1. Sampling regions (east, central, west) in Mississippi coastal waters for FY-22. Cat, Ship, Horn, and Petit Bois are barrier islands. Deer and Round are nearshore islands.

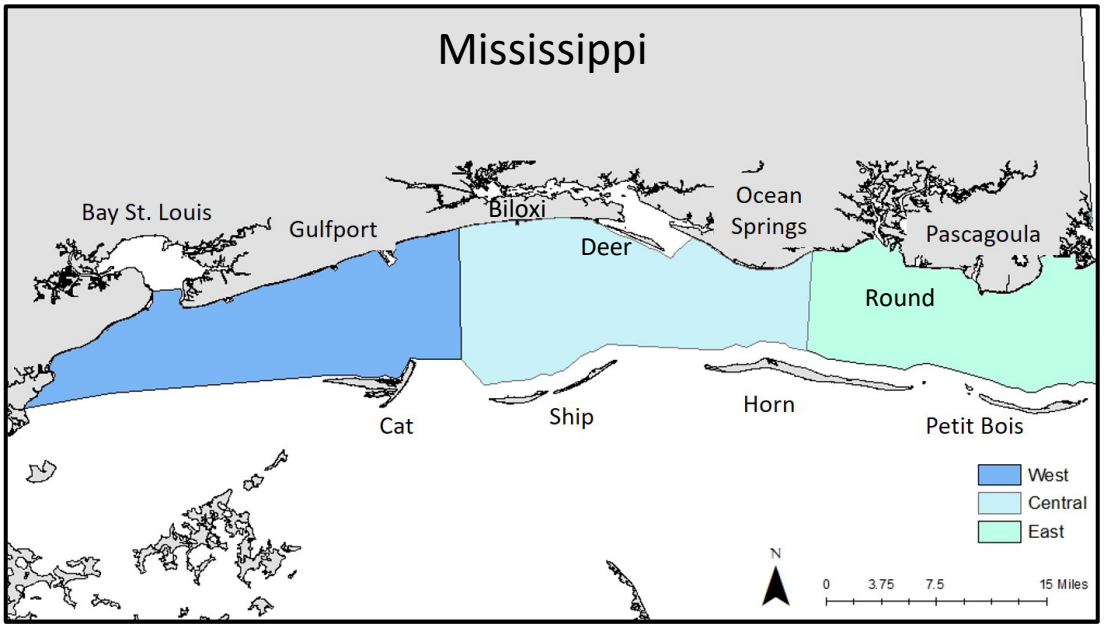


Figure 2. Locations of gillnet sets (n=21) made in Mississippi coastal waters for FY-22.

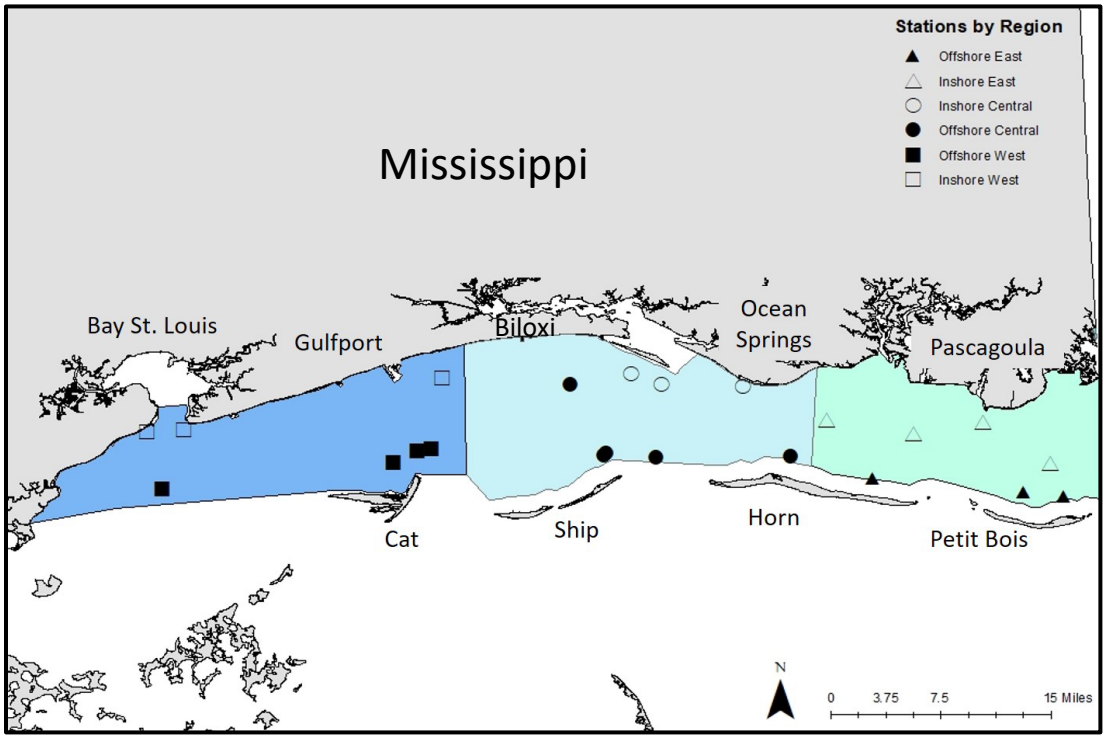


Table 1. Summary of Mississippi fish catch and number of individuals during FY-22 sampling. Elasmobranchs are denoted by an asterisk.

SPECIES NAME	COUNT
Ariopsis felis	259
Bagre marinus	263
Brevoortia patronus	153
Caranx hippos	7
*Carcharhinus isodon**	10
*Carcharhinus leucas**	13
*Carcharhinus limbatus**	6
Cynoscion arenarius	19
Cynoscion nebulosus	1
*Hypanus say**	1
Elops saurus	2
Lepisosteus osseus	2

Menticirrhus americanus	2
Micropogonias undulatus	1
Peprilus paru	17
*Rhinoptera bonasus**	2
*Rhinoptera brasiliensis**	7
*Rhizoprionodon terraenovae**	14
Sciaenops ocellatus	8
Scomberomorus maculatus	21

Figure 3. Elasmobranch catch per unit effort (elasmobranchs per net hour) at gillnet sampling sites in Mississippi coastal waters for FY-22.

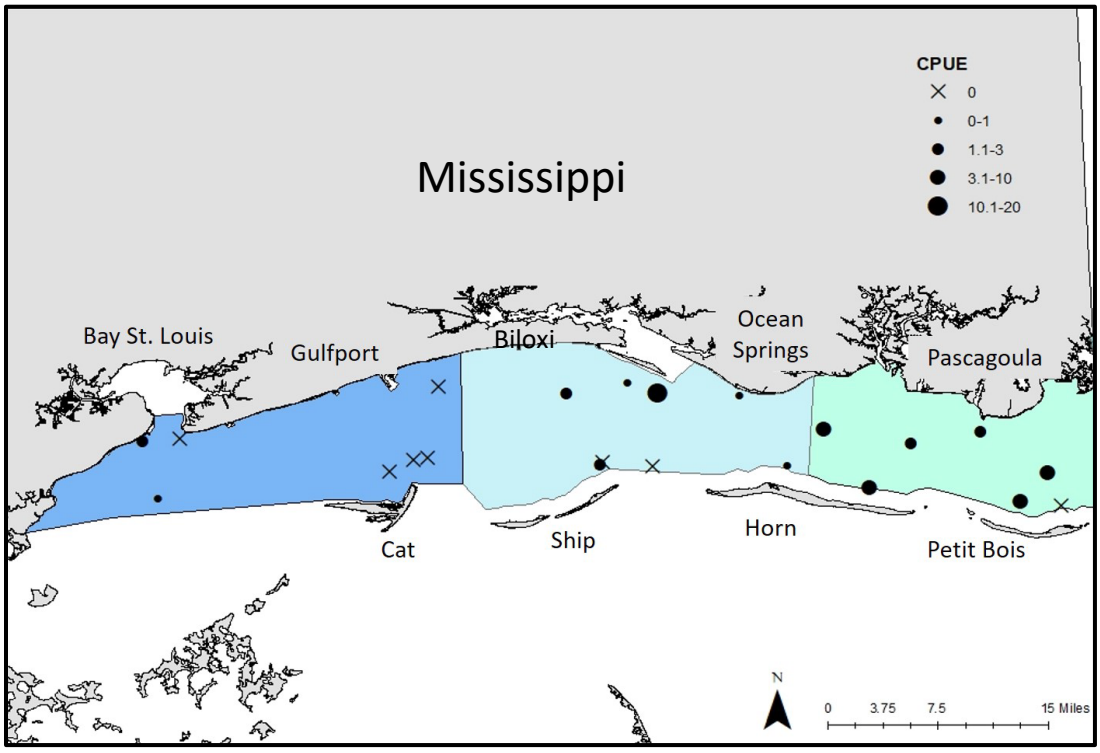


Table 2. Summary of CPUE (number of sharks per net hour) by life history stage and region for sharks caught in Mississippi coastal waters for FY-22. Mean values are presented with standard deviation in parentheses. Sexes are combined. Young-of-the-year includes neonates.
Species are listed by abundance caught.

(a) Atlantic sharpnose shark, *Rhizoprionodon terraenovae*

Life stage	West	Central	East	Inshore West	Inshore Central	Inshore East
Young-of-the-year	--	--	0.61 (1.05)	--	--	--
Juveniles	--	--	1.82 (3.15)	--	0.14 (0.24)	--
Adults	--	--	0.62 (0.63)	--	--	--
All	--	--	1.02 (0.69)	--	0.14 (0.24)	--

(b) Bull shark, *Carcharhinus leucas (note: 3 sharks were not classified by life stage)*

Life stage	West	Central	East	Inshore West	Inshore Central	Inshore East
Young-of-the-year	--	--	--	--	--	--
Juveniles	0.20 (0.41)	0.17 (0.33)	--	0.17 (0.29)	0.55 (0.73)	0.20 (0.39)
Adults	--	--	--	--	--	--
All	0.20 (0.41)	0.17 (0.33)	--	0.17 (0.29)	0.55 (0.73)	0.20 (0.39)

(c) Finetooth shark, *Carcharhinus isodon*

Life stage	West	Central	East	Inshore West	Inshore Central	Inshore East
Young-of-the-year	--	--	--	--	--	--
Juveniles	--	0.17 (0.33)	--	--	0.98 (1.70)	0.35 (0.70)
Adults	--	--	--	--	--	--
All	--	0.17 (0.33)	--	--	0.98 (1.70)	0.35 (0.70)

(d) Blacktip shark, *Carcharhinus limbatus*

Life stage	West	Central	East	Inshore West	Inshore Central	Inshore East
Young-of-the-year	--	--	--	--	--	0.30 (0.59)
Juveniles	--	--	--	--	--	0.45 (0.89)
Adults	--	0.18 (0.35)	--	--	--	--
All	--	0.18 (0.35)	--	--	--	0.74 (1.49)

Table 3. Summary of CPUE (number of rays per net hour) by life history stage and region for rays caught in Mississippi coastal waters for FY-22. Mean values are presented with standard deviation in parentheses. Sexes are combined. Young-of-the-year includes neonates.
Species are listed by abundance caught.

(a) Cownose ray, *Rhinoptera bonasus*

Life stage	West	Central	East	Inshore West	Inshore Central	Inshore East
Young-of-the-year	--	--	--	--	--	--
Juveniles	--	--	--	--	--	--
Adults	--	--	--	--	--	1.11 (1.54)
All	--	--	--	--	--	1.11 (1.54)

(b) Brazilian cownose ray, *Rhinoptera brasiliensis*

Life stage	West	Central	East	Inshore West	Inshore Central	Inshore East
Young-of-the-year	--	--	--	--	--	--
Juveniles	--	--	--	--	--	--
Adults	--	--	1.48 (2.56)	--	--	--
All	--	--	1.48 (2.56)	--	--	--

(c) Bluntnose stingray, *Hypanus say*

Life stage	West	Central	East	Inshore West	Inshore Central	Inshore East
Young-of-the-year	--	--	--	--	--	--
Juveniles	--	--	--	--	--	--
Adults	--	--	--	--	--	0.15 (0.30)
All	--	--	--	--	--	0.15 (0.30)

Table 4. Summary of the habitat associations for the Atlantic sharpnose shark, *Rhizoprionodon terraenovae,* by life stage in Mississippi coastal waters for FY22. Young-of-the-year includes neonate life stage. Means are presented. Ranges are in parentheses. Bottom type is presented in descending predominance.

Life stage	Temperature (°C)	Salinity (ppt)	Depth (m)	Water clarity (cm)	Dissolved oxygen (mg l^{-1})	Bottom type
Young-of-the year n=3	20.0 (20.0)	27.6 (27.6)	5.6 (5.6)	80 (80)	5.5 (5.5)	mud/sand
Juvenile n=10	21.25 (20.0 - 22.5)	26.7 (25.8 - 27.6)	4.1 (2.5 – 5.6)	100.5 (80 – 121)	6.2 (5.5 – 6.9)	mud/sand
Adult n=3	22.4 (20 – 24.7)	26.9 (26.3 – 27.6)	4.8 (4.0 – 5.6)	190 (80 - 300)	6.3 (5.5 – 7.1)	mud/sand

Table 5. Summary of the habitat associations for the bull shark, *Carcharhinus leucas*, by life stage in Mississippi coastal waters for FY22. Young-of-the-year includes neonate life stage. Means are presented. Ranges are in parentheses. Bottom type is presented in descending predominance. *(note: 3 sharks were not classified by life stage and do not show up in the analyses below)*

Life stage	Temperature (ºC)	Salinity (ppt)	Depth (m)	Water clarity (cm)	Dissolved oxygen (mg l^{-1})	Bottom type
Young-of-the year	--	--	--	--	--	--
n=0	--	--	--	--	--	
Juvenile	28.9	14.7	3.1	114.4	5.9	mud/sand/silt
n=9	(24.3 - 30.5)	(4.4 - 22.5)	(1.3 – 4.1)	(68 - 201)	(4.6 – 8.2)	
Adult	--	--	--	--	--	--
n=0	--	--	--	--	--	

Table 6. Summary of the habitat associations for the finetooth shark, *Carcharhinus isodon*, by life stage in Mississippi coastal waters for FY16. Young-of-the-year includes neonate life stage. Means are presented. Ranges are in parentheses. Bottom type is presented in descending predominance.

