Occurrence and movements of sawfish in southern Florida

Mote Marine Laboratory Technical Report 787

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Abstract

The smalltooth sawfish (*Pristis pectinata*) population in US waters has been decimated by years of fishing (commercial and recreational) and habitat loss. Despite the severe decline in the sawfish population little biological data is available for the development of conservation actions. The aim of this project was to gather conservation-relevant data on sawfish using targeted surveys and acoustic telemetry. Data on sawfish encounters by other researchers, fishermen and the public were also gathered. On the basis of data in the database the current range of the smalltooth sawfish is from St. Petersburg, Florida, to St. Augustine, Florida. A total of 214 survey events were undertaken, with 11 sawfish captured. Eight sawfish were fitted with acoustic tags and tracked from a few hours to five months. One animal was tracked intermittently over five months during which time it remained within the same small cove and adjacent beach area. Data on habitat preference indicated that factors such as water depth, salinity, temperature, presence of mangroves and creek/river mouths are all important in determining the habitat of this species. The results of these data are being used to evaluate the critical habitat of smalltooth sawfish, giving direct conservation relevance to this research funded by National Graphic Society's Committee for Research and Exploration.

Background

The smalltooth sawfish, *Pristis pectinata*, is a distinctive large elasmobranch that was once commonly distributed throughout the Gulf of Mexico and the Atlantic coast of the United States as far north as New Jersey (Adams and Wilson 1995). However, more than a century of fishing (both commercial and recreational) and destruction of their inshore habitat by coastal development has seen the population decimated (Simpfendorfer 2000). Its range has also contracted, now only being found regularly in southern Florida, especially in the marine and estuarine sections of the Everglades National Park.

Despite the unique form of the smalltooth sawfish, and the recognition of its status, this species has been poorly studied. The lack of biological data for this species has limited the ability of scientists and resource managers to design conservation programs. The lack of data prompted the Center for Shark Research at Mote Marine Laboratory (MML) to begin a research program to provide data on which to base effective conservation actions. This research program has a number of components:

- Surveys of south Florida to determine distribution and abundance.
- Acoustic and satellite telemetry to investigate movements and habitat utilization.
- Public reporting database to gather data on sawfish encounters by the public.
- Population dynamics.
- Conservation genetics, to investigate how the population decline has impacted the genetic diversity.

Funding for this project was obtained from a number of sources, including National Geographic Society's Committee for Research and Exploration (CRE), the National Marine Fisheries Service, Mote Marine Laboratory and the Disney Wildlife Conservation Fund. Funding from the CRE was applied to a portion of the research for the period from July 2000 to June 2001.

The components of the research for which CRE funding was requested included a portion of the sawfish surveys and a portion of the acoustic tracking. This report provides the results of this research, in part funded by the CRE. The original proposal to the CRE also indicated that we were seeking funding to obtain satellite tags to examine longer-term movement patterns. Funding for this portion of the research was delayed, and is only currently being implemented.

Materials and methods

Surveys

Field surveys for sawfish undertaken by MML staff began in June 2000 and are ongoing. A variety of survey methods were used, including longline, rod and reel, gillnet and setlines. The principal method of surveying was longline, with rod and reel, and gillnets the next most common (Table 1). Although rod and reel was less commonly used it was more successful at capturing sawfish – a result of working closely with experienced fishing guides who use only rod and reel.

Table 1:   Numbers of survey sets by gear type and the numbers of sawfish captures for Mote
   Marine Laboratory's sawfish surveys, June 2000 to October 2001.

Gear type	Number of sets	Number of sawfish
Longline	177	4
Rod and reel	22	6
Gillnet	12	1
Setline	3	0

Survey sets have been carried out between Tampa Bay and the outer Florida Keys, with the majority in the Everglades National Park (Figure 1). Gillnets were used as a survey technique north of the Caloosahatchee River (26.4°N). The majority of sets occurred inside the Everglades National Park (ENP), with 129 sets (60.3%) inside the ENP.

