COOPERATIVE SHARK AND RAY RESEARCH IN THE SOUTHEAST REGION BY THE CENTER FOR SHARK RESEARCH, 2001-2003

FINAL REPORT
NOAA/NMFS GRANT NA17FL1542

SUBMITTED TO:

NOAA/NMFS
Southeast Regional Office
9721 Executive Center Drive
St. Petersburg, Florida 33702

SUBMITTED BY:

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MOTE TECHNICAL REPORT No. 954

EXECUTIVE SUMMARY

Cooperative research involving scientists and staff from Mote Marine Laboratory's Center for Shark Research (CSR), collaborating scientists from the NOAA/NMFS Southeast Fisheries Science Center, and commercial and recreational fishermen in Florida, South Carolina, and Louisiana was conducted from September 2001 to December 2003. This research was designed to understand better the life history, movement patterns, reproduction and population dynamics of several species of sharks and one endangered species of ray, the smalltooth sawfish (*Pristis pectinata*). Research methods included conventional and archival tagging, acoustic and satellite telemetry, habitat characterization, and specimen collection and dissection. Home range size and habitat use of juvenile blacktip sharks (*Carcharhinus limbatus*) were discovered for a southwest Florida nursery area, and movement patterns of juvenile and adult blacktips along the Florida Gulf coast were described. Results of satellite tagging were not satisfactory due to premature releases of many of the tags and other factors, calling for further development of this technology as applied to large coastal sharks. The reproductive biology of the shortfin mako shark (*Isurus oxyrinchus*) and other large sharks was studied with help from cooperating fishermen. Tracking studies of smalltooth sawfish in southwest Florida rivers were used to define essential habitat for this endangered species, important in rebuilding efforts, and satellite archival tagging revealed movement of sawfish from shallow coastal waters to deep areas off the Florida Keys. The results of these studies provide fisheries-relevant information that will help lead to better management of shark fisheries and protection of remnant sawfish populations.

PROJECT INFORMATION

Award Number: NA17FL1542

Amount of Award: Federal $ 200,000 Applicant Match $ 21,808 Total $ 221,808

Project Title: Cooperative Shark and Ray Research in the Southeast Region by the Center for Shark Research, 2001-2003

Recipient: Mote Marine Laboratory, Sarasota, Florida

Award Period: September 1, 2001 to December 31, 2003

Reporting Period: September 1, 2001 to December 31, 2003 (Final Report)

SUMMARY OF PROJECT ACCOMPLISHMENTS

I. Blacktip shark life history, stock identification and essential habitat in the southeast U.S. region (Dr. Michelle Heupel, Dr. Colin Simpfendorfer and Dr. Robert Hueter, Principal Investigators)

A. Juvenile blacktip shark movement patterns

Methods:

Examination of the movement patterns and site fidelity of neonate and juvenile blacktip sharks (*Carcharhinus limbatus*) in Charlotte Harbor, Florida was conducted from May to November of 2002 and 2003. Receivers record the presence of sharks fitted with transmitters when they come within range of the receiver (c. 800m). In 2002, 19 VR2 acoustic receivers were deployed in lower Pine Island Sound in the region between Pine Island and Sanibel Island (Fig. 1). The total area covered by the acoustic array was 19 km^2. In 2003, the acoustic array was expanded to 41 acoustic receivers covering approximately 89 km^2 (Fig. 1).

Results: 2002

A total of 26 neonate *C. limbatus* were fitted with transmitters and monitored within the acoustic array. Sharks remained within the study site for variable periods of time ranging from 1-157 days. The last shark present within the study site exited on November 13, 2002. Seven sharks (27%) were monitored within the study site for 1-7 days, 7 (27%) for 8-30 days, 6 (23%) for 31-60 days 0 for 61-100 days and 3 (12%) for over 100 days. Three of the sharks fitted with transmitters (12%) suffered mortality during the study period. Examination of monitoring data showed that residence within and use of the habitat was variable. The total area covered by the acoustic array was 19 km^2 and several of the sharks monitored used the entire monitored portion of the habitat (Fig. 2). Home range sizes for individuals monitored for longer than 30 days ranged in size from 6.7 – 19.2 km^2. Although the monitored area within Pine Island Sound was twice the size of that previously monitored in Terra Ceia Bay, it was apparent that the entire home range of young *C. limbatus* within Pine Island Sound was not contained within the study region. The loss of receiver contact with individuals for several days at a time suggests that sharks were moving outside the study area for variable periods. This suggests that individuals in Pine Island Sound use a larger activity space than their cohorts in Terra Ceia Bay and that the home range estimates of 19 km^2 are underestimates of the total space used. This difference in home range size and habitat use is most likely due to the larger area and more open structure of the habitat within Pine Island Sound compared to the enclosed nature of Terra Ceia Bay.