Life stage	Temperature (ºC)	Salinity (ppt)	Depth (m)	Water clarity (cm)	Dissolved oxygen (mg l^{-1})	Bottom type
Young-of-the year	--	--	--	--	--	--
n=0	--	--	--	--	--	
Juvenile	27.9	21.8	3.0	102.7	4.9	mud/sand
n=10	(22.5 – 30.7)	(18.9 – 25.8)	(2.3 – 4.1)	(37 – 150)	(2.5 – 6.9)	
Adult	--	--	--	--	--	--

n=0	--	--	--	--	--

Table 7. Summary of the habitat associations for the blacktip shark, *Carcharhinus limbatus* by life stage in Mississippi coastal waters for FY22. Young-of-the-year includes neonate life stage. Means are presented. Ranges are in parentheses. Bottom type is presented in descending predominance.

Life stage	Temperature (ºC)	Salinity (ppt)	Depth (m)	Water clarity (cm)	Dissolved oxygen (mg l^{-1})	Bottom type
Young-of-the year	29.3	20.9	4.4	129	5.7	mud/silt/sand
n=2	(29.3)	(20.9)	(4.4)	(129)	(5.7)	
Juvenile	29.3	20.9	4.4	129	5.7	mud/silt
n=3	(29.3)	(20.9)	(4.4)	(129)	(5.7)	
Adult	28.5	17.9	4.3	101	5.0	Mud/sand
n=1	(28.5)	(17.9)	(4.3)	(101)	(5.0)	

Table 8. Summary of the habitat associations for the cownose ray, *Rhinoptera bonasus*, by life stage in Mississippi coastal waters for FY16. Young-of-the-year includes neonate life stage. Means are presented. Ranges are in parentheses. Bottom type is presented in descending predominance.

Life stage	Temperature (ºC)	Salinity (ppt)	Depth (m)	Water clarity (cm)	Dissolved oxygen (mg l^{-1})	Bottom type
Young-of-the year	--	--	--	--	--	--
n=0	--	--	--	--	--	
Juvenile	--	--	--	--	--	--
n=0	--	--	--	--	--	
Adult	24.6	17.1	3.6	92	6.1	Sand/mud/silt
n=7	(19.8 – 29.3)	(13.2 – 20.9)	(2.8 – 4.4)	(55 - 129)	(5.7 - 6.4)	

Table 9. Summary of the habitat associations for the Brazilian cownose ray, *Rhinoptera brasiliensis*, by life stage in Mississippi coastal waters for FY16. Young-of-the-year includes neonate life stage. Means are presented. Ranges are in parentheses. Bottom type is presented in descending predominance.

Life stage	Temperature (ºC)	Salinity (ppt)	Depth (m)	Water clarity (cm)	Dissolved oxygen (mg l^{-1})	Bottom type
Young-of-the year	--	--	--	--	--	--
n=0	--	--	--	--	--	
Juvenile	--	--	--	--	--	--
n=0	--	--	--	--	--	
Adult	23.4	15.9	5.5	136	2.8	Silt

n=7	(23.4)	(15.9)	(5.5)	(136)	(2.8)	

Table 10. Summary of the habitat associations for the Atlantic stingray, *Hypanus say*, by life stage in Mississippi coastal waters for FY16. Young-of-the-year includes neonate life stage. Means are presented. Ranges are in parentheses. Bottom type is presented in descending predominance.

Life stage	Temperature (ºC)	Salinity (ppt)	Depth (m)	Water clarity (cm)	Dissolved oxygen (mg l^{-1})	Bottom type
Young-of-the year	--	--	--	--	--	--
n=0	--	--	--	--	--	
Juvenile	--	--	--	--	--	--
n=0	--	--	--	--	--	
Adult	29.3	20.9	4.4	129	5.7	Mud/silt
n=1	(29.3)	(20.9)	(4.4)	(129)	(5.7)	

REGION 2: NORTHWEST FLORIDA – ST. ANDREW BAY TO ST. VINCENT ISLAND, FLORIDA (NOAA FISHERIES SEFSC PANAMA CITY LABORATORY)

Information Specific to Region 2

Sampling sites in this region were located in four major areas along the panhandle of Florida: St. Andrew Bay, Crooked Island Sound, St. Joseph Bay, and Apalachicola/St. Vincent Island (Figures 1-4). Due to restrictions on sampling due to COVID19, not all areas were sampled throughout the field season. A total of 33 gillnet sets were made, capturing ten species of shark and rays. This work was permitted under Florida Fish and Wildlife Conservation Commission Special Activity Licenses SAL-20-1292-SRP and SAL-21-1292-SRP.

Elasmobranch catch consisted of 36% adult, 25% juvenile, and 33% young-of-the-year, including neonates. Comprising 33% of the total catch, bonnethead was the most abundant shark encountered overall. Atlantic sharpnose shark was the second-most encountered species overall (24.7% of total catch) followed by scalloped hammerhead shark (13.3%) (Table 1). Average size size for all elasmobranchs captured is in Table 2.

Overall, relative abundance was lowest in St. Andrews Bay and highest in Apalachicola/St.

Vincent Island. Only two species were captured in St. Andrews Bay, cownose ray and bonnethead shark. Four species were captured in Apalachicola/St. Vincent Island with CPUE as high as 4.35 sharks per hour for adult bonnethead sharks. Both St. Joe Bay and Crooked Island Sound were dominated by Atlantic sharpnose shark and bonnethead (Table 3). Some species were only captured in one bay system. Blacknose shark were only captured in St. Joe Bay, finetooth and scalloped hammerhead shark only in Apalachicola/St. Vincent Island, and lemon shark, southern stingray and smooth butterfly ray in Crooked Island Sound.

Essential fish habitat (EFH) profiles for elasmobranchs collected in northwest Florida from St. Andrews Bay to St. Vincent Island in 2021 are summarized in Tables 4-6. As sampling was limited in 2021 due to COVID restrictions, correlations with environmental factors for 2021 should be interpreted with caution.

Region 2 Tables

Table 1. Percent contribution of total elasmobranchs by species and life stage.

Species	Percent total by species	Percent of adults	Percent of juveniles	Percent of young-of-the-year
Carcharhinus acronotus	2.9	0.0	0.0	8.6
Carcharhinus isodon	4.8	2.6	11.1	0.0
Carcharhinus limbatus	6.7	2.6	7.4	11.4
Dasyatis americana	1.0	2.6	0.0	0.0
Gymnura micrura	1.9	0.0	3.7	0.0
Negaprion brevirostris	1.0	0.0	3.7	0.0
Rhinoptera bonasus	10.5	7.9	14.8	2.9
Rhizoprionodon terraenovae	24.8	15.8	25.9	37.1
Sphyrna lewini	13.3	0.0	3.7	37.1
Sphyrna tiburo	33.3	68.4	29.6	2.9

Table 2**.** Elasmobranch average size by area. FL = fork length. DW = disc width. Number in parenthesis are standard deviation of the mean.

Area	**Species**	**Sex**	**Mean size FL (cm)**	**Mean size DW (cm)**
Apalachicola Bay/St. Vincent Island	*Carcharhinus isodon*	F	88.0 (7.1)	
	Carcharhinus isodon	M	93.0 (8.5)	
	Carcharhinus leucas	M	60.0	
	Carcharhinus limbatus	F	84.7 (35.7)	
	Carcharhinus limbatus	M	61.0	
	Gymnura micrura	F		45.0
	Sphyrna lewini	F	60.8 (22.2)	
	Sphyrna lewini	M	44.3 (3.2)	
	Sphyrna tiburo	F	75.3 (10.7)	
	Sphyrna tiburo	M	64.6 (5.8)	
Crooked Island Sound	*Carcharhinus limbatus*	F	94.0	
	Dasyatis americana	M		58.0
	Gymnura micrura	F		28.0
	Rhinoptera bonasus	M		45.0
	Rhizoprionodon terraenovae	F	54.5 (26.2)	
	Rhizoprionodon terraenovae	M	60.5 (12.7)	
	Sphyrna tiburo	M	52.0	
St. Andrew Bay	*Rhinoptera bonasus*	F		67.1 (16.9)
	Rhinoptera bonasus	M		56.8 (13.1)
	Sphyrna tiburo	F	69.5 (7.8)	
St. Joe Bay	*Carcharhinus acronotus*	M	44.0 (2.2)	
	Carcharhinus limbatus	F	97.0	
	Rhinoptera bonasus			
	Rhizoprionodon terraenovae	F	38.0 (5.7)	
	Rhizoprionodon terraenovae	M	56.0 (4.3)	
	Sphyrna tiburo	F	54.3 (17.9)	
	Sphyrna tiburo	M	51.8 (7.3)	

Table 3. Summary of CPUE (number of animals per net hour) for elasmobranchs by life history stage and area sampled in northwest Florida for 2021. Numbers in parenthesis are standard deviations of the mean. Young-of-the-year includes neonate life stage. Sexes are combined. Specimens with an undetermined life stage are included in total CPUE calculation. Species are listed alphabetically by scientific name.

(a) *Carcharhinus acronotus*

Life stage	St. Andrew Bay	Crooked Island Sound	St. Joseph Bay	Apalachicola Bay/St. Vincent Island
Young-of-the-year	--	--	0.42 (0.92)	--
Juveniles	--	--	--	--
Adults	--	--	--	--
All	--	--	0.42 (0.92)	--

(b) *Carcharhinus isodon*

Life stage	St. Andrew Bay	Crooked Island Sound	St. Joseph Bay	Apalachicola Bay/St. Vincent Island
Young-of-the-year	--	--	--	--
Juveniles	--	--	--	0.55 (1.11)
Adults	--	--	--	0.18 (0.37)
All	--	--	--	0.93 (1.86)

(c) *Carcharhinus limbatus*

Life stage	St. Andrew Bay	Crooked Island Sound	St. Joseph Bay	Apalachicola Bay/St. Vincent Island
Young-of-the-year	--	--	--	0.81 (1.06)
Juveniles	--	0.13 (0.39)	0.12 (0.38)	--
Adults	--	--	--	0.18 (0.37)
All	--	0.13 (0.39)	0.12 (0.38)	0.99 (1.41)

(d) *Dasyatis americana*

Life stage	St. Andrew Bay	Crooked Island Sound	St. Joseph Bay	Apalachicola Bay/St. Vincent Island
Young-of-the-year	--	--	--	--
Juveniles	--	--	--	--

Adults	--	0.19 (0.57)	--	--
All	--	0.19 (0.57)	--	--

(e) *Gymnura micrura*

Life stage	St. Andrew Bay	Crooked Island Sound	St. Joseph Bay	Apalachicola Bay/St. Vincent Island
Young-of-the-year	--	--	--	--
Juveniles	--	0.15 (0.44)	--	--
Adults	--	--	--	--
All	--	0.15 (0.44)	--	--

(f) *Negaprion brevirostris*

Life stage	St. Andrew Bay	Crooked Island Sound	St. Joseph Bay	Apalachicola Bay/St. Vincent Island
Young-of-the-year	--	--	--	--
Juveniles	--	0.17 (0.49)	--	--
Adults	--	--	--	--
All	--	0.17 (0.49)	--	--

(g) *Rhinoptera bonasus*

Life stage	St. Andrew Bay	Crooked Island Sound	St. Joseph Bay	Apalachicola Bay/St. Vincent Island
Young-of-the-year	0.17 (0.54)	--	--	--
Juveniles	0.49 (1.07)	0.15 (0.44)	--	--
Adults	0.44 (1.41)	--	--	--
All	1.35 (2.35)	0.15 (0.44)	0.29 (0.63)	--

(h) *Rhizoprionodon terraenovae*

Life stage	St. Andrew Bay	Crooked Island Sound	St. Joseph Bay	Apalachicola Bay/St. Vincent Island
Young-of-the-year	--	0.63 (1.38)	1.09 (3.03)	--
Juveniles	--	0.74 (2.22)	0.24 (0.76)	--
Adults	--	0.84 (1.67)	--	--
All	--	2.21 (4.82)	1.33 (3.78)	--

(i) *Sphyrna lewini*

Life stage	St. Andrew Bay	Crooked Island Sound	St. Joseph Bay	Apalachicola Bay/St. Vincent Island
Young-of-the-year	--	--	--	2.74 (3.19)
Juveniles	--	--	--	0.37 (0.74)
Adults	--	--	--	--
All	--	--	--	3.11 (2.83)

(j) *Sphyrna tiburo*

Life stage	St. Andrew Bay	Crooked Island Sound	St. Joseph Bay	Apalachicola Bay/St. Vincent Island
Young-of-the-year			0.13 (0.42)	
Juveniles	0.14 (0.47)	0.14 (0.44)	0.31 (0.67)	0.80 (1.06)
Adults	0.14 (0.47)		0.46 (1.03)	4.35 (6.33)
All	0.29 (0.94)	0.14 (0.44)	0.92 (1.66)	5.16 (7.38)

Table 4. Summary of the habitat associations for young-of-the year elasmobranchs. Sexes are combined. Young-of-the-year includes neonate life stage.

Species	Water temperature (°C)	Salinity (ppt)	Depth (m)	Turbidity (cm)	Dissolved oxygen (mg/L)	Bottom type
Carcharhinus acronotus	29.2	31.2	1.2	155.0	4.7	Seagrass/sand
Carcharhinus leucas	28.3	31.1	1.7	60.0	5.0	Mud
Carcharhinus limbatus	28.4	31.2	1.6	53.3	5.6	Mud
Rhinoptera bonasus	23.7	24.2	3.5	90.0	5.9	Mud
Rhizoprionodon terraenovae	27.2	29.7	2.8	123.7	5.2	Seagrass/mud
Sphyrna lewini	28.4	31.2	1.6	52.9	5.6	Mud
Sphyrna tiburo	28.7	31.0	1.3	150.0	3.5	Seagrass

Table 5. Summary of the habitat associations for juvenile elasmobranchs. Sexes are combined.