Acoustic telemetry

A sub-sample of sawfish caught during surveys were fitted with acoustic transmitters (Vemco V16 transmitters) to examine movement patterns and habitat utilization. Transmitters sent a coded signal on a frequency of 69kHz. A Vemco VR-60 acoustic receiver and directional hydrophone were used to locate and decode transmitter signals. Sawfish were located at regular intervals (typically 15 minutes) and tracked as long as possible. Initial plans were to track sawfish continuously for 24 - 48 hours. However, the depth preferences of the animals fitted with transmitters (see below, typically less than one meter on high tide) restricted tracking to periods of tides above mid-water. Thus a strategy of relocating animals on successive days was used to build up a picture of movement patterns and habitat use. Water quality parameters and habitat data were recorded regularly during tracks to aid in investigation of habitat utilization.

Figure 1:   Location of sawfish surveys in southwest Florida between June 2000 and October 2001. Red markers indicate the location of sets; the blue line is the boundary of the Everglades National Park.
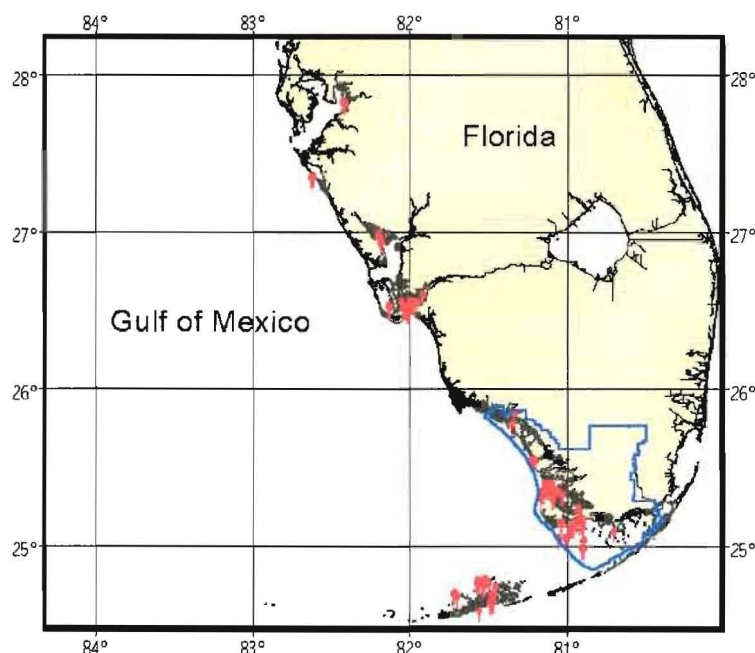
Reporting database

The MML sawfish reporting database was established in 2000 to compile information on the distribution and abundance of sawfish. The intention of this section of the sawfish research project was to provide data beyond that which was achievable using surveys. The data that is included in the database comes from a variety of sources, including reports from the public and data from fishing guides, the MML Gulf Coast Shark Census , the Florida Museum of Natural History Shark Fishery Observer Program and other researchers.

The database currently contains 110 reports relating to 207 sawfish. Most reports relate to individual sawfish, but some contain reports of multiple animals. For the past ten years (from 1991 onwards) there are 101 reports related to 146 sawfish (Figure 2). The majority of reports came from people engaged in recreational or commercial fishing (66.0%). However, other activities when sawfish were encountered included research (19.8%), diving or snorkeling (6.6%), boating (3.8%) and other (4.8%).

Results

Distribution and abundance

The results from the public reporting database (Figure 2) show that the current distribution of smalltooth sawfish is from St Petersburg on the west coast of Florida south and east to St. Augustine on the east coast of Florida. Within this range, the greatest abundance is within the boundaries of the Everglades National Park, especially at river and creek mouths between Cape Sable and Chokoloskee.

Details of the 11 smalltooth sawfish caught during the surveys are given in Table 2. The majority of animals were smaller juveniles, all caught at one site in the central Everglades National Park near the mouth of the Lostmans River. Three larger animals were also captured, including two in excess of 300 cm caught at the mouth of the Shark River.

Table 2:   Details of eleven smalltooth sawfish caught in Mote Marine Laboratory sawfish surveys.