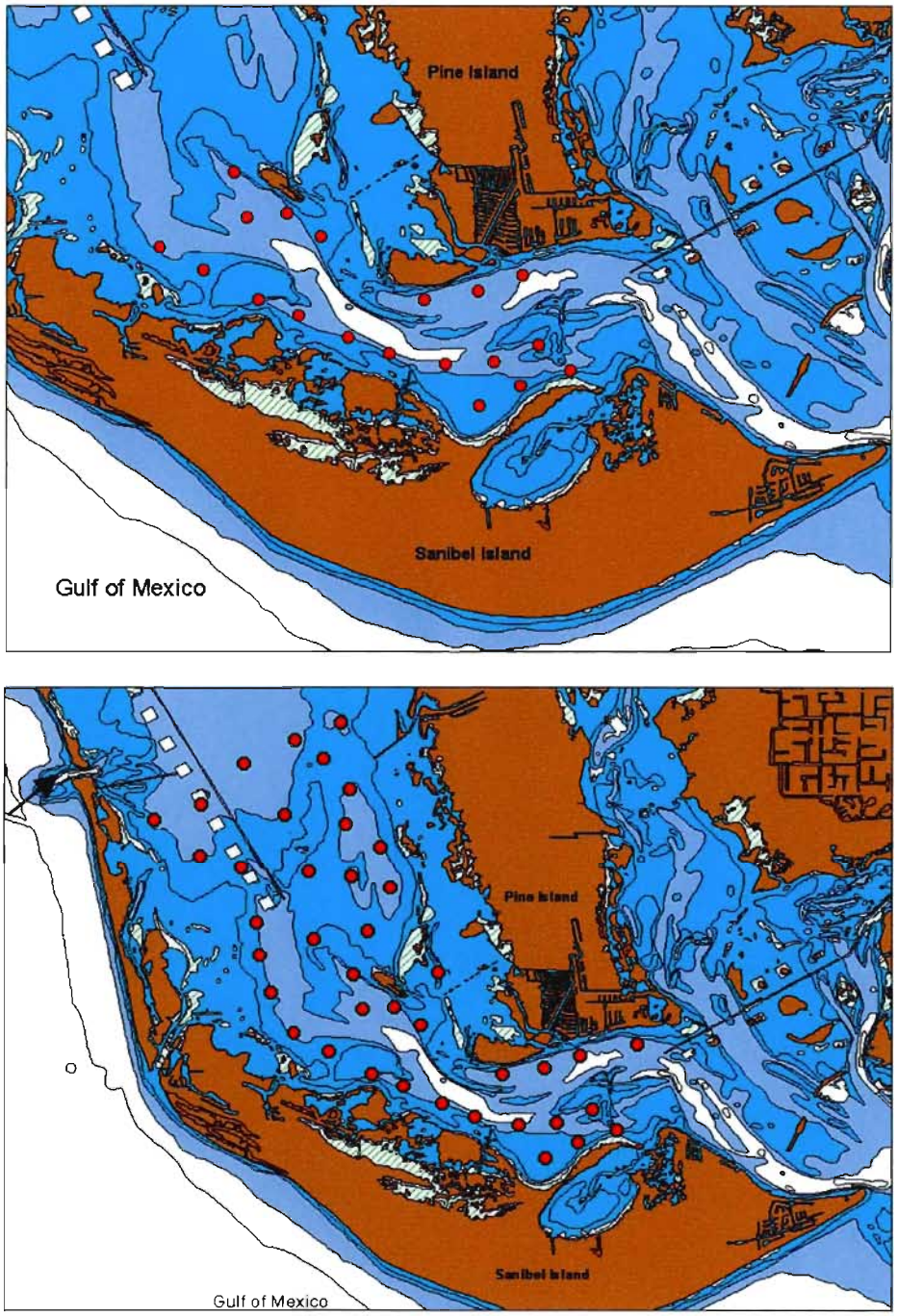

Figure 1. Acoustic receiver locations in Pine Island Sound, Charlotte Harbor in 2002 (top) and 2003 (bottom). Red dots indicate receiver locations within the study site. Arrow indicates Redfish Pass at the northern extent of the study area.