Species	Water temperature (ºC)	Salinity (ppt)	Depth (m)	Turbidity (cm)	Dissolved oxygen (mg/L)	Bottom type
Carcharhinus isodon	28.3	31.1	1.7	60.0	5.0	Mud
Carcharhinus limbatus	27.1	29.2	3.2	135.0	5.3	Mud
Gymnura micrura	27.3	30.4	4.3	95.0	5.3	Mud
Rhinoptera bonasus	28.1	26.8	3.5	113.8	3.9	Mud
Rhizoprionodon terraenovae	27.2	30.1	3.6	107.9	5.3	Mud
Sphyrna lewini	28.2	30.9	5.5	540.0	5.3	Mud
Sphyrna tiburo	27.9	27.4	1.7	71.9	5.8	Seagrass

Table 6. Summary of the habitat associations for adult elasmobranchs. Sexes are combined.

Species	Water temperature (ºC)	Salinity (ppt)	Depth (m)	Turbidity (cm)	Dissolved oxygen (mg/L)	Bottom type
Carcharhinus isodon	28.3	31.1	1.7	60.0	5.0	mud
Carcharhinus limbatus	28.3	31.1	1.7	60.0	5.0	mud
Dasyatis americana	27.1	29.0	1.5	145.0	5.3	mud
Rhinoptera bonasus	31.2	27.1	1.7	120.0	2.0	mud
Rhizoprionodon terraenovae	27.2	29.7	4.5	112.5	5.4	mud
Sphyrna lewini	28.5	31.3	1.3	40.0	6.8	mud
Sphyrna tiburo	28.2	30.0	1.6	60.8	5.4	mud

Region 2 Figures

Figure 1. Locations of sets made in St. Andrew Bay, Crooked Island Sound, St. Joe Bay and Apalachicola/St. Vincent Island.

REGION 3: BIG BEND OF FLORIDA – ST. GEORGE SOUND TO ANCLOTE KEYS, FLORIDA (FLORIDA STATE UNIVERSITY COASTAL AND MARINE LABORATORY)

GULFSPAN sampling by the FSUCML in 2021 was similar to 2009-2020; covering more than 300 km of Florida's coastline from St. George Sound to the Anclote Keys. The distribution of 64 gillnet and 64 longline sets conducted by FSUCML in 2021 are shown in Region 3 Figure 1. St. George Sound was sampled monthly from April to October 2021 with paired gillnet (n = 14) and longline (n = 14) sets at fixed stations along Turkey Point Shoal and Dog Island Reef; the sampling of which has been conducted by FSUCML since 2008. A spatially balanced sampling design was employed to survey areas from Apalachee Bay to the Anclote Keys. Sampling effort was focused in or adjacent to seagrass habitats. Our goal was to conduct at least 40 paired gillnet/longline sets from June through August 2021 in this region. We completed 20 paired sets north of Cedar Key spanning Apalachee Bay to Suwanee Sound, and 20 paired sets south of Cedar Key spanning Waccasassa Bay to the Anclote Keys.

Experimental longlines designed to capture all size classes of coastal sharks were fished concurrently with all 54 gillnet sets. A standard set in the FSUCML longline survey included 100 demersal gangions spaced at 10-meter intervals along a mainline of 4.0 mm monofilament. Each end of the mainline is anchored and marked with a large buoy bearing the FWC Special Activity License number permitted for the project. The line consisted of four 25-hook sections separated by buoys, with a unique hook size employed within each section. The total length of a standard set was approximately 1,500 meters. Four sizes of Mustad circle hooks (10/0, 12/0, 14/0, and 16/0) were used to minimize size-selection bias and allow capture of all sharks present from the smallest neonate to the largest adult sharks. Each gangion began with a stainless-steel tuna clip attached to two meters of monofilament (136 kg test for 10/0, 12/0 and 14/0 hooks and 318 kg test for the 16/0 hooks). The monofilament was crimped to an 8/0 stainless steel barrel swivel followed by a one-meter section of 7x7 stainless-steel aircraft cable (1.8mm for 10/0, 12/0, and 14/0 hooks; 2.2mm for 16/0 hooks). Each gangion was terminated by a circle hook crimped to the steel cable. Hooks were baited with Spanish mackerel (*Scomberomorus maculatus*). Each set soaked for one to two hours, depending on gillnet haul duration, from first hook in the water until last hooked removed from the water. Temperature, salinity and dissolved oxygen were recorded at top-, mid- and bottom-water column using a YSI ProSolo for each longline and gillnet set. Clarity as well as minimum and maximum depths were recorded for each set via secchi disk and observation of onboard sonar, respectively. When clarity exceeded depth, a clarity measurement could not be precisely obtained by secchi disk. In Region 3 Tables 2-14, the sets for which clarity exceeded depth were included in the calculations by substituting the max depth for clarity in order to minimize underestimation of clarity means and ranges.

In total, 593 elasmobranchs from 15 species were caught. Three species (Atlantic sharpnose sharks, *Rhizoprionodon terraenovae*; bonnetheads, *Sphyrna tiburo*; and blacktip sharks, *Carcharhinus limbatus*) combined for 84.5% of the total. The gillnets captured 269 sharks from 8 species and 11 batoids from 4 species. The longlines captured 313 sharks of 9 species. Of 593 sharks captured, 269 were tagged upon release. Catch per unit of effort

summaries are provided for all 15 species of elasmobranchs captured in Region 3 Table 1. Data are reported separately for St. George Sound, Apalachee Bay to Suwanee Sound, and Waccasassa Bay to the Anclote Keys. As in previous years, sampling in 2021 indicated that this region serves as a primary nursery for at least two species of small coastal sharks (Atlantic sharpnose sharks; blacknose sharks, *C. acronotus*) and one species of large coastal shark (blacktip sharks).

Abundance trends

The overall catch rates across all areas were 4.86 (S.D. = 5.99) sharks per net-hour for the gillnets and 5.80 (S.D. = 5.25) sharks per 100 hooks for the longlines. Of the three dominant shark species captured, catch rates of Atlantic sharpnose sharks were comparable in the two gear types, catch rates of blacktip sharks were higher across all life stages using longlines, and bonnetheads were only encountered in gillnets.

Atlantic sharpnose sharks and bonnetheads combined for 77.7% of the shark catch in the gillnets (32.1% and 45.6%, respectively). Lengths of captured Atlantic sharpnose sharks (30.0-78.0 cm FL; mean = 57.3 cm FL) and bonnetheads (28.0-83.0 cm FL; mean = 57.8 cm FL) were relatively similar. Of the Atlantic sharpnose sharks captured, all mature individuals were male (n = 38), while juveniles (n = 34) and young-of-the-year (YOY; n = 25) displayed relatively even sex ratios. Bonnethead catch included juveniles (n = 99) and adults (n = 45) of both sexes and one young-of-year individual. Six other species of sharks were captured in the gillnets: 13 YOY (39.0-61.0 cm FL; mean = 47.0 cm FL), 13 juvenile (67.0-109.0 cm FL; mean = 87.3 cm FL) and 3 mature (118-125.0 cm FL; mean = 121.3cm FL) blacktip sharks of both sexes; one YOY, 2 juvenile and 2 mature blacknose sharks of both sexes (38.0-88 cm FL; mean = 58.6 cm FL); one mature female great hammerhead shark (*Sphyrna mokarran*; 219.0 cm FL); 3 juvenile narrowfin smooth-hound sharks (*Mustelis norrisi*; 40.0-43.0 cm FL; mean = 41.6 cm FL) of both sexes; one mature female bull shark (*Carcharhinus leucas*; 199.0 cm FL) and one YOY female spinner shark (*Carcharhinus brevpinna*; 53.0 cm FL). Four species of batoids were encountered in the gillnets: 6 Atlantic stingrays (*Hypanus sabina*; 10.0-22.0 cm disk width (DW)) of both sexes; 3 Southern stingrays (*Hypanus americana*; 40.0-55.0 cm DW) of both sexes; one mature male cownose ray (*Rhinoptera bonasus*; 69.0 cm DW) and one smooth butterfly ray (lost at boat).

Blacktip sharks dominated longline shark catch (n = 148; 47.3% of total; 39.0 – 145.0 cm FL, mean = 93.9 cm FL), with both sexes of all life stages captured. Atlantic sharpnose sharks were the second most common species captured on the longlines (n = 94; 30.0% of total; 25.0 – 83.0 cm FL, mean = 53.0 cm FL). YOY and juvenile Atlantic sharpnose of both sexes were captured, but all mature individuals captured were male. Blacknose sharks were the third most common species encountered on the longlines (n = 36; 11.5% of total catch; 35.0 – 95.0 cm FL, mean = 63.6 cm FL). Both sexes from each life stage of blacknose sharks were encountered. Tiger sharks were the fourth most common species (*Galeocerdo cuvier*; n = 18; 5.4% of total shark catch), most of which being juveniles with the exception of two mature individuals (126.0 – 290.0 cm FL; mean = 194.4 cm FL).

Nineteen sharks of five other species were caught on the longlines. These included the following: four spinner sharks (*Carcharhinus brevpinna*; 2:2 M:F; 51.0 – 81.0 cm FL); four bull sharks (*Carcharhinus leucas*; 3:1 M:F; 155.0 – 219.0 cm FL); two nurse sharks (*Ginglymostoma*

cirratum; both lost at boat); seven lemon sharks (*Negaprion brevirostris*; 5:2 M:F; 180.0 – 222.0 cm FL); and two juvenile female great hammerheads (*Sphyrna mokarran*; 192.0 cm FL for both).

Catch-per-unit-effort by area

Shark catch rates varied with latitude. Mean catch rates for the gillnets (sharks per net-hour) were 8.56 (S.D. = 7.58) in St. George Sound, 3.74 (S.D. = 6.17) from Apalachee Bay to Suwanee Sound, and 3.39 (S.D. = 7.58) from Waccasassa Bay to the Anclote Keys. Catch rates on longlines (sharks per 100 hooks) were 8.29 (S.D. = 4.46) in St. George Sound, 4.10 (S.D. = 3.34) from Apalachee Bay to Suwanee Sound, and 5.75 (S.D. = 6.68) from Waccasassa Bay to the Anclote Keys.

Catch rates of young-of-the-year blacktip sharks, especially on longlines, were higher in Waccasassa Bay to the Anclote Keys than in St. George Sound or Apalachee Bay to Suwanee Sound (Region 3 Table 1d). Young-of-the-year blacknose sharks were caught in both Apalachee Bay to Suwanee Sound and Waccasassa Bay to the Anclote Keys, with highest catch rates observed in Apalachee Bay to Suwanee Sound (Region 3 Table 1a).

Species essential fish habitat profiles

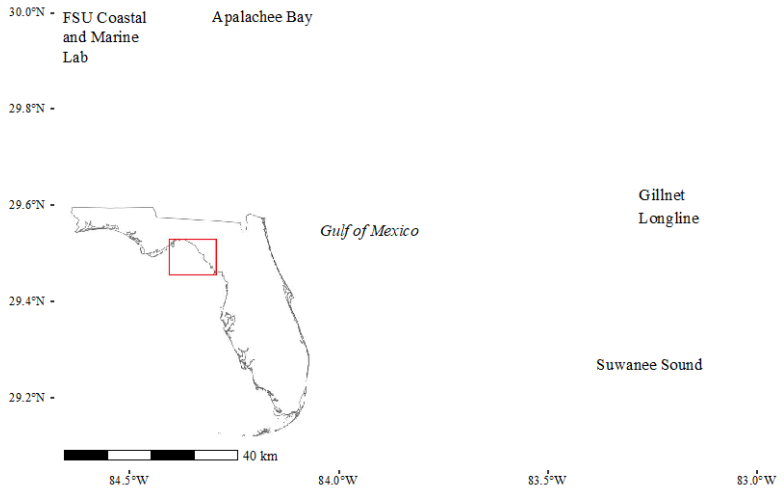
The essential fish habitat profiles for elasmobranchs from St. George Sound to Tarpon Springs are summarized in Region 3 Tables 2-16. This region clearly includes habitats that serve as important primary and secondary nurseries for several species of large coastal and small coastal sharks. Habitats sampled included seagrass (*Thallassia testudinum, Syringodium filiforme, Halodule wrighti*), drift algae dominated bottom, mud bottom, sandy ridges, and hardbottom reefs (dominated by soft corals and sponges). This region primarily consists of seagrass habitats in waters shallower than 4 m; therefore most effort was in this habitat type. All life stages of Atlantic sharpnose sharks, except adult females, were found in all habitats sampled, although very few were captured over hardbottom reefs. Juvenile and adult bonnetheads were most common in seagrass habitats. All life stages of blacktip sharks were typically captured on the edges of muddy channels and sandy ledges adjacent to seagrass habitats. All life stages of blacknose sharks were typically captured in on the edges of muddy channels adjacent to seagrass habitats.

Sampling in St. George Sound occurred from the 12th of April to the 14th of October 2021. Water temperatures ranged from 20.4 to 29.7°C and salinity ranged from 26.0 to 33.3. Sampling from Apalachee Bay to the Anclote Key occurred over June and July 2020 with water temperatures from 26.7 to 29.5°C. Salinity ranged from 17.8 to 38.9 (salinity at most stations was above 25.0). Of the three dominant species captured, generalized additive models indicate that capture rates of Atlantic sharpnose sharks and blacktip sharks are significantly correlated with clarities under 300 cm and bonnetheads are negatively correlated with clarity and maximum depth, but correlation coefficients suggest weak relationships.