Total length (cm)	Sex	Month caught	Location	Fate
300	unknown	August	Mouth of the Shark River	Released alive
267	female	January	Apollo Bay (near Tampa)	Acoustic track
350	unknown	March	Mouth of the Shark River	Acoustic track
155	female	June	Mouth of Lostmans River	Acoustic track
142	male	June	Mouth of Lostmans River	Acoustic track
155	female	June	Mouth of Lostmans River	Acoustic track
195	male	June	Mouth of Lostmans River	Acoustic track
185	male	June	Mouth of Lostmans River	Acoustic track
210	female	July	Mouth of Lostmans River	Acoustic track
131	female	September	Mouth of Lostmans River	Acoustic track
155	female	October	Mouth of Lostmans River	Acoustic track

Figure 2:   Reported sawfish encounters post-1991 (red triangles) from the Mote Marine Laboratory

sawfish reporting database. The blue line marks the boundary of the Everglades National

Park.
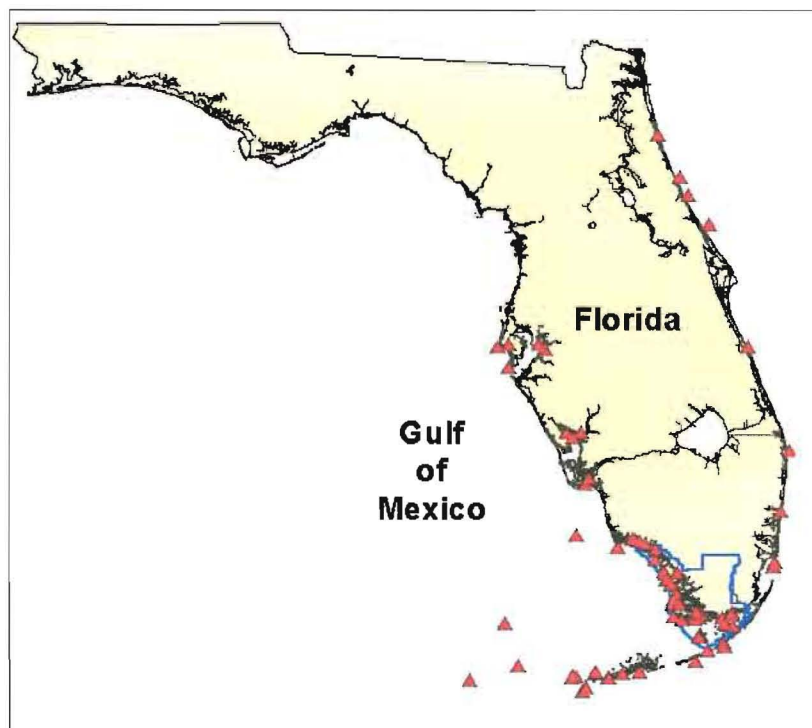
There appeared to be differences in the distribution of smalltooth sawfish depending upon their size.

Figure 3 shows the locations of encounters for four size groups of sawfish. The smallest animals appear to

inhabit shallow protected waterways with lower salinities. The largest animals (>300 cm) occurred across a broad range of depths and were the only animals that occurred in waters deeper than seven meters. There was a significant relationship between animal size and depth (Figure 4).