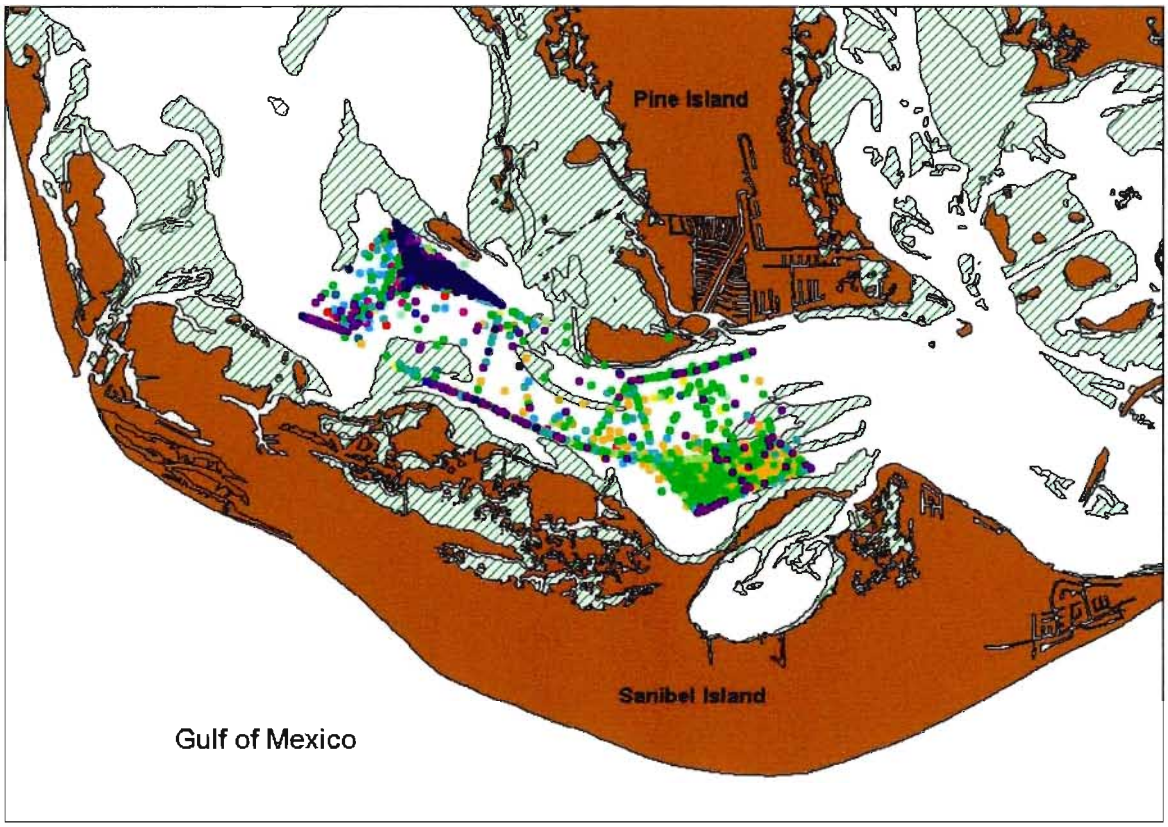

Figure 2. Recorded locations for all blacktip sharks monitored within Pine Island Sound in 2002. Monitored sharks used the entire region of acoustic coverage (19 km^2).