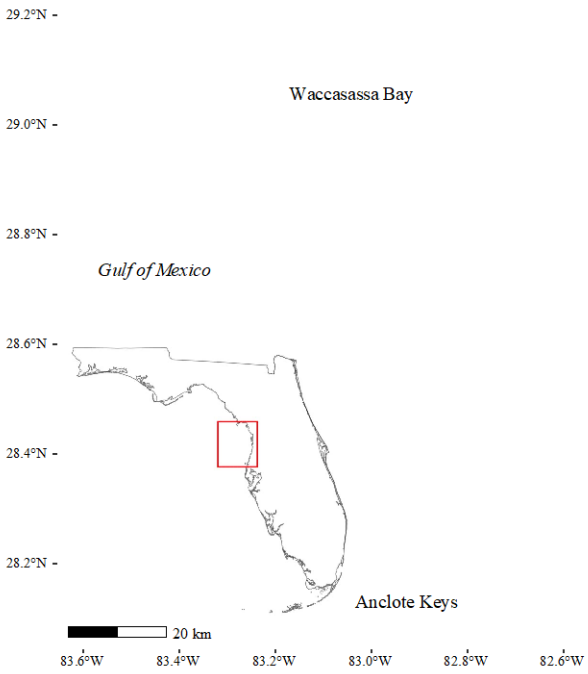
Region 3 Figures

Figure 1. Locations of gillnet (N=64) and longline (N=64) sets in FY-21 a) in St. George Sound and Apalachee Bay to Suwanee Sound and b) Waccasassa Bay to the Anclote Keys.

a)



b)



Region 3 Tables

Table 1. Summary of CPUE in gillnet (number of animals per net-hour) and longline (number of animals per 100 hooks) for elasmobranchs by life history stage sampled in Apalachee Bay, Florida, for FY-20. Means (standard deviations) are presented. Young-of-the-year includes neonate life stage. Sexes are combined. Specimens with an undetermined life stage are included in total CPUE calculation. Species are listed alphabetically by scientific name.

(a) *Carcharhinus acronotus*, blacknose shark

	St. George Sound		Apalachee Bay to Suwanee Sound		Waccasassa Bay to Anclote Keys	
Life Stage	Gillnet	Longline	Gillnet	Longline	Gillnet	Longline
Young-of-the-year	0.07 (0.27)	–	0.05 (0.22)	0.70 (2.30)	–	0.05 (0.22)
Juveniles		0.07 (0.27)	0.03 (0.11)	0.20 (0.89)	–	0.20 (0.52)
Adults	0.14 (0.35)	0.50 (0.94)	–	0.05 (0.22)	–	0.20 (0.89)
All	0.21 (0.42)	0.57 (1.09)	0.10 (0.31)	0.67 (1.81)	–	0.45 (1.23)

(b) *Carcharhinus brevipinna*, spinner shark

	St. George Sound		Apalachee Bay to Suwanee Sound		Waccasassa Bay to Anclote Keys	
Life Stage	Gillnet	Longline	Gillnet	Longline	Gillnet	Longline
Young-of-the-year	–	–	0.05 (0.22)	0.10 (0.31)	–	–
Juveniles	–	0.07 (0.27)	–	–	–	–
Adults	–	–	–	–	–	–
All	–	0.07 (0.27)	0.05 (0.22)	0.10 (0.31)	–	–

(c) *Carcharhinus leucas*, bull shark

	St. George Sound		Apalachee Bay to Suwanee Sound		Waccasassa Bay to Anclote Keys	
Life Stage	Gillnet	Longline	Gillnet	Longline	Gillnet	Longline
Young-of-the-year	–	–	–	–	–	–
Juveniles	–	–	–	0.10 (0.31)	–	0.05 (0.22)

Adults	–	–	–	0.05 (0.22)	0.05 (0.22)	–
All	–	–	–	0.15 (0.37)	0.05 (0.22)	0.05 (0.22)

(d) *Carcharhinus limbatus*, blacktip shark

	St. George Sound		Apalachee Bay to Suwanee Sound		Waccasassa Bay to Anclote Keys	
Life Stage	Gillnet	Longline	Gillnet	Longline	Gillnet	Longline
Young-of-the-year	0.07 (0.26)	0.07 (0.27)	0.15 (0.49)	0.05 (0.22)	0.40 (1.35)	0.85 (2.16)
Juveniles	0.07 (0.26)	3.14 (2.48)	0.20 (0.52)	0.90 (1.65)	0.20 (0.52)	1.60 (3.22)
Adults	0.07 (0.27)	1.36 (1.91)	–	0.35 (0.67)	0.30 (1.34)	0.40 (0.94)
All	0.21 (0.56)	4.64 (3.75)	0.35 (0.75)	1.30 (2.25)	0.90 (2.34)	2.85 (4.86)

(e) *Ginglymostoma cirratum*, nurse shark

	St. George Sound		Apalachee Bay to Suwanee Sound		Waccasassa Bay to Anclote Keys	
Life Stage	Gillnet	Longline	Gillnet	Longline	Gillnet	Longline
Young-of-the-year	–	–	–	–	–	–
Juveniles	–	–	–	0.05 (0.22)	–	0.05 (0.22)
Adults	–	–	–	–	–	–
All	–	–	–	0.05 (0.22)	–	0.05 (0.22)

(f) *Galeocerdo cuvier*, tiger shark

	St. George Sound		Apalachee Bay to Suwanee Sound		Waccasassa Bay to Anclote Keys	
Life Stage	Gillnet	Longline	Gillnet	Longline	Gillnet	Longline
Young-of-the-year	–	–	–	–	–	–
Juveniles	–	0.36 (0.63)	–	0.20 (0.52)	–	0.30 (0.47)
Adults	–	–	–	0.05 (0.22)	–	–
All	–	0.36 (0.63)	–	0.25 (0.55)	–	0.30 (0.47)

(g) *Gymnura micrura*, smooth butterfly ray

	St. George Sound		Apalachee Bay to Suwanee Sound		Waccasassa Bay to Anclote Keys	
Life Stage	Gillnet	Longline	Gillnet	Longline	Gillnet	Longline
Young-of-the-year	–	–	–	–	–	–
Juveniles	–	–	–	–	–	–
Adults	0.07 (0.27)	–	–	–	–	–
All	0.07 (0.27)	–	–	–	–	–

(h) *Hypanus americana*, Southern stingray

	St. George Sound		Apalachee Bay to Suwanee Sound		Waccasassa Bay to Anclote Keys	
Life Stage	Gillnet	Longline	Gillnet	Longline	Gillnet	Longline
Young-of-the-year	–	–	–	–	–	–
Juveniles	–	–	–	–	–	–
Adults	–	–	0.15 (0.49)	–	–	–
All	–	–	0.15 (0.49)	–	–	–

(i) *Hypanus sabinus*, Atlantic stingray

	St. George Sound		Apalachee Bay to Suwanee Sound		Waccasassa Bay to Anclote Keys	
Life Stage	Gillnet	Longline	Gillnet	Longline	Gillnet	Longline
Young-of-the-year	–	–	–	–	–	–
Juveniles	–	–	–	–	0.13 (0.57)	–
Adults	0.07 (0.27)	–	–	–	0.04 (0.19)	–
All	0.07 (0.27)	–	0.05 (0.22)	–	0.17 (0.77)	–

(j) *Mustelis norrisi*, narrowfin smooth-hound shark

	St. George Sound		Apalachee Bay to Suwanee Sound		Waccasassa Bay to Anclote Keys	
Life Stage	Gillnet	Longline	Gillnet	Longline	Gillnet	Longline
Young-of-the-year	–	–	–	–	–	–
Juveniles	–	–	0.15 (0.67)	–	–	–

Adults	–	–	–	–	–	–
All	–	–	0.15 (0.67)	–	–	–

(k) *Negaprion brevirostris*, lemon shark

	St. George Sound		Apalachee Bay to Suwanee Sound		Waccasassa Bay to Anclote Keys	
Life Stage	Gillnet	Longline	Gillnet	Longline	Gillnet	Longline
Young-of-the-year	–	–	–	–	–	–
Juveniles	–	–	–	0.10 (0.45)	–	0.15 (0.49)
Adults	–	0.14 (0.36)	–	–	–	–
All	–	0.14 (0.36)	–	0.10 (0.45)	–	0.15 (0.49)

(l) *Rhinoptera bonasus*, cownose ray

	St. George Sound		Apalachee Bay to Suwanee Sound		Waccasassa Bay to Anclote Keys	
Life Stage	Gillnet	Longline	Gillnet	Longline	Gillnet	Longline
Young-of-the-year	–	–	–	–	–	–
Juveniles	–	–	–	–	–	–
Adults	–	–	–	–	0.04 (0.19)	–
All	–	–	–	–	0.04 (0.19)	–

(m) *Rhizoprionodon terraenovae*, Atlantic sharpnose shark

	St. George Sound		Apalachee Bay to Suwanee Sound		Waccasassa Bay to Anclote Keys	
Life Stage	Gillnet	Longline	Gillnet	Longline	Gillnet	Longline
Young-of-the-year	1.74 (3.59)	0.93 (1.44)	–	0.05 (0.22)	0.05 (0.22)	1.10 (2.61)
Juveniles	1.35 (2.50)	0.43 (0.65)	0.20 (0.62)	0.65 (1.95)	0.45 (0.69)	0.15 (0.49)
Adults	1.15 (1.99)	1.07 (1.49)	0.10 (0.31)	0.45 (0.76)	0.79 (1.10)	0.60 (0.82)
All	4.25 (4.90)	2.36 (2.02)	0.35 (0.81)	1.15 (2.23)	1.29 (1.38)	1.85 (3.05)

(n) *Sphyrna mokarran*, great hammerhead shark

	St. George Sound		Apalachee Bay to Suwanee Sound		Waccasassa Bay to Anclote Keys	
Life Stage	Gillnet	Longline	Gillnet	Longline	Gillnet	Longline
Young-of-the-year	–	–	–	–	–	–
Juveniles	–	0.07 (0.27)	–	0.05 (0.22)	–	–
Adults	–	–	0.05 (0.22)	–	–	–
All	–	0.07 (0.27)	0.05 (0.22)	0.05 (0.22)	–	–

(o) *Sphyrna tiburo*, bonnethead shark

	St. George Sound		Apalachee Bay to Suwanee Sound		Waccasassa Bay to Anclote Keys	
Life Stage	Gillnet	Longline	Gillnet	Longline	Gillnet	Longline
Young-of-the-year	–	–	–	–	–	–
Juveniles	3.41 (4.12)	–	1.90 (4.75)	–	0.40 (0.99)	–
Adults	0.56 (0.91)	–	0.80 (1.47)	–	0.74 (1.37)	–
All	2.07 (2.45)	–	1.35 (2.94)	–	0.58 (1.00)	–

Table 2. Summary of the habitat associations for blacknose shark, *Carcharhinus acronotus*, by life stage from St. George Sound to Anclote Keys, Florida for FY-21. Sexes are combined. Young-of-the-year includes neonate life stage. Bottom type is presented in descending predominance unless otherwise stated.

Life Stage	Temperature (°C)	Salinity	Depth (m)	Water clarity (cm)	Dissolved oxygen (mg l^{-1})	Bottom type
Young-of-the-year N=17	28.0 (27.3-29.7)	31.0 (29.2-33.6)	4.2 (1.2-6.5)	362 (280-450)	6.00 (3.68-7.43)	Seagrass/sand
Juveniles N=10	28.2 (27.1-29.0)	32.4 (31.3-33.6)	4.1 (2.3-6.1)	321.7 (150-500)	6.43 (5.93-6.99)	Seagrass/mud

Adults N=14	27.3 (24.6-29.7)	31.2 (28.2-33.3)	4.5 (1.2-6.5)	306.3 (150-500)	5.70 (3.65-6.81)	Mud/seagrass

Table 3. Summary of the habitat associations for spinner shark, *Carcharhinus brevipinna*, by life stage from St. George Sound to Anclote Keys, Florida for FY-21. Sexes are combined. Young-of-the-year includes neonate life stage. Bottom type is presented in descending predominance unless otherwise stated.

Life Stage	Temperature (°C)	Salinity	Depth (m)	Water clarity (cm)	Dissolved oxygen (mg l^{-1})	Bottom type
Young-of-the-year N=3	27.5 (27.3-27.8)	30.2 (29.2-31.3)	3.6 (1.8-4.9)	393.3 (350-450)	7.27 (6.78-8.10)	Seagrass/sand
Juveniles N=1	25.6	31.2	3.05 (1.2-4.9)	325	6.00	Seagrass/mud
Adults N=0						

Table 4. Summary of the habitat associations for bull shark, *Carcharhinus leucas*, by life stage from St. George Sound to Anclote Keys, Florida for FY-21. Sexes are combined. Young-of-the-year includes neonate life stage. Bottom type is presented in descending predominance unless otherwise stated.

Life Stage	Temperature (°C)	Salinity	Depth (m)	Water clarity (cm)	Dissolved oxygen (mg l^{-1})	Bottom type
Young-of-the-year N=0						
Juveniles N=3	28.0 (26.7-29.4)	34.0 (29.9-38.9)	3.0 (1.0-4.3)	242 (100-425)	6.24 (5.83-6.80)	Seagrass/mud
Adults N=2	28 (26.8-29.3)	32 (29.5-33.5)	2.0 (0.5-3.5)	225 (100-350)	6.32 (6.29-6.35)	Seagrass

Table 5. Summary of the habitat associations for blacktip shark, *Carcharhinus limbatus*, by life stage from St. George Sound to Anclote Keys, Florida for FY-21. Sexes are combined. Young-of-the-year includes neonate life stage. Bottom type is presented in descending predominance unless otherwise stated.

Life Stage	Temperature (°C)	Salinity	Depth (m)	Water clarity (cm)	Dissolved oxygen (mg l^{-1})	Bottom type
Young-of-the-year N=32	28.1 (26.6-29.4)	27.9 (24.0-33.2)	2.6 (1.0-6.0)	132 (50-425)	6.24 (5.10-7.10)	Mud/seagrass
Juveniles N=103	27.3 (20.4-29.7)	29.4 (25.8-38.9)	3.3 (0.5-6.8)	188 (50-340)	5.61 (3.20-7.10)	Mud/seagrass
Adults N=41	27.9 (24.6-29.6)	30.7 (25.8-38.9)	3.4 (1.0-6.2)	225 (75-425)	5.90 (3.70-7.44)	Mud/seagrass

Table 6. Summary of the habitat associations for nurse shark, *Ginglymostoma cirratum*, by life stage from St. George Sound to Anclote Keys, Florida for FY-21. Sexes are combined. Young-of-the-year includes neonate life stage. Bottom type is presented in descending predominance unless otherwise stated.