Figure 3: Locations of encounters with four size classes of smalltooth sawfish. Data from the Mote Marine Laboratory sawfish reporting database.
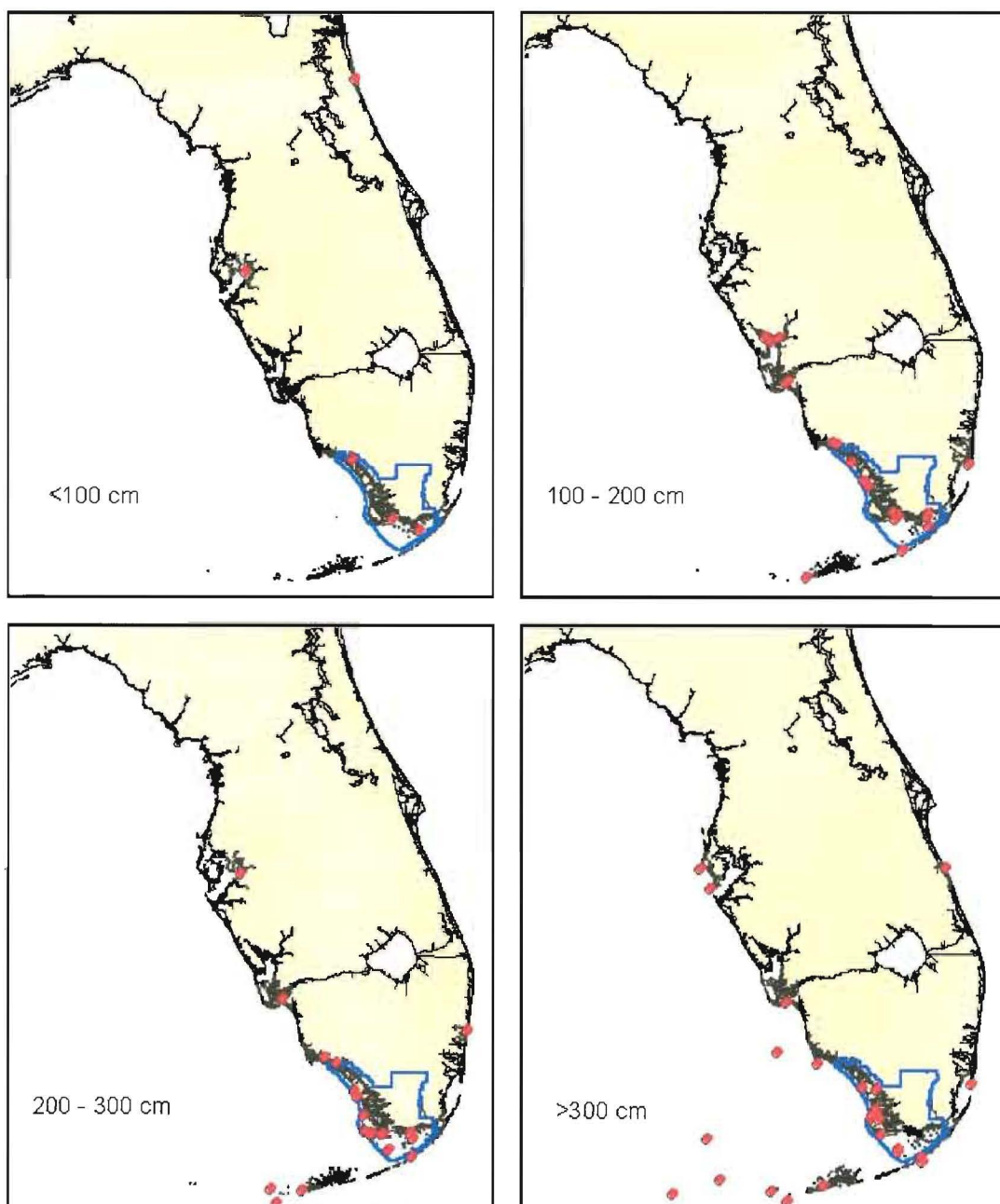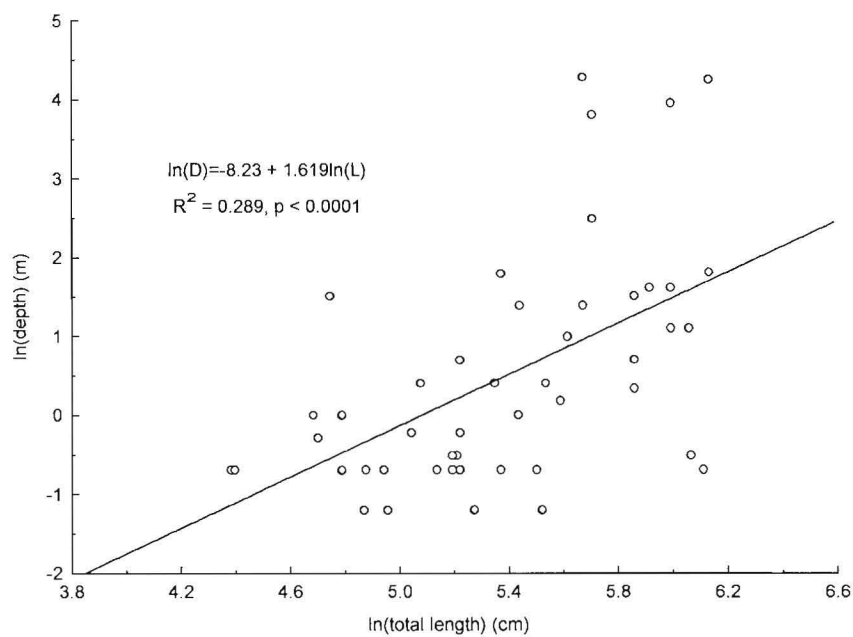
Figure 4:   Relationship between sawfish length and encounter depth. Data for 46 individuals
encounters that contained reliable depth and length data.