Kernel home range estimators calculated for blacktip sharks in 2002 indicate regions within the study site that sharks used most intensively. Several key areas were defined via kernel analysis (Fig. 3). One location in the northeast region of the study site just south of Chino Island appeared to be heavily used by neonate blacktip sharks. In addition, a bay region along the southern portion of the study site was also heavily used by young blacktip sharks. In general the young sharks were found to avoid deep water areas within the study site and remained close to shore or islands in shallower waters. The limited acoustic array in 2002 made it difficult to define the extent of movements by young blacktip sharks. The indicated areas may only be critical for a portion of the blacktip population or for a limited portion of time. As stated earlier, sharks were observed to move outside the study region making it difficult to define the extent of movement and home range of sharks in Pine Island Sound.

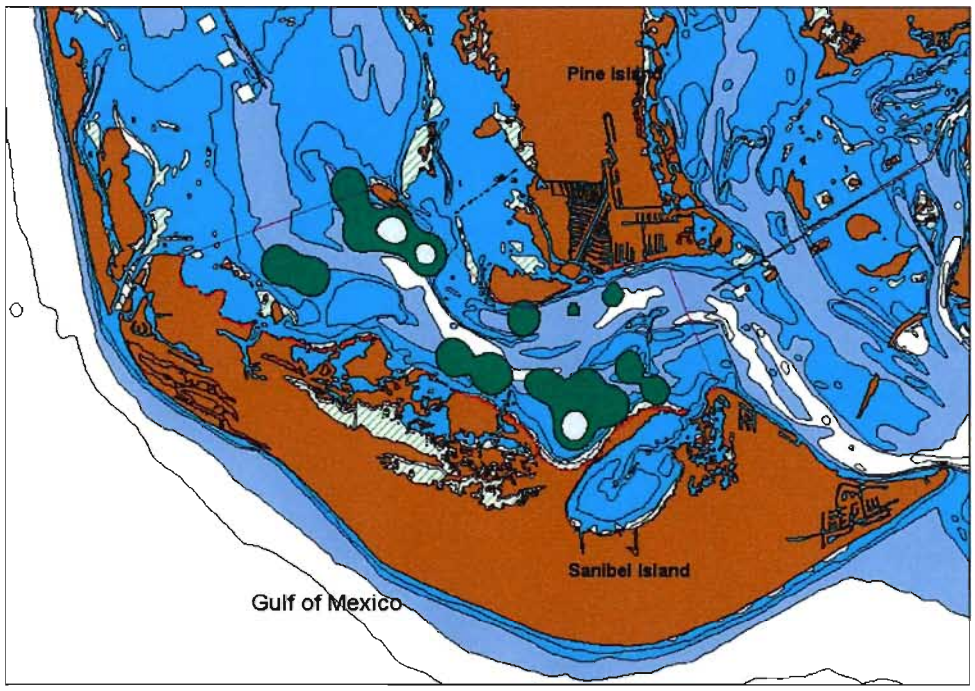

Figure 3. Kernel estimates of habitat usage by all blacktip sharks monitored within Pine Island Sound in 2002. Green areas indicate regions where 95% of shark locations were recorded. Light gray areas represent areas of highest habitat usage with 50% of location points being recorded in those areas.

Results: 2003

In 2003, a total of four young-of-the-year and four adult blacktip sharks were captured within Pine Island Sound and fitted with acoustic transmitters. A major red tide bloom in the Charlotte Harbor region is thought to have altered shark distribution within the study site. Numerous reports of blacktip sharks off coastal beaches were reported, but sharks were difficult to capture within Pine Island Sound. Young sharks may have been using habitats off the beaches as an alternative to exposure to red tide within the harbor.

The capture of adult blacktips within Pine Island Sound was a novel and unexpected result. All four captured sharks were mature females. None of the females were pregnant and it was uncertain whether any had recently pupped. Adult females were not present within the study site for longer than 10 days. One individual was only recorded for one day, the others were present for 5, 8, 10 days prior to exiting the study site. The individual that remained for one day was recorded in the southern end of the study site and then apparently left via Matanzas Pass at the southeastern portion of the study site (Fig. 4). The other three individuals were recorded to move farther north into the study site and either continued to move north out of the study region or exited at Redfish Pass at the northern limit of the detection range (Fig. 4). All sharks were captured on May 26 or 27 (2003). No adult blacktips were captured within the study site after this period.