Life Stage	Temperature (°C)	Salinity	Depth (m)	Water clarity (cm)	Dissolved oxygen (mg l^{-1})	Bottom type
Young-of-the-year N=0						
Juveniles N=2	28.1 (27.1-29.0)	32.6 (31.5-33.6)	2.2 (1.5-.8)	250 (220-280)	6.50 (6.23-6.74)	Seagrass
Adults N=0						

Table 7. Summary of the habitat associations for tiger shark, *Galeocerdo cuvier*, by life stage from St. George Sound to Anclote Keys, Florida for FY-21. Sexes are combined. Young-of-the-year includes neonate life stage. Bottom type is presented in descending predominance unless otherwise stated.

Life Stage	Temperature (°C)	Salinity	Depth (m)	Water clarity (cm)	Dissolved oxygen (mg l^{-1})	Bottom type
Young-of-the-year N=0						
Juveniles N=15	27.9 (20.4-29.7)	31.0 (26.3-33.6)	3.9 (1.0-6.5)	311 (150-500)	6.07 (3.99-7.57)	Mud/seagrass/ sand
Adults N=2	28.3 (27.1-29.4)	31.9 (30.6-33.2_	4.3 (2.9-5.5)	388 (350-425)	6.75 (6.70-6.80)	Seagrass/sand

Table 8. Summary of the habitat associations for smooth butterfly ray, *Gymnura micrura*, by life stage from St. George Sound to Anclote Keys, Florida for FY-21. Sexes are combined. Young-of-the-year includes neonate life stage. Bottom type is presented in descending predominance unless otherwise stated.

Life Stage	Temperature (°C)	Salinity	Depth (m)	Water clarity (cm)	Dissolved oxygen (mg l^{-1})	Bottom type
Young-of-the-year N=0						
Juveniles N=0						
Adults N=1	28.4	29.4	1.7 (1.0-23)	150	3.70	Seagrass

Table 9. Summary of the habitat associations for Southern stingray, *Hypanus americana*, by life stage from St. George Sound to Anclote Keys, Florida for FY-21. Sexes are combined. Young-of-the-year includes neonate life stage. Bottom type is presented in descending predominance unless otherwise stated.

Life Stage	Temperature (°C)	Salinity	Depth (m)	Water clarity (cm)	Dissolved oxygen (mg l^{-1})	Bottom type
Young-of-the-year N=0						
Juveniles N=0						
Adults N=3	28.0 (27.8-28.2)	24.0 (22.9-25.1)	1.4 (0.9-1.8)	160 (140-180)	8.39 (7.25-9.52)	Seagrass/sand

Table 10. Summary of the habitat associations for Atlantic stingray, *Hypanus sabinus*, by life stage from St. George Sound to Anclote Keys, Florida for FY-21. Sexes are combined. Young-of-the-year includes neonate life stage. Bottom type is presented in descending predominance unless otherwise stated.

Life Stage	Temperature (°C)	Salinity	Depth (m)	Water clarity (cm)	Dissolved oxygen (mg l^{-1})	Bottom type
Young-of-the-year N=0						
Juveniles N=2	28.4	27.2	2.4 (2.2-2.5)	85	6.48	
Adults N=3	28.4	28.3 (27.2-29.4)	2.0 (1.0-2.5)	117.5 (85-150)	5.1 (3.70-6.48)	Seagrass

Table 11. Summary of the habitat associations for narrowfin smooth-hound shark, *Mustelis norrisi*, by life stage from St. George Sound to Anclote Keys, Florida for FY-21. Sexes are combined. Young-of-the-year includes neonate life stage. Bottom type is presented in descending predominance unless otherwise stated.

Life Stage	Temperature (°C)	Salinity	Depth (m)	Water clarity (cm)	Dissolved oxygen (mg l^{-1})	Bottom type
Young-of-the-year N=0						
Juveniles N=3	27.1	31.0	2.5 (2.1-2.9)	225	6.23	Mud/seagrass
Adults N=0						

Table 12. Summary of the habitat associations for lemon shark, *Negaprion brevirostris*, by life stage from St. George Sound to Anclote Keys, Florida for FY-21. Sexes are combined. Young-of-the-year includes neonate life stage. Bottom type is presented in descending predominance unless otherwise stated.

Life Stage	Temperature (°C)	Salinity	Depth (m)	Water clarity (cm)	Dissolved oxygen (mg l^{-1})	Bottom type
Young-of-the-year N=0						
Juveniles N=5	28.1 (26.8-29.4)	30.4 (28.6-33.2)	2.3 (1.0-4.7)	200 (75-400)	6.40 (6.05-6.80)	Seagrass/mud
Adults N=2	27.9 (27.1-28.7)	31.7 (30.1-33.2)	3.0 (1.0-4.7)	275 (200-350)	6.30 (5.8-6.7)	Seagrass/mud

Table 13. Summary of the habitat associations for cownose ray, *Rhinoptera bonasus*, by life stage from St. George Sound to Anclote Keys, Florida for FY-21. Sexes are combined. Young-of-the-year includes neonate life stage. Bottom type is presented in descending predominance unless otherwise stated.

Life Stage	Temperature (°C)	Salinity	Depth (m)	Water clarity (cm)	Dissolved oxygen (mg l^{-1})	Bottom type
Young-of-the-year N=0						
Juveniles N=0						
Adults N=1	28.4	27.2	2.35 (0.5-2.0)	85	6.48	Mud

Table 14. Summary of the habitat associations for Atlantic sharpnose shark, *Rhizoprionodon terraenovae*, by life stage from St. George Sound to Anclote Keys, Florida for FY-21. Sexes are combined. Young-of-the-year includes neonate life stage. Bottom type is presented in descending predominance unless otherwise stated.

Life Stage	Temperature (°C)	Salinity	Depth (m)	Water clarity (cm)	Dissolved oxygen (mg l^{-1})	Bottom type
Young-of-the-year N=62	26.9 (20.4-29.7)	30.3 (28.1-33.3)	3.6 (0.5-6.8)	215 (75-500)	5.70 (3.65-7.66)	Seagrass/mud
Juveniles N=55	28.1 (25.6-30.1)	30.6 (25.6-33.5)	2.8 (0.8-6.7)	251.6 (100-500)	5.60 (3.21-7.43)	Seagrass/mud
Adults N=71	27.8 (20.4-30.1)	29.9 (24.1-38.9)	2.8 (0.8-6.7)	232.1 (50-500)	6.20 (3.2-12.95)	Seagrass/mud

Table 15. Summary of the habitat associations for great hammerhead shark, *Sphyrna mokarran*, by life stage from St. George Sound to Anclote Keys, Florida for FY-21. Sexes are combined. Young-of-the-year includes neonate life stage. Bottom type is presented in descending predominance unless otherwise stated.

Life Stage	Temperature (°C)	Salinity	Depth (m)	Water clarity (cm)	Dissolved oxygen (mg l^{-1})	Bottom type
Young-of-the-year N=0						
Juveniles N=2	26.1 (24.6-27.5)	31.75 (31.7-31.8)	4.85 (3.1-6.0)	325	6.23 (6.20-6.25)	Mud
Adults N=1	27.1	31.0	2.5 (2.1-2.9)	225	6.23	Mud/seagrass

Table 16. Summary of the habitat associations for bonnethead shark, *Sphyrna tiburo*, by life stage from St. George Sound to Anclote Keys, Florida for FY-21. Sexes are combined. Young-of-the-year includes neonate life stage. Bottom type is presented in descending predominance unless otherwise stated.

Life Stage	Temperature (°C)	Salinity	Depth (m)	Water clarity (cm)	Dissolved oxygen (mg l^{-1})	Bottom type
Young-of-the-year N=0						
Juveniles N=96	27.4 (20.8-30.1)	28.2 (24.0-32.4)	2.2 (0.9-6.8)	189.8 (50-350)	5.80 (3.21-8.10)	Seagrass/mud
Adults N=39	28.1 (25.9-30.1)	27.3 (17.4-31.8)	1.9 (0.9-6.8)	160 (75-350)	6.12 (3.70-8.41)	Seagrass/mud

REGION 4: SOUTHERN TAMPA BAY, FLORIDA (NEW COLLEGE FLORIDA)

In 2021, New College of Florida conducted GULFSPAN sampling in three areas: Terra Ceia Bay, the Manatee River, and Sarasota Bay (Figure 1). As in previous years, sampling was conducted monthly from April to October in all three areas. A total of 193 sets were made, 95 gillnet sets and 98 longline sets, capturing nine shark species and five batoid species. This work was permitted under Florida Fish and Wildlife Conservation Commission Special Activity License SAL-21-1666-SRP.

In all three areas, the survey consisted of paired gillnet/longline sets. The experimental bottom longline gear consisted of a 700m braided nylon rope (8mm) mainline, anchored and marked at either end with a large buoy, with up to 100 demersal gangions spaced at approximately 3-4m intervals. Each gangion consisted of a stainless-steel tuna clip attached to 1m of 5mm braided nylon cord, a 6/0 stainless-steel swivel, 1 m of 1/16" stainless-steel wire, and a Mustad circle hook. A mixture of 12/0, 14/0, and 16/0 hook sizes were used. Hooks were baited primarily with ladyfish, supplemented with Spanish mackerel, bluefish, yellowfin menhaden, striped mullet, and Crevalle jack, to reflect natural prey availability. Longline soak times, calculated from the time the gear first entered the water until it was completely removed from the water, varied from 1 to 3 hours, depending on the duration of the gillnet set haulback.

In Terra Ceia Bay, 3-4 paired gillnet/longline sets were completed monthly, for a total of 24 gillnet sets and 24 longline sets. Attempts were made to spatially balance these sampling efforts, to the degree possible owing to weather conditions, boat traffic, and the inaccessibility of some areas at either high (due to a low-clearance bridge) or low tides (Figure 2). In the Manatee River, the goal in 2021, as in prior years, was to conduct paired gillnet/longline sets across a range of different salinity levels (low, moderate, and high) each month. Salinity in the estuarine portion of the river is highly dynamic, sections of the river are extremely shallow, and in some areas, spatial constraints precluded deploying a gillnet (insufficient space outside the navigation channel). A total of 20 gillnet sets and 22 longline sets were accomplished. For the purposes of data analyses, as in prior years, the Manatee River was divided into a western portion and an eastern portion (Figure 2). In Sarasota Bay, the goal for 2021 was to complete 8 paired gillnet/longline sets per month, spatially balanced across the bay (excluding areas <1m depth, the intracoastal waterway, and other marked navigation channels). This goal was largely accomplished, with a total of 51 gillnet sets and 52 longline sets (Figure 3).

Abundance trends

A total of 366 elasmobranchs from 14 species were caught, 66% of which were immature animals. Of the immature animals, 24% were young-of-the-year (YOY) and 76% were age 1+. Twelve neonates were caught: five blacktip sharks, three bull sharks, an Atlantic sharpnose shark, a blacknose shark, a great hammerhead, and a scalloped hammerhead. Approximately 7% of the catch was not assigned a life stage.

Abundance and size trends differed slightly by area (Tables 1-3). The blacktip shark, *Carcharhinus limbatus*, was the most abundant elasmobranch species encountered overall, comprising 26% of the total elasmobranch catch. Catch of this species was composed primarily of immature animals of both sexes. The bonnethead, *Sphyrna tiburo*, was the second most

abundant elasmobranch species encountered overall, comprising 25% of the total elasmobranch catch. Over 80% of the catch of this species was female this year, with approximately equal numbers of mature and juvenile animals. The cownose ray, *Rhinoptera bonasus*, was the third most abundant species encountered overall, comprising 19% of the total elasmobranch catch. Catch of this species was primarily males, mature and immature. The Atlantic sharpnose shark, *Rhizoprionodon terraenovae*, was the fourth most abundant species encountered overall, at 13% of the total elasmobranch catch. Catch of this species was predominantly male (77%), mostly immature animals. The bull shark, *Carcharhinus leucas*, was the fifth most abundant species, at 4% of the catch. Catch of this species was consisted of immature animals of both sexes. Elasmobranchs encountered in low abundance (<4% of the catch) included the Atlantic stingray, *Hypanus sabinus* (immature and mature animals of both sexes), the blacknose shark, *Carcharhinus acronotus* (mostly female neonate/YOY), the great hammerhead (mostly immature females), the southern stingray, *Hypanus americanus* (all female), the scalloped hammerhead (all neonate/YOY), the bluntnose stingray, *Hypanus say*, the nurse shark, *Ginglymostoma cirratum*, the smooth butterfly ray, *Gymnura micrura*, and the lemon shark. Among the five most abundant elasmobranch species, catches of bonnetheads were much greater using gillnets (only two individuals were caught using longlines) and cownose rays were only caught using gillnets, meanwhile catches of Atlantic sharpnose sharks, blacktip sharks, and bull sharks were greater using longlines than gillnets.

Teleosts

Teleost abundance and lengths are listed in Tables 1-3. A total of 32 different species were encountered. Hardhead catfish, *Ariopsus felis*, was the most abundant teleost species across all three areas, representing 46% of the total teleost catch, followed by gafftopsail catfish, *Bagre marinus*, at 29% of the total teleost catch, crevalle jack, *Caranx hippos*, at 6.1% of the total teleost catch, yellowfin menhaden, *Brevoortia smithii*, at 3% of the total teleost catch. The remainder of the catch consisted of Florida pompano, *Trachinotus carolinus* (2.5% of the teleost catch), striped pinfish, *Lagodon rhomboides* (2.4% of the teleost catch), permit, *Trachinotus falcatus* (1.9% of the teleost catch), ladyfish, *Elops saurus*, (1.7% of the teleost catch), and Spanish mackerel, *Scomberomorus maculatus* (1.0% of the teleost catch). Additional species were encountered at low abundance (<1% of the total teleost catch), see Tables 1-3.