Plot with y-axis "ln(depth) (m)" ranging from -2 to 5, x-axis "ln(total length) (cm)" ranging from 3.8 to 6.6.

$\ln(D) = -8.23 + 1.619\ln(L)$

$R^2 = 0.289$, $p < 0.0001$

Movements

A total of eight smalltooth sawfish were fitted with acoustic transmitters. Of these two could not be tracked for more than a few minutes due to adverse tidal or weather conditions. Extensive attempts to relocate these animals were unsuccessful. Another three animals were tracked for short periods (<4 hours) but never relocated. The other three animals were tracked over multiple days. The results for two of these animals are shown in Figure 5. One animal was tracked over five months (Figure 5a) and was always relocated in the same area over this period indicating that it had a small home range and high site fidelity. The other animal was tracked over four consecutive days and occupied a similar range to that of the other animal (Figure 5b). However, this animal was not relocated on trips to this study site in subsequent months, indicating that it had moved out of the search area. During the entire time that animals were tracked they remained in very shallow water, typically less than one meter. All of these movement and
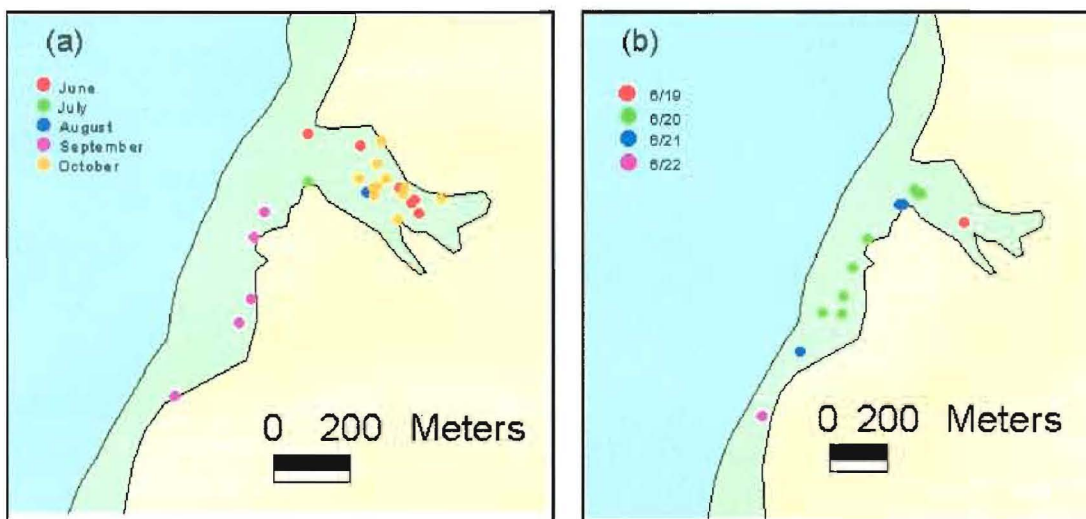
greater than seven meters were for large animals (see above). Temperature is known to be an important factor controlling smalltooth sawfish distribution since historically they migrated along the Atlantic coast of the US, with their lower threshold believed to be 16 - 18 °C (Bigelow and Schroeder 1953). In the current study, the majority of encounters occurred at temperatures greater than 26 °C, but occurred as low as 19.7 °C (Figure 6b). The early literature reporting the occurrence of smalltooth sawfish in US waters indicates that they occur in water from fresh to full seawater (Compagno and Cook 1995). In the present study sawfish were encountered in relatively similar numbers at salinities between 20 and 36 ppt (Figure 6c). Smalltooth sawfish occurred in waters with dissolved oxygen levels between 3 and 8 mg/l (Figure 6d). Three milligrams per liter may represent a lower tolerance level, but further research will be required to test this hypothesis.