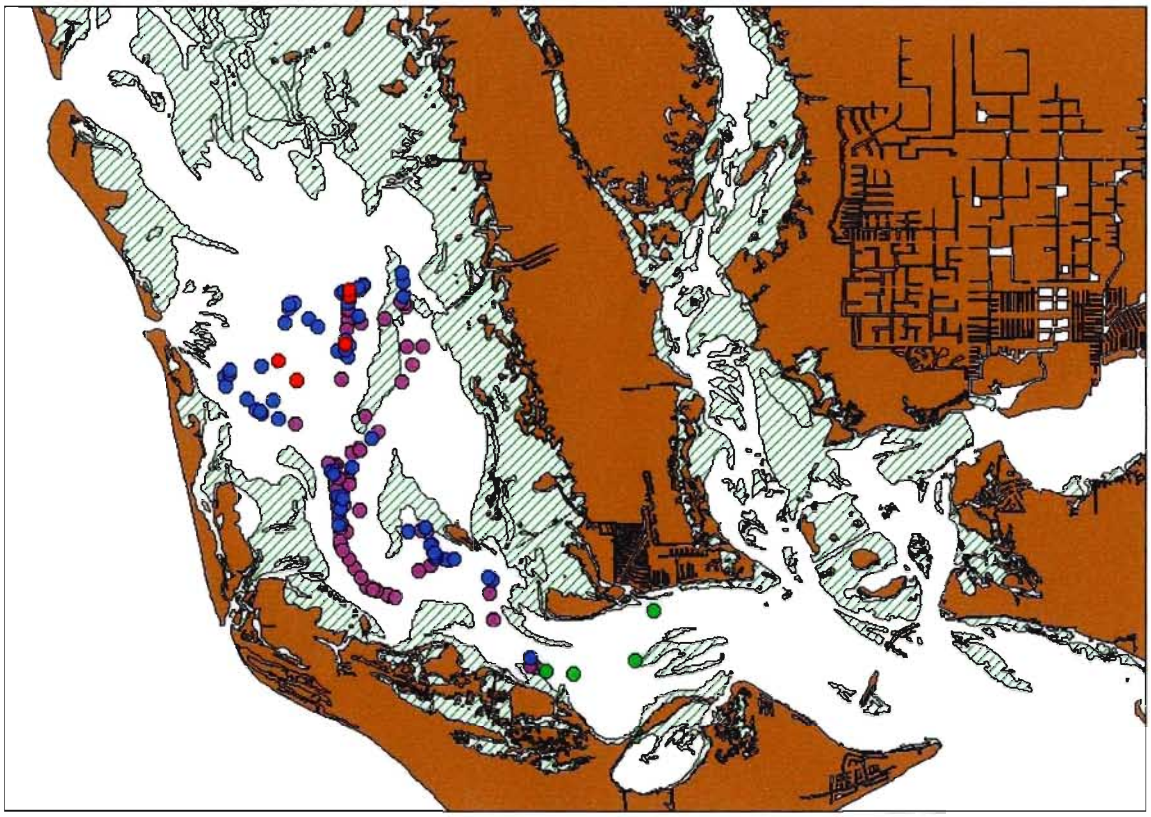

Figure 4. Position locations for four adult female blacktip sharks within Pine Island Sound as recorded by acoustic receivers. Sharks were present from 1 – 10 days.