Catch-per-unit-effort by area

Mean catch rates varied by location (Table 4). Elasmobranch abundance was highest overall in the western portion of the Manatee River, 3.06 (S.D. 3.07) elasmobranchs per net-hour and 2.49 (S.D. = 2.27) elasmobranchs per 100 hooks, followed by Terra Ceia Bay, 1.33 (S.D. = 1.08) elasmobranchs per net hour and 2.76 (S.D. = 2.98) elasmobranchs per 100 hooks, Sarasota Bay, 2.03 (S.D. = 2.37) elasmobranchs per net-hour and 1.14 (S.D. = 1.45) elasmobranchs per 100 hooks, and the eastern portion of the Manatee River, 0.41 (S.D. = 0.61) elasmobranchs per net-hour and 1.93 (S.D. 2.58) elasmobranchs per 100 hooks. The relative abundance of sharks was highest in Terra Ceia Bay, 0.60 (S.D. = 1.08) sharks per net-hour and 2.76 (S.D. = 2.98) sharks per 100 hooks, followed by Sarasota Bay, 1.82 (S.D. = 2.25) sharks per net-hour and 1.14 (S.D. = 1.45) sharks per 100 hooks, the western portion of the Manatee River, 0.43 (S.D. = 0.88)

sharks per net-hour and 2.34 (S.D. = 2.38) sharks per 100 hooks, and the eastern portion of the Manatee River, 0.10 (S.D. = 0.35) sharks per net-hour and 1.93 (S.D. = 2.58) sharks per 100 hooks. The abundance of batoids was much higher in the western portion of the Manatee River, 2.63 (S.D. = 3.32) batoids per net-hour and 0.15 (S.D. = 0.48) batoids per 100 hooks, compared with other areas, Terra Ceia Bay: 0.73 (S.D. = 1.08) batoids per net-hour, the eastern portion of the Manatee River: 0.31 (S.D. = 0.56) batoids per net-hour, and Sarasota Bay: 0.21 (S.D. = 1.17) batoids per net-hour. No batoids were captured on the longline in Terra Ceia Bay, Sarasota Bay, or the eastern portion of the Manatee River.

Essential Fish Habitat Profiles

The three systems differed in abiotic profiles. As in prior years, salinity was consistently higher in Sarasota Bay than Terra Ceia Bay or the Manatee River (Tables 5-8). Salinity in the Manatee River was highly dynamic, particularly in the eastern portion of the river. The essential habitat profiles for Terra Ceia Bay and Sarasota Bay are summarized in Tables 9-22. These data suggest that these systems serve as primary and secondary nursery areas for several species of sharks and rays. Habitats sampled included seagrass (*Syringodium filiforme*, *Thalassia testudinium*, *Halodule wrightii*, and *Halophila* sp.), sand, and mud dominated bottom types, as well as a mix of all three. A few areas included patchy oyster beds.

Atlantic stingrays, particularly the adults, were associated with the widest range of salinities and were captured in almost the entire range of salinities sampled. They were encountered primarily over sandy to muddy bottoms and were mostly associated with shallower areas (Table 15). Juvenile bull sharks were associated with a similarly wide range of salinities and a broader range of depths, but were only encountered over muddy to sandy habitat in the Manatee River, whereas YOY bull sharks were found in similar habitat, but only encountered in low salinity areas (Table 10). Cownose rays were also encountered in a wide range of salinities, a range of depths, and over all bottom habitat types (Table 18). Blacktip sharks were associated with a broad range of abiotic factors and were captured over all bottom types and in all depths sampled (Table 11). Atlantic sharpnose sharks were associated with moderate to high salinity and mostly sandy to muddy bottoms, but were similarly found in all depths sampled (Table 19). Bonnetheads were similarly associated with moderate to high salinities, but were primarily associated with a mixture of sandy and seagrass bottom and shallower depths (Table 22). Southern stingrays were associated with a broad range of salinities and a range of depths, over all bottom types (Table 14). Bluntnose stingrays were encountered in moderate to high salinities, in relatively shallow waters over sandy bottoms and seagrass beds (Table 12). Great hammerheads were associated with higher salinities and sandy bottoms at a range of depths (Table 21). Blacknose sharks and scalloped hammerheads were only encountered in Sarasota Bay this year, were found only at high salinity (>32 ppt) and associated primarily with sand or mixed sand and seagrass bottoms (Tables 10 and 20). Nurse sharks were encountered only in the deeper waters sampled, associated with moderate to high salinity, and sandy bottoms (Table 12). One lemon shark was encountered this year in Terra Ceia Bay during one of the earliest, and thus coldest sets of the season, in a shallow area with mixture of mud and seagrass (Table 17). One butterfly ray was also encountered in Terra Ceia Bay, captured in a shallow area over muddy bottom (Table 13).

Figures:

Figure 1. Southern Tampa Bay region.

Figure 2. Locations of gillnet and longline sets made in Terra Ceia Bay (gillnet: n=24, longline: n = 24) and the Manatee River (gillnet: n = 20, longline: n = 22) in 2021.

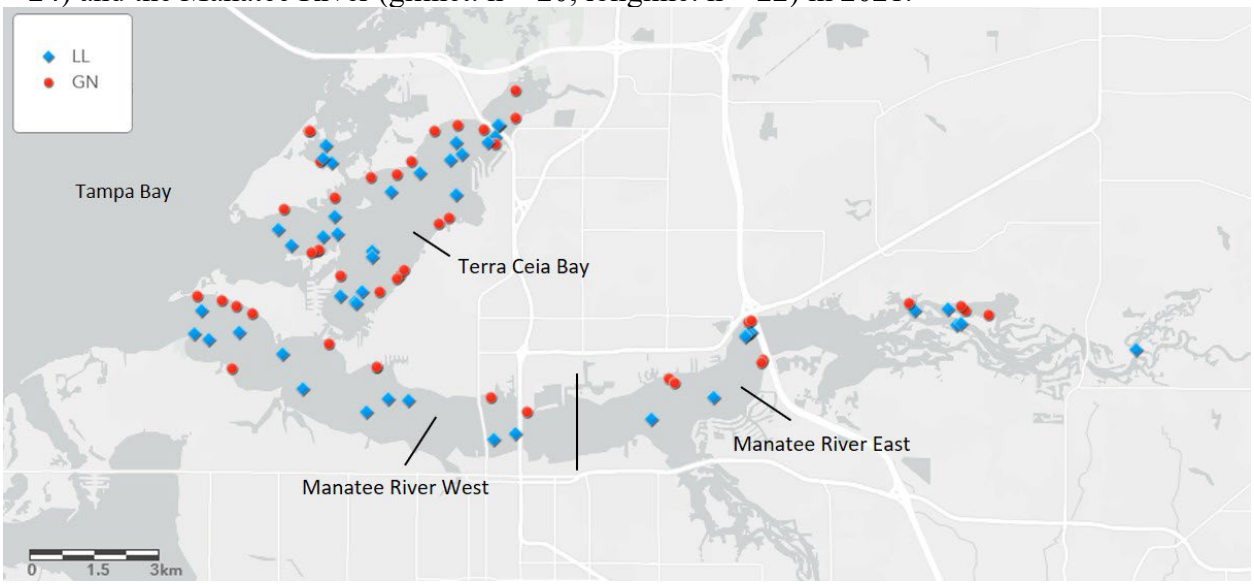
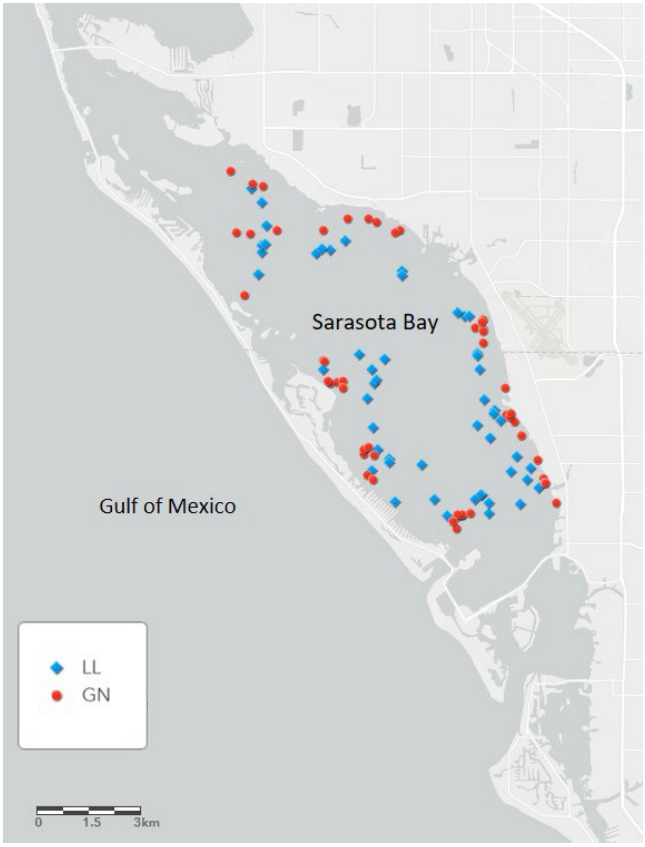


Figure 3. Locations of gillnet (n = 51) and longline (n = 52) sets made in Sarasota Bay in 2021.



Tables:

Table 1. Species table for Terra Ceia Bay. Species are listed in order of abundance. NM = not measured

Species	Common Name	Sex	Count	Mean (SD) FL/DW (cm)	Minimum FL (cm)	Maximum FL (cm)
Elasmobranchs						
Carcharhinus limbatus	Blacktip shark	F	26	67.4 (19.6)	45	139
		M	27	67.0 (14.0)	42	102
		U	1	46		
Sphyrna tiburo	Bonnethead	F	10	60.7 (12.2)	38	77
		M	5	47.4 (9.9)	35	58
Rhinoptera bonasus	Cownose ray	M	8	68.0 (5.7)	59	73
		U	3			
Rhizoprionodon terraenovae	Atlantic sharpnose shark	F	4	61.3 (11.4)	50	72
		M	5	56.2 (9.7)	46	67
Hypanus sabinus	Atlantic stingray	F	3	21.0 (7.0)	16	29
		M	4	20.3 (3.5)	16	24
Hypanus americanus	Southern stingray	F	4	60.0 (2.2)	58	63

Sphyrna mokarran	Great hammerhead	F	3	101.3 (23.1)	77	123
		M	1	107		
Dasyatis say	Bluntnose stingray	F	1	50		
		M	1	34		
Gymnura micrura	Smooth butterfly ray	M	1	36		
		U	1			
Carcharhinus leucas	Bull shark	M	1	95		
Ginglymostoma cirratum	Nurse shark	M	1			
Negaprion brevirostris	Lemon shark	M	1	97		
Teleosts						
Ariopsus felis	Hardhead catfish		182	32.1 (4.0)	16	40
Bagre marinus	Gafftopsail catfish		42	40.6 (8.2)	25	55
Trachinotus falcatus	Permit		19	36.1 (6.4)	22	46
Caranx hippos	Crevalle jack		15	27.1 (4.7)	24	41
Lagodon rhomboides	Striped pinfish		11	17.2 (1.2)	16	20
Trachinotus carolinus	Florida pompano		9	30.8 (5.2)	21	37
Chaetodipterus faber	Atlantic spadefish		7	15.6 (3.3)	10	19
Chilomycterus schoepfi	Striped burrfish		6	22.2 (2.2)	20	25
Micropogonias undulatus	Atlantic croaker		4	21.0 (0.8)	20	22
Lutjanus griseus	Mangrove snapper		3	25.7 (2.1)	24	28
Orthopristis chrysopte	Pigfish		3	18.3 (1.5)	17	20
Pomatomus saltatrix	Bluefish		3	40.7 (1.5)	39	42
Archosargus probatocephalus	Sheepshead		2	29		
Echeneis neucratoides	Whitefin remora		2	14.0 (2.8)	12	16
Pogonias chromis	Black drum		2	44.5 (9.2)	38	51
Scomberomorus maculatus	Spanish mackerel		2	51.0 (2.8)	49	53
Acanthostracion quadricornis	Scrawled cowfish		1			
Centropomus undecimalis	Common snook		1	79		
Cynoscion nebulosus	Spotted seatrout		1	46		
Lepisosteus osseus	Longnose gar		1			
Mugil cephalus	Striped mullet		1	35		
Mugil curema	White mullet		1	29		
Paralichthys sp	Flounder		1			

Table 2. Species diversity table for the Manatee River. Species are listed in order of abundance. NM = not measured.

Species	**Common Name**	**Sex**	**Count**	**Mean (SD) FL/DW (cm)**	**Minimum FL (cm)**	**Maximum FL (cm)**
Elasmobranchs						

Rhinoptera bonasus	Cownose ray	F	6	41.8 (5.1)	37	50
		M	18	54.6 (10.8)	41	73
		U	9			
Rhizoprionodon terraenovae	Atlantic sharpnose shark	F	4	66.5 (7.0)	57	74
		M	11	62.3 (9.8)	46	76
Carcharhinus leucas	Bull shark	F	9	75.2 (18.4)	56	107
		M	5	70.2 (10.8)	53	78
Carcharhinus limbatus	Blacktip shark	F	5	61.8 (11.9)	48	74
		M	5	72.4 (17.7)	57	99
Sphyrna tiburo	Bonnethead	F	4	66.0 (10.2)	55	77
		M	2	53.0 (5.7)	49	57
		U	1			
Hypanus sabinus	Atlantic stingray	F	3	25.7 (4.2)	21	29
		M	2	19.0 (5.7)	15	23
Ginglymostoma cirratum	Nurse shark	U	1			
Hypanus americanus	Southern stingray	F	1	80		
Sphyrna mokarran	Great hammerhead	M	1	69		
Teleosts						
Ariopsus felis	Hardhead catfish		138	32.6 (3.9)	20	39
Bagre marinus	Gafftopsail catfish		49	36.8 (6.9)	25	50
Lepisosteus osseus	Longnose gar		6	84.8 (5.1)	79	93
Caranx hippos	Crevalle jack		4	28.2 (2.9)	25	32
Elops saurus	Ladyfish		4	35.7 (3.5)	32	39
Lagodon rhomboides	Striped pinfish		3	17.0 (1.7)	16	19
Trachinotus falcatus	Permit		3	39.5 (9.2)	33	46
Cynoscion nebulosus	Spotted seatrout		2	40.5 (4.9)	37	44
Orthopristis chrysopte	Pigfish		2	21.0 (0)	21	21
Rachycentron canadum	Cobia		2	58.0 (12.7)	49	67
Trachinotus carolinus	Florida pompano		2	30.0 (7.1)	25	35
Chaetodipterus faber	Atlantic spadefish		1	20		
Chilomycterus schoepfi	Striped burrfish		1			
Lutjanus griseus	Mangrove snapper		1			
Megalops atlanticus	Atlantic tarpon		1	145		
Mugil sp	Mullet		1	26		
Sygnathidae sp	Pipefish		1	9		

Table 3. Species diversity table for Sarasota Bay. Species are listed in order of abundance. NM = not measured.