Biological factors

The major biological feature of the habitats in which smalltooth sawfish occurred was the presence of mangroves. A large proportion of encounters reported occurred within a few meters of mangroves (Figure 7), all sawfish caught during surveys were within 100 m of mangroves, and all sawfish acoustically tracked remained within 100 m of mangroves. Smaller sawfish showed a stronger preference for mangroves, probably due to the size-depth relationship reported earlier. Another biological feature of habitats where smalltooth sawfish were encountered was the presence of bull sharks (*Carcharhinus leucas*). This species was regularly encountered in areas where sawfish were caught, probably because both species have a wide salinity tolerance.

occurrence data are for periods above mid-tide. It was not possible to obtain data at lower tides due to limitations of the water depth.

Figure 5:   Results of active tracking and relocating of (a) a 142 cm female sawfish released 19th of June 2001 and relocated over a period of five months, and (b) a 180 cm female released on the 19th of June 2001. Yellow areas are land, green areas depths less than 30 cm (from mean lower water), and blue areas depths between 30 cm and 100 cm (from mean low water).

Habitat preferences

Habitat preferences for smalltooth sawfish were based on data collected during survey fishing events, acoustic tracking, and from data supplied to the MML sawfish reporting database by other research groups. Preferences were divided into physical and biological factors.

Physical factors

Smalltooth sawfish displayed a strong preference for shallow waters. The majority of encounters occurred in depths less than one meter, and most were less than 7 meters (Figure 6a). The few encounters at depths

greater than seven meters were for large animals (see above). Temperature is known to be an important factor controlling smalltooth sawfish distribution since historically they migrated along the Atlantic coast of the US, with their lower threshold believed to be 16 - 18 °C (Bigelow and Schroeder 1953). In the current study, the majority of encounters occurred at temperatures greater than 26 °C, but occurred as low as 19.7 °C (Figure 6b). The early literature reporting the occurrence of smalltooth sawfish in US waters indicates that they occur in water from fresh to full seawater (Compagno and Cook 1995). In the present study sawfish were encountered in relatively similar numbers at salinities between 20 and 36 ppt (Figure 6c). Smalltooth sawfish occurred in waters with dissolved oxygen levels between 3 and 8 mg/l (Figure 6d). Three milligrams per liter may represent a lower tolerance level, but further research will be required to test this hypothesis.

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Figure 6: Frequency histograms of encounters with smalltooth sawfish by (a) depth, (b) temperature, (c) salinity, and (d) dissolved oxygen. Data from Mote Marine Laboratory surveys, acoustic tracking and other research groups.
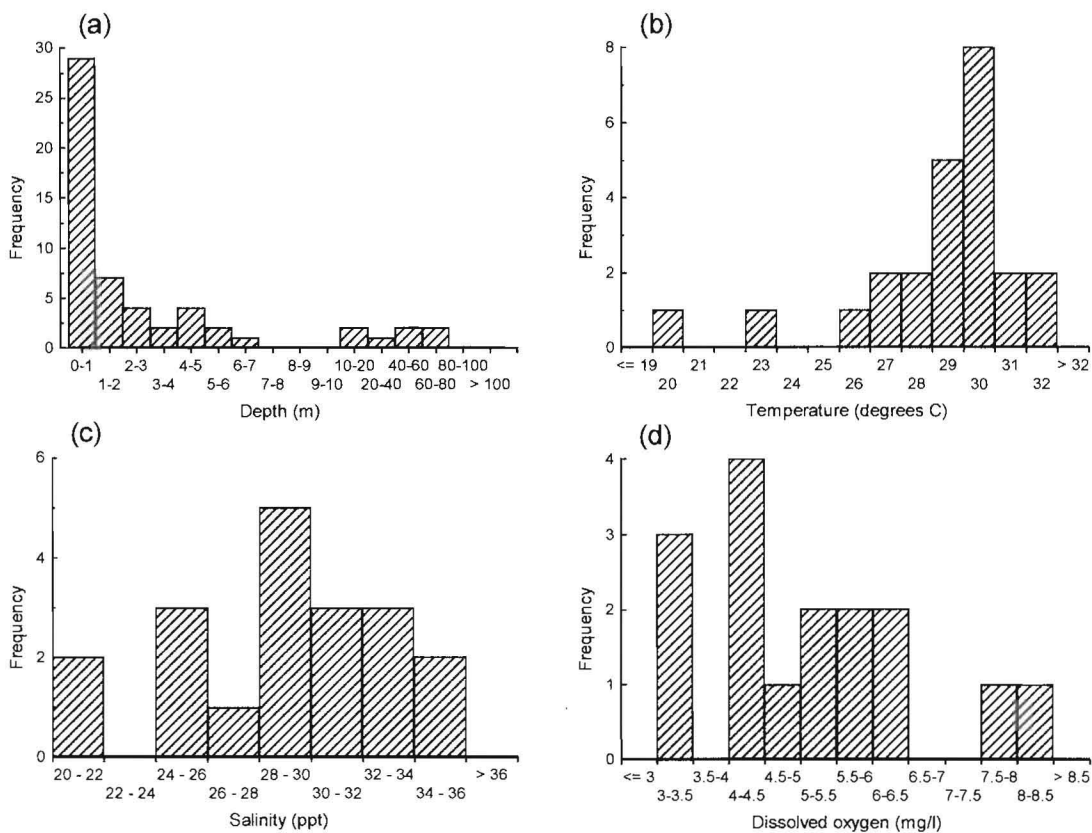