In addition to the adult sharks, four juvenile blacktip sharks were captured within Pine Island Sound. All four of these individuals were captured on July 23, 2003. Two of the sharks were neonate and the other two were considered young-of-the-year (judged by the presence of a healed umbilical scar). All four were captured in the bay region at the southern end of the study site. This area was previously described as a heavily used region by young blacktip sharks in 2002. Fishing in other regions within Pine Island Sound did not result in the capture of blacktip sharks. Of the four collected individuals one individual was female and the other three were male. Data gathered from these four sharks were very limited and two individuals appeared to suffer mortality within the study site after a week. The surviving two individuals left the study site after 1 and 3 days each. Location data for these four individuals are limited due to the exit and mortality of individuals (Fig. 5). As stated previously, a strong red tide bloom is thought to have created conditions within Charlotte Harbor that were not acceptable for young blacktip sharks. It is unclear whether the mortality or exit of these four individuals was directly related to the red tide bloom.

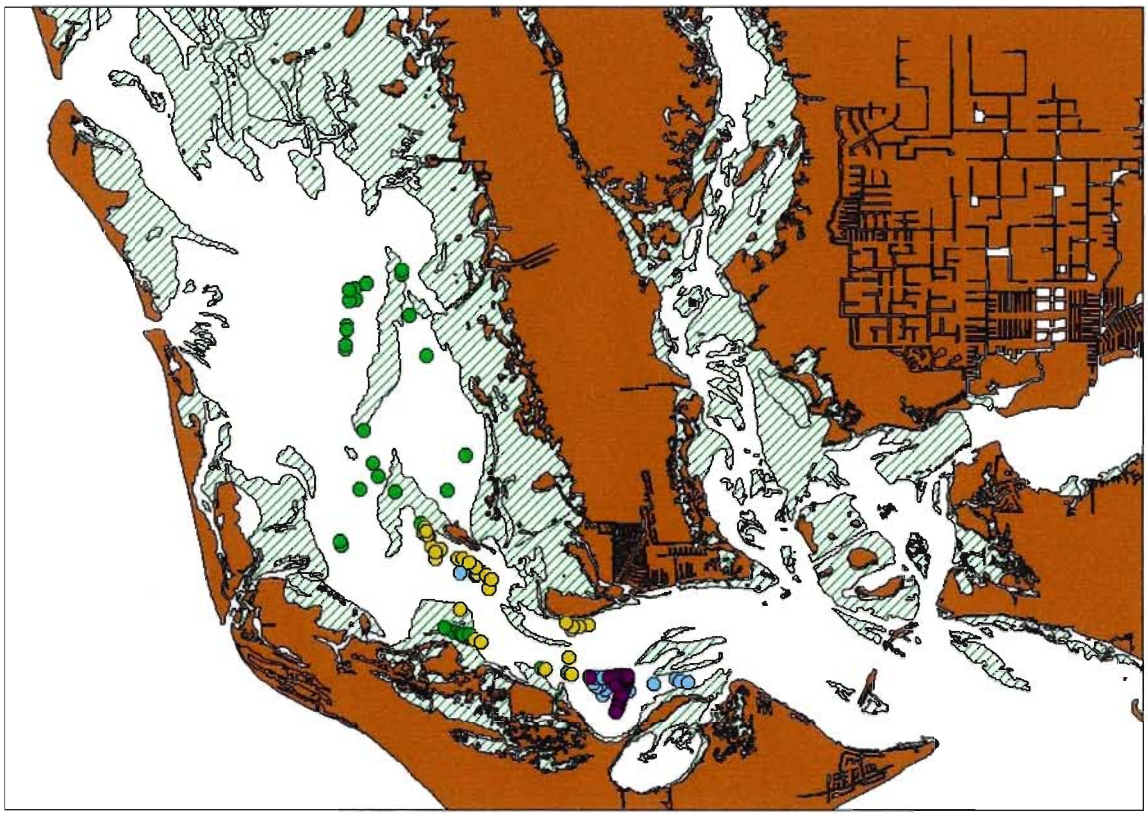

Figure 5. Position locations for four juvenile blacktip sharks captured within Pine Island Sound in July 2003. Sharks were not present for longer than 3 days.