Species	**Common Name**	**Sex**	**Count**	**Mean (SD) FL/DW**	**Minimum**	**Maximum FL (cm)**

				(cm)	FL (cm)	
Elasmobranchs						
Sphyrna tiburo	Bonnethead	F	59	64.9 (10.9)	33	81
		M	9	50.3 (9.0)	35	64
		U	1			
Carcharhinus limbatus	Blacktip shark	F	13	69.1 (6.8)	60	85
		M	17	70.2 (10.2)	56	91
		U	1			
Rhinoptera bonasus	Cownose ray	F	10	77.6 (4.3)	71	84
		M	8	68.9 (10.3)	44	76
		U	9	82		
Rhizoprionodon terraenovae	Atlantic sharpnose shark	F	2	51.5 (2.1)	50	53
		M	19	56.8 (7.0)	45	74
		U	2			
Carcharhinus acronotus	Blacknose shark	F	7	63.9 (17.8)	37	88
		M	2	54.5 (19.1)	41	68
Sphyrna lewini	Scalloped hammerhead	F	3	35.3 (3.1)	32	38
		M	2	49.0 (17.0)	37	61
Dasyatis say	Bluntnose stingray	M	1	28		
Sphyrna mokarran	Great hammerhead	F	1	111		
Teleosts						
Bagre marinus	Gafftopsail catfish		246	40.5 (5.7)	21	51
Ariopsus felis	Hardhead catfish		209	33.0 (4.0)	23	40
Caranx hippos	Crevalle jack		51	24.5 (3.0)	22	43
Brevoortia smithi	Yellowfin menhaden		32	25.5 (2.0)	20	30
Trachinotus carolinus	Florida pompano		18	31.2 (4.0)	24	38
Elops saurus	Ladyfish		16	36.2 (4.6)	29	49
Lagodon rhomboides	Striped pinfish		14	15.9 (0.8)	15	17
Scomberomorus maculatus	Spanish mackerel		10	40.9 (8.1)	31	58
Echaneidae sp	Remora		3	19		
Lutjanus griseus	Mangrove snapper		2	26.5 (0.7)	26	27
Opisthonema oglinum	Threadfin herring		2	16.5 (0.7)	16	17
Pomatomus saltatrix	Bluefish		2	43		
Acanthostracion quadricornis	Scrawled cowfish		1	20		
Chaetodipterus faber	Atlantic spadefish		1	14		
Chilomycterus schoepfi	Striped burrfish		1	21		
Cynoscion nebulosus	Spotted seatrout		1	36		
Micropogonias undulatus	Atlantic croaker		1	21		
Opsanus beta	Gulf toadfish		1	28		

Table 4. Summary of CPUE (number of animals per net hour) for elasmobranchs by life history stage and area sampled in southern Tampa Bay for 2021. Means (SD) are presented. Young-of-the-year includes neonate life stage. Sexes are combined. Specimens with an undetermined life stage are included in the total CPUE calculation. Species are listed alphabetically by scientific name.

(a) *Carcharhinus acronotus*, blacknose shark

	Terra Ceia Bay		Manatee River West		Manatee River East		Sarasota Bay	
Life Stage	Gillnet	Longline	Gillnet	Longline	Gillnet	Longline	Gillnet	Longline
Young-of-the-year	0	0	0	0	0	0	0	0.23 (0.82)
Juveniles	0	0	0	0	0	0	0	0.04 (0.30)
Adults	0	0	0	0	0	0	0	0.02 (0.20)
All	0	0	0	0	0	0	0	0.29 (0.87)

(b) *Carcharhinus leucas*, bull shark

	Terra Ceia Bay		Manatee River West		Manatee River East		Sarasota Bay	
Life Stage	Gillnet	Longline	Gillnet	Longline	Gillnet	Longline	Gillnet	Longline
Young-of-the-year	0	0	0	0	0	1.08 (2.65)	0	0
Juveniles	0	0.04 (0.28)	0	0.15 (0.48)	0.10 (0.35)	0.85 (1.28)	0	0
Adults	0	0	0	0	0	0	0	0
All	0	0.04 (0.28)	0	0.15 (0.48)	0.10 (0.35)	1.93 (2.58)	0	0

(c) *Carcharhinus limbatus*, blacktip shark

	Terra Ceia Bay		Manatee River West		Manatee River East		Sarasota Bay	
Life Stage	0.06 (0.28)	0.70 (1.68)	0	0.30 (0.84)	0	0	0.05 (0.28)	0.06 (0.33)
Young-of-the-year	0	1.38 (2.96)	0	0.48 (1.11)	0	0	0.13 (0.51)	0.43 (1.17)
Juveniles	0	0.08 (0.35)	0	0	0	0	0	0
Adults	0.06 (0.28)	2.15 (3.07)	0	0.78 (1.28)	0	0	0.18 (0.57)	0.48 (1.20)
All	0.06 (0.28)	0.70 (1.68)	0	0.30 (0.84)	0	0	0.05 (0.28)	0.06 (0.33)

(d) *Gymnura micrura*, smooth butterfly ray

	Terra Ceia Bay		Manatee River West		Manatee River East		Sarasota Bay	
Life Stage	Gillnet	Longline	Gillnet	Longline	Gillnet	Longline	Gillnet	Longline
Young-of-the-	0	0	0	0	0	0	0	0

year								
Juveniles	0	0	0	0	0	0	0	0
Adults	0.02							
	(0.15)	0	0	0	0	0	0	0
All	0.06							
	(0.28)	0	0	0	0	0	0	0

(e) *Ginglymostoma cirratum*, nurse shark

	Terra Ceia Bay		Manatee River West		Manatee River East		Sarasota Bay	
Life Stage	Gillnet	Longline	Gillnet	Longline	Gillnet	Longline	Gillnet	Longline
Young-of-the-year	0	0	0	0	0	0	0	0
Juveniles				0.08				
	0	0	0	(0.37)	0	0	0	0
Adults		0.05						
	0	(0.30)	0	0	0	0	0	0
All		0.05		0.08				
	0	(0.30)	0	(0.37)	0	0	0	0

(f) *Hypanus americanus*, southern stingray

	Terra Ceia Bay		Manatee River West		Manatee River East		Sarasota Bay	
Life Stage	Gillnet	Longline	Gillnet	Longline	Gillnet	Longline	Gillnet	Longline
Young-of-the-year	0	0	0	0	0	0	0	0
Juveniles	0.13							
	(0.49)	0	0	0	0	0	0	0
Adults				0.07				
	0	0	0	(0.33)	0	0	0	0
All	0.13			0.07				
	(0.49)	0	0	(0.33)	0	0	0	0

(g) *Hypanus sabinus*, Atlantic stingray

	Terra Ceia Bay		Manatee River West		Manatee River East		Sarasota Bay	
Life Stage	Gillnet	Longline	Gillnet	Longline	Gillnet	Longline	Gillnet	Longline
Young-of-the-year	0	0	0	0	0.10 (0.35)	0	0	0
Juveniles	0.09		0.08					
	(0.60)	0	(0.34)	0	0	0	0	0
Adults	0.07		0.06	0.08	0.11			
	(0.45)	0	(0.26)	(0.37)	(0.37)	0	0	0
All	0.17		0.14	0.08	0.21			
	(0.75)	0	(0.41)	(0.37)	(0.49)	0	0	0

(h) *Hypanus say*, bluntnose stingray

	Terra Ceia Bay		Manatee River West		Manatee River East		Sarasota Bay	
Life Stage	Gillnet	Longline	Gillnet	Longline	Gillnet	Longline	Gillnet	Longline
Young-of-the-	0	0	0	0	0	0	0	0

year								
Juveniles					0.02			
	0	0	0	0	(0.18)	0	0	0
Adults							0.06	
	0	0	0	0	0	0	(0.27)	0
All					0.02		0.06	
	0	0	0	0	(0.18)	0	(0.27)	0

(i) *Negaprion brevirostris*, lemon shark

	Terra Ceia Bay		Manatee River West		Manatee River East		Sarasota Bay	
Life Stage	Gillnet	Longline	Gillnet	Longline	Gillnet	Longline	Gillnet	Longline
Young-of-the-year	0	0	0	0	0	0	0	0
Juveniles	0	0.04 (0.23)	0	0	0	0	0	0
Adults	0	0	0	0	0	0	0	0
All	0	0.04 (0.23)	0	0	0	0	0	0

(j) *Rhinoptera bonasus*, cownose ray

	Terra Ceia Bay		Manatee River West		Manatee River East		Sarasota Bay	
Life Stage	Gillnet	Longline	Gillnet	Longline	Gillnet	Longline	Gillnet	Longline
Young-of-the-year	0	0	0.15 (0.43)	0	0	0	0	0
Juveniles	0.08 (0.36)	0	1.39 (3.39)	0	0.10 (0.35)	0	0.01 (0.06)	0
Adults	0.17 (0.60)	0	0.19 (0.82)	0	0	0	0.12 (1.06)	0
All	0.32 (0.78)	0	2.49 (3.41)	0	0.10 (0.35)	0	0.19 (1.16)	0

(k) *Rhizoprionodon terraenovae*, Atlantic sharpnose shark

	Terra Ceia Bay		Manatee River West		Manatee River East		Sarasota Bay	
Life Stage	Gillnet	Longline	Gillnet	Longline	Gillnet	Longline	Gillnet	Longline
Young-of-the-year	0	0	0	0.15 (0.47)	0	0	0	0
Juveniles	0.04 (0.24)	0.17 (0.63)	0	0.55 (1.96)	0	0	0.04 (0.27)	0.45 (1.08)
Adults	0	0.18 (1.19)	0	0.48 (1.95)	0	0	0	0.09 (0.42)
All	0.04 (0.24)	0.35 (1.32)	0	1.18 (2.64)	0	0	0.04 (0.27)	0.59 (1.14)

(l) *Sphyrna lewini*, scalloped hammerhead

	Terra Ceia Bay		Manatee River West		Manatee River East		Sarasota Bay	
Life Stage	Gillnet	Longline	Gillnet	Longline	Gillnet	Longline	Gillnet	Longline
Young-of-the-	0	0	0	0	0	0	0.09	0.02

year							(0.40)	(0.19)
Juveniles	0	0	0	0	0	0	0	0
Adults	0	0	0	0	0	0	0	0
All	0	0	0	0	0	0	0.09 (0.40)	0.02 (0.19)

(m) *Sphyrna mokarran*, great hammerhead

	Terra Ceia Bay		Manatee River West		Manatee River East		Sarasota Bay	
Life Stage	Gillnet	Longline	Gillnet	Longline	Gillnet	Longline	Gillnet	Longline
Young-of-the-year	0.04 (0.23)	0.04 (0.25)	0	0.08 (0.37)	0	0	0	0
Juveniles	0	0.09 (0.61)	0	0	0	0	0	0.03 (0.22)
Adults	0	0	0	0	0	0	0	0
All	0.04 (0.23)	0.13 (0.65)	0	0.08 (0.37)	0	0	0	0.03 (0.22)

(n) *Sphyrna tiburo*, bonnethead

	Terra Ceia Bay		Manatee River West		Manatee River East		Sarasota Bay	
Life Stage	Gillnet	Longline	Gillnet	Longline	Gillnet	Longline	Gillnet	Longline
Young-of-the-year	0.14 (0.53)	0	0	0	0	0	0.05 (0.32)	0
Juveniles	0.12 (0.60)	0	0.21 (0.61)	0	0	0	0.67 (1.50)	0
Adults	0.20 (0.60)	0	0.22 (0.70)	0	0	0	0.76 (2.09)	0.02 (0.19)
All	0.46 (0.92)	0	0.43 (0.88)	0.07 (0.33)	0	0	1.50 (2.35)	0.02 (0.19)

Table 5. Means ± standard deviation (ranges) of monthly abiotic measurements for Terra Ceia Bay in 2021.

Month	Temperature (C)	Salinity (ppt)	Depth (m)	Water clarity (cm)	D.O. (mg/L)
Apr	23.6 ± 0.7 (22.3-24.3)	31.1 ± 0.6 (30.4-32.1)	1.4 ± 0.8 (0.9-3.3)	129 ± 70 (25-250)	5.89 ± 0.59 (5.01-6.62)
May	28.3 ± 0.3 (27.8-28.7)	31.7 ± 0.4 (31.0-32.3)	2.0 ± 0.6 (1.2-2.8)	135 ± 59 (75-250)	5.95 ± 0.46 (5.26-6.40)
Jun	29.1 ± 0.6 (28.3-29.7)	34.0 ± 1.1 (32.5-35.4)	1.6 ± 0.8 (0.9-3.1)	181 ± 44 (150-250)	5.71 ± 0.31 (5.20-6.12)
Jul	28.6 ± 0.5 (28.2-29.4)	27.3 ± 0.6 (26.6-28.1)	1.9 ± 0.8 (1.0-3.3)	139 ± 59 (100-250)	5.62 ± 0.29 (5.32-6.13)
Aug	29.6 ± 0.6 (29.2-30.8)	25.1 ± 0.4 (24.4-25.5)	1.8 ± 0.7 (0.8-2.7)	112 ± 38 (75-175)	5.21 ± 0.57 (4.25-5.99)

Sep	28.8 ± 0.4 (28.5-29.5)	27.1 ± 2.5 (24.8-30.1)	1.8 ± 0.4 (1.1-2.2)	172 ± 49 (125-252)	5.42 ± 0.89 (4.32-6.42)
Oct	24.6 ± 1.2 (23.1-25.5)	30.2 ± 1.1 (29.4-31.6)	1.9 ± 1.3 (0.7-4.0)	112 ± 70 (50-200)	5.92 ± 0.19 (5.66-6.13)

Table 6. Means ± standard deviation (ranges) of monthly abiotic measurements for the western portion of the Manatee River in 2021.