Significance of research results

The results of this research have provided a substantial improvement in the understanding of the smalltooth sawfish population in US waters. The results of the surveys and data in the MML sawfish reporting database have clearly defined the current range, and identified the marine and estuarine sections of the Everglades National Park as the core area of their current range. The acoustic telemetry data indicate that young sawfish can have a high level of site fidelity, inhabiting a small area for months at a time. The habitat preference data gathered indicate that while sawfish are able to move over long

distances they show preferences for a number of habitats, including very shallow, lower salinity, water and areas with mangroves. All of these data are currently being used to identify critical habitat for the Endangered Species listing of smalltooth sawfish (Simpfendorfer in prep.), giving a direct conservation importance to this work funded by National Geographic Society's Committee for Research and Exploration.

Figure 7: Association between encounters with smalltooth sawfish (animals <200 cm red points, > 200 cm blue points) and mangroves (green areas) in south Florida.
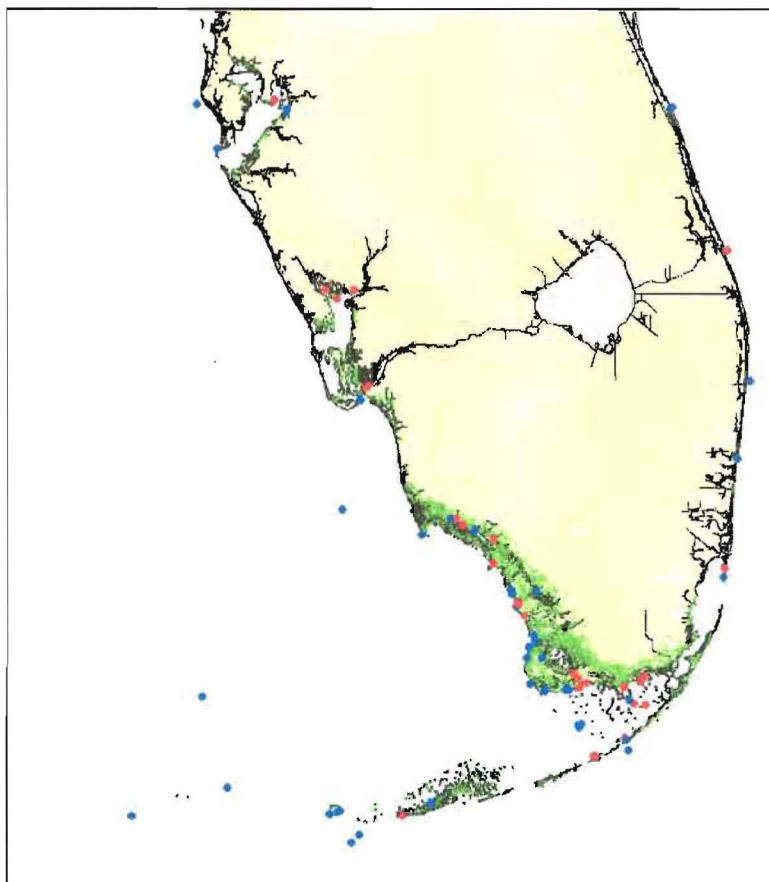
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