In addition to sharks collected in 2003 four other blacktip sharks were monitored within Pine Island Sound. All four of these individuals had been fitted with transmitters in 2002 and monitored for the entire summer season of that year. One of the returning individuals was previously tracked in Pine Island Sound in the smaller array system in 2002. This individual was originally monitored for a period of 102 days in 2002. Upon return to Pine Island Sound on August 25, 2003 this shark was recorded for 22 days. The remaining three individuals were tracked as part of a complementary study in Terra Ceia Bay, Tampa Bay in 2002. All three of those individuals were monitored for over 140 days (143, 158, 166 days). All three individuals from Terra Ceia Bay were recorded within Pine Island Sound earlier than the returning individual. Terra Ceia sharks arrived on July 13, 18 and August 1, 2003. These three individuals remained within the study site for variable periods of time ranging from 3 – 43 days. All four sharks entered the study site from the north or via Redfish Pass at the northern extent of the study site (Fig. 6). None of these sharks used the southern portion of the study area.

Based on the limited data collected from 2003, it is not possible to compare habitat use between the two years of this project. Further study into the home range size and activity space of juvenile *C. limbatus* in various habitats should be pursued to better define the essential habitat needs of this species.

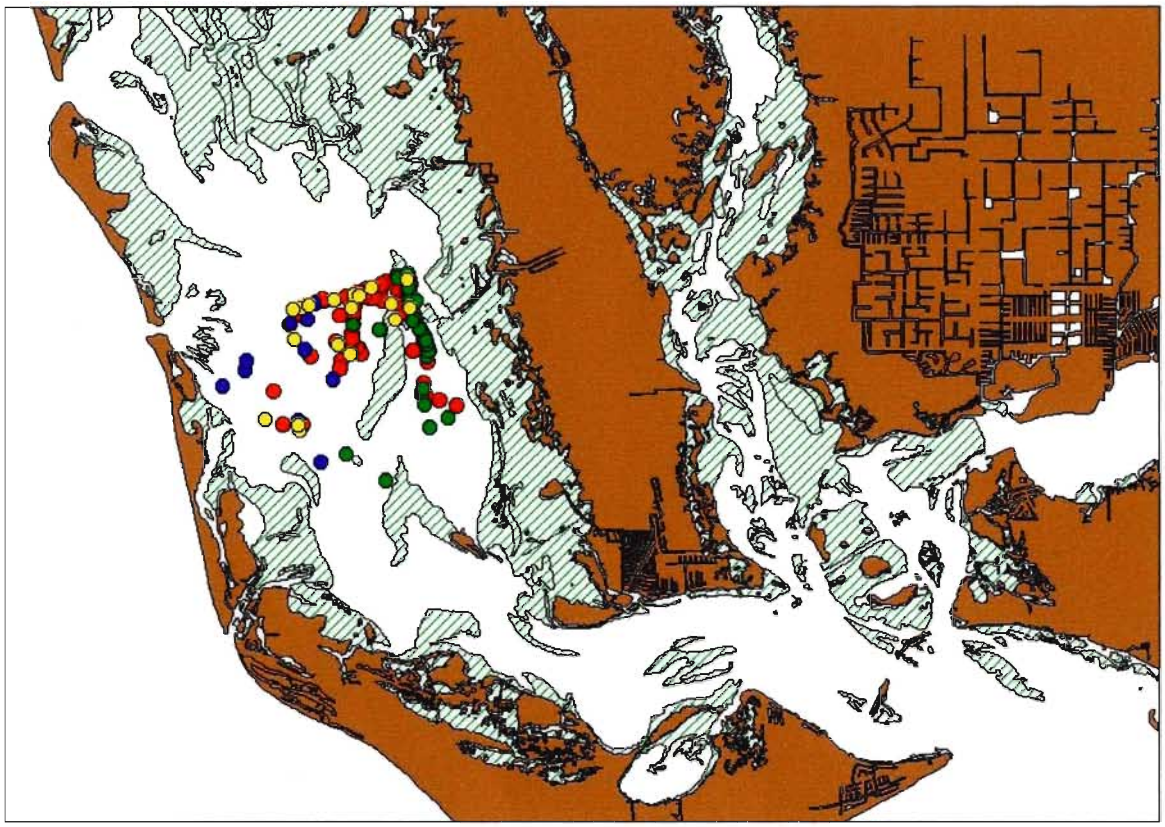

Figure 6. Position locations for one-year-old- blacktip sharks fitted with transmitters in 2002 that were recorded within Pine Island Sound in 2003.