Month	Temperature (C)	Salinity (ppt)	Depth (m)	Water clarity (cm)	D.O. (mg/L)
Apr	25.1 ± 0.3 (24.6-25.3)	27.1 ± 2.4 (24.5-29.5)	2.2 ± 1.0 (1.1-3.1)	222 ± 42 (162-250)	6.57 ± 0.77 (5.73-7.52)
May	28.5 ± 0.1 (28.4-28.6)	31.8 ± 0.8 (31.2-32.3)	2.9 ± 1.4 (2.0-3.9)	212 ± 87 (150-273)	7.04 ± 0.13 (6.95-7.14)
Jun	29.7 ± 0.6 (29.2-30.3)	34.0 ± 0.5 (33.4-34.4)	3.8 ± 1.9 (1.6-4.9)	125 ± 66 (75-200)	6.46 ± 0.85 (5.93-7.44)
Jul	28.8 ± 0.2 (28.5-28.9)	16.0 ± 4.8 (10.5-20.6)	2.1 ± 0.6 (1.2-2.5)	119 ± 38 (75-150)	5.90 ± 1.23 (4.91-7.53)
Aug	30.7 ± 0.3 (30.4-31.0)	23.3 ± 6.7 (15.3-28.9)	2.1 ± 0.9 (1.2-2.9)	100 ± 20 (75-125)	5.87 ± 1.02 (4.44-6.84)
Sep	29.3	28.1	2.3 ± 0.5 (1.9-2.6)	175	5.34
Oct	25.6	27.6	2.8 ± 1.9 (1.4-4.1)	202 ± 3 (200-204)	6.05

Table 7. Means ± standard deviation (ranges) of monthly abiotic measurements for the eastern portion of the Manatee River Bay in 2021.

Month	Temperature (C)	Salinity (ppt)	Depth (m)	Water clarity (cm)	D.O. (mg/L)
Apr	26.2 ± 0.3 (26.0-26.4)	16.6 ± 0.1 (16.5-16.6)	1.6 ± 0.9 (1.0-2.2)	150	6.30 ± 0.05 (6.26-6.33)
May	28.8 ± 0.4 (28.4-29.1)	17.0 ± 7.7 (10.4-25.1)	1.5 ± 0.6 (1.0-2.2)	119 ± 24 (100-150)	6.30 ± 1.28 (5.20-7.44)
Jun	29.0 ± 0.2 (28.9-29.3)	19.6 ± 2.8 (16.3-21.2)	1.1 ± 0.3 (0.7-1.4)	92 ± 14 (75-100)	4.43 ± 0.05 (4.40-4.49)
Jul	27.8 ± 0.0 (27.8-27.8)	5.2 ± 0.8 (4.6- 5.8)	1.9 ± 0.6 (1.5-2.3)	75	4.32 ± 0.10 (4.25-4.39)
Aug	29.9 ± 0.4 (29.6-30.1)	3.6 ± 0.1 (3.6- 3.7)	1.9 ± 1.0 (1.2-2.6)	62 ± 18 (50- 75)	4.65 ± 0.44 (4.34-4.96)
Sep	29.4 ± 0.3 (29.1-29.7)	8.7 ± 7.9 (1.6-16.2)	2.1 ± 0.8 (1.4-3.2)	65 ± 6 (60- 70)	4.25 ± 0.96 (3.26-5.11)
Oct	24.9 ± 0.2 (24.6-25.1)	15.9 ± 6.0 (9.6-21.1)	1.7 ± 0.9 (0.9-2.9)	100 ± 35 (50-130)	5.72 ± 0.18 (5.49-5.92)

Table 8. Means ± standard deviation (ranges) of monthly abiotic measurements for Sarasota Bay in 2021.

Month	Temperature (C)	Salinity (ppt)	Depth (m)	Water clarity (cm)	D.O. (mg/L)
Apr	26.2 ± 0.8 (25.2-27.6)	34.6 ± 0.8 (33.3-35.6)	2.1 ± 0.4 (1.3-2.8)	207 ± 32 (150-255)	6.18 ± 0.83 (4.43-7.22)
May	25.1 ± 0.5 (24.5-26.0)	36.7 ± 0.1 (36.5-36.9)	2.5 ± 0.5 (1.8-3.3)	203 ± 44 (150-310)	6.43 ± 0.34 (5.91-7.18)
Jun	29.1 ± 0.5 (28.2-30.2)	36.9 ± 0.2 (36.6-37.4)	2.5 ± 0.5 (1.8-3.2)	196 ± 43 (125-250)	5.93 ± 0.43 (5.12-6.61)
Jul	28.6 ± 0.6 (27.7-29.7)	34.2 ± 0.9 (32.7-35.2)	2.6 ± 0.6 (2.0-4.0)	216 ± 52 (150-350)	6.51 ± 0.77 (4.69-7.83)
Aug	30.0 ± 0.5 (29.2-31.1)	32.3 ± 0.9 (30.3-33.4)	2.6 ± 0.7 (1.6-3.6)	224 ± 45 (150-300)	6.38 ± 0.78 (5.03-7.18)
Sep	29.3 ± 0.6 (28.4-30.3)	32.2 ± 0.5 (31.7-33.1)	2.3 ± 0.7 (1.4-3.6)	235 ± 58 (150-325)	5.86 ± 0.47 (5.02-6.57)
Oct	25.5 ± 0.5 (24.7-26.2)	34.4 ± 0.4 (34.0-35.0)	2.6 ± 0.6 (1.7-3.4)	254 ± 43 (186-309)	6.04 ± 0.47 (5.37-6.67)

Table 9. Summary of habitat associations for the blacknose shark, *Carcharhinus acronotus*, by life stage in southern Tampa Bay. 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 (N=7)	27.6 (25.5-29.4)	34.5 (32.1-36.9)	2.6 (1.8-3.1)	242 (200-312)	6.10 (4.46-7.02)	Sand/seagrass
Juveniles (N=1)	29.3	36.7	2.8	200	6.61	Sand
Adults (N=1)	28.9	32	2.7	291	5.80	Sand

Table 10. Summary of habitat associations for the bull shark, *Carcharhinus leucas*, by life stage in southern Tampa Bay. 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 (N=6)	29.0 (27.8-29.6)	4.3 (3.6- 5.8)	2.5 (2.3-2.6)	75	4.72 (4.25-4.96)	Mud
Juveniles (N=9)	28.9 (27.8-30.5)	16.0 (5.8-25.1)	1.8 (1.0-2.8)	97 (75-125)	4.73 (4.25-5.22)	Mud/sand
Adults (N=0)						

Table 11. Summary of habitat associations for the blacktip shark, *Carcharhinus limbatus*, by life stage in southern Tampa Bay. 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 (N=27)	27.9 (25.2-29.8)	29.3 (19.5-35.6)	2.5 (1.0-4.1)	138 (75-250)	5.83 (4.46-7.53)	Sand/mud/ seagrass
Juveniles (N=66)	27.5 (23.6-31.1)	31.6 (24.8-37.2)	2.7 (0.9-4.9)	158 (50-350)	6.11 (5.01-7.83)	Sand/seagrass /mud
Adults (N=2)	28.7 (28.2-29.2)	33.0 (31.7-34.4)	2.6 (2.4-2.8)	138 (125-150)	6.04 (5.69-6.38)	Sand/mud

Table 12. Summary of habitat associations for the nurse shark, *Ginglymostoma cirratum*, by life stage in southern Tampa Bay. 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 (N=0)						
Juveniles (N=1)	25.6	27.6	4.1	200	6.05	Sand
Adults (N=1)	29.6	34	3.1	250	6.12	Sand

Table 13. Summary of habitat associations for the smooth butterfly ray, *Gymnura micrura*, by life stage in southern Tampa Bay. 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 (N=0)						
Juveniles (N=0)						

Adults (N=1)	29.7	32.5	1	175	5.51	Mud

Table 14. Summary of habitat associations for the southern stingray, *Hypanus americanus*, by life stage in southern Tampa Bay. 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 (N=0)						
Juveniles (N=4)	26.2 (23.8-28.8)	30.3 (24.8-35.4)	1.1 (0.9-1.7)	81 (25-150)	5.56 (5.26-5.92)	Mud/sand
Adults (N=1)	28.9	19.5	2.5	150	7.53	Sand/seagrass

Table 15. Summary of habitat associations for the Atlantic stingray, *Hypanus sabinus*, by life stage in southern Tampa Bay. 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 (N=1)	28.4	10.4	1	100	5.2	Mud
Juveniles (N=5)	28.9 (25.6-29.7)	31.6 (27.6-32.5)	1.1 (1.0-1.4)	181 (175-204)	5.62 (5.51-6.05)	Mud/sand/ seagrass
Adults (N=6)	29.7 (28.5-30.3)	24.9 (3.7-34.2)	1.3 (1.0-2.3)	121 (50-175)	5.55 (4.34-7.44)	Mud/sand

Table 16. Summary of habitat associations for the bluntnose stingray, *Hypanus say*, by life stage in southern Tampa Bay. 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 (N=0)						
Juveniles (N=1)	28.6	32.4	1.4	150	5.23	Seagrass/sand
Adults (N=2)	29.8 (28.8-30.8)	25.0 (24.8-25.2)	1.5 (1.4-1.7)	100 (75-125)	5.48 (5.04-5.92)	Sand/mud

Table 17. Summary of habitat associations for the lemon shark, *Negaprion brevirostris*, by life stage in southern Tampa Bay. 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 (N=0)						
Juveniles (N=1)	24.3	32.1	0.9	129	5.74	Mud/seagrass
Adults (N=0)						

Table 18. Summary of habitat associations for the cownose ray, *Rhinoptera bonasus*, by life stage in southern Tampa Bay. 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 (N=2)	26.8 (24.6-28.9)	22.5 (20.6-24.5)	1.7 (1.1-2.3)	131 (100-162)	6.21 (6.19-6.23)	Mud/sand/ seagrass
Juveniles (N=23)	29.9 (28.2-31.1)	25.8 (10.4-32.1)	1.7 (1.0-2.5)	118 (75-175)	5.81 (5.04-7.13)	Sand/seagrass /mud
Adults (N=26)	30.3 (23.8-31.1)	30.5 (20.6-34.1)	2.2 (0.9-2.5)	97 (25-150)	6.66 (5.04-7.13)	Sand/mud/ seagrass

Table 19. Summary of habitat associations for the Atlantic sharpnose shark, *Rhizoprionodon terraenovae*, by life stage in southern Tampa Bay. 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 (N=2)	27.4 (25.6-29.2)	30.5 (27.6-33.4)	4.5 (4.1-4.9)	150 (100-200)	6.03 (6.00-6.05)	Sand/mud
Juveniles (N=30)	27.7 (23.7-31.1)	33.6 (29.5-37.4)	2.8 (1.5-4.9)	187 (100-312)	6.47 (4.46-7.18)	Sand/seagrass /mud
Adults (N=13)	26.0 (23.7-28.4)	31.9 (29.5-36.7)	3.4 (2.0-3.9)	202 (150-300)	6.78 (6.00-7.14)	Sand

Table 20. Summary of habitat associations for the scalloped hammerhead, *Sphyrna lewini*, by life stage in southern Tampa Bay. 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 (N=5)	27.5 (24.6-29.7)	34.4 (32.7-36.7)	2.3 (2.0-3.3)	190 (150-250)	6.87 (6.10-7.67)	Sand/seagrass
Juveniles (N=0)						
Adults (N=0)						

Table 21. Summary of habitat associations for the great hammerhead, *Sphyrna mokarran*, by life stage in southern Tampa Bay. 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 (N=3)	26.4 (25.2-28.3)	29.4 (27.6-31.0)	2.9 (1.9-4.1)	117 (75-200)	5.76 (5.57-6.05)	Sand
Juveniles (N=3)	28.0 (24.9-29.6)	34.9 (34.0-36.6)	3.1	242 (225-250)	6.17 (6.12-6.28)	Sand
Adults (N=0)						

Table 22. Summary of habitat associations for the bonnethead, *Sphyrna tiburo*, by life stage in southern Tampa Bay. 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 (N=6)	26.4 (23.6-28.8)	33.3 (31.0-36.6)	1.7 (1.3-2.2)	171 (150-200)	6.20 (5.20-6.52)	Sand/seagrass
Juveniles (N=41)	27.8 (25.1-31.0)	33.5 (25.2-37.2)	1.9 (1.2-2.4)	189 (75-253)	5.81 (4.32-7.52)	Sand/seagrass /mud
Adults (N=96)	27.3 (24.6-31.0)	34.1 (25.2-36.9)	1.8 (1.2-2.3)	196 (75-253)	5.85 (4.43-7.67)	Seagrass/sand

ACKNOWLEDGEMENTS

J. Hendon, A. Hoover, and J. Higgs would like to thank G. Gray, A. Millender, M. Byrnes, P. Graham, O. Lestrade, H. Anderson, G. Spooner, C. Willoughby, A. Bryan, A. Baldino, J. Tilley, and L. Collins for their assistance in the field and management of the data.

J. Carlson and A. Kroetz thank the assistance of Dean Courtney.

Ashley Dawdy, and R.D. Grubbs would like to thank Cheston Peterson, Cullen Morris, Matt Edwards, and many volunteers for assistance on this survey.

J. Gardiner, J. Beaver and T. Wiley thank E. Eastes, R. Loudy, A. Moreno, O. Murillo, S. Bustetter, Z. Carey, V. Goldner, C. Hampton, and J. Graham for assistance in the field and the Pritzker Marine Biology Research Center for providing logistical support.. Sarasota Bay Estuary Program and the Mote Scientific Foundation provided funding for the southern Tampa Bay sampling.