B. Adult blacktip shark movement patterns in the eastern Gulf of Mexico

To examine the movement patterns and habitat use of adult blacktip sharks in the eastern Gulf of Mexico individual adult *Carcharhinus limbatus* were fitted with Wildlife Computers Pop-up Archival Transmitting (PAT) tags. PAT tags were attached using a variety of techniques, including dorsal fin plates, plastic headed dart tags, double metal headed dart tags and encircling cable ties. This variety of attachment methods was used use to identify the best method of tag attachment. The PAT tags store data on light level (for geolocation), depth and water temperature. At a pre-programmed time the tag detaches from the animal, floats to the surface and sends the stored data via the ARGOS satellite system. A variety of data gathering durations were tested, from as long as a year to as short as a few weeks. Adult sharks were captured either on drumline sets or in beach seines in the eastern Gulf of Mexico in the region from Sarasota to Tampa Bay. Sharks were sexed and measured, and fitted with a PAT tag.

Results:

A total of five adult *C. limbatus* were fitted with PAT tags during this period (Table 1). Durations from 30 to 363 days were used. All tags that had a long duration (>100 d) were not heard from. Many potential factors could have caused this failure to report, including tag failure, biofouling and battery pacification. Shorter duration deployments all reported or were returned. However, in each case the tags prematurely released and so minimal data were recorded. The results indicate that plastic- and metal-headed dart tags do not provide sufficient hold on adult blacktips. Given the speed with which these tags released from the shark, it is likely that the sharks are actively attempting to remove these tags and were successful in a short period of time. Given the data, it was not possible to determine if the longer durations tested failed because of the attachment or other problems. Further research on PAT tag attachment methods on coastal pelagic shark species is required to identify appropriate methods of attachment for long-term studies of shark movements. Given the short duration of attachment of the three tags that reported no further analysis was performed.

Table 1. Details of animals fitted with Wildlife Computers PAT tags between September 2001 and December 2003.

Location	Date	Tag #	STL (cm)	Sex	Attachment type	Duration (days)	Result
Longboat Key	6/5/02	01P0085	186	F	Dorsal fin plate	183	Not heard from
Big Pass	6/7/02	01P0136	190	F	Dorsal fin plate	363	Not heard from
Longboat Key	4/7/03	02P0572	160	F	Plastic dart tag	30	Premature release (<7 d on shark)
Big Pass	10/9/03	03P0078	164	F	Double metal dart tag	62	Premature release (<7 d on shark)
Longboat Key	10/10/03	03P0080	169	F	Double metal dart tag	85	Premature release(<7 d on shark); returned

II. Cooperative research with NMFS/SEFSC scientific staff and commercial fishermen (Dr. Jose Castro, Principal Investigator)

A. Archival & satellite tagging of postpartum and newly gravid blacktip sharks in the nursery areas off South Carolina

In an early phase of this project (June 2002), we tagged blacktip females with archival tags to determine their movements and return to the South Carolina nursery. Out of nine archival tags deployed (Table 2), one was caught and re-released by personnel of the South Carolina Department of Natural Resources. Another shark was caught by Steve Poston, our cooperating fisherman from Georgetown, South Carolina, some three weeks after tagging, in the same area where it was tagged. Mr. Poston re-released the shark according to our previous instructions. No other tags have been recovered to date. Although tag recovery is often a long-term project, with tags sometimes being recovered years after deployment, we shifted to satellite tags because we are aware that many commercial fishermen are not returning the tags that they recover from sharks. Today many commercial fishermen believe that by returning tags they are contributing to restrictive fishing quotas or seasons, hence they are not returning the tags.

We had three satellite tags and we had planned to deploy two on females in the nursery, and one on a female in the wintering grounds. Because most investigators are experiencing premature release of the tags, we programmed the tags for a three-month duration. We planned to tag the females in the nursery just prior to the start of their southern migration. This migration starts in very late September and most sharks have left the nursery by the third week in October. Hopefully, a tag with a three-month release time, implanted just before the migration, would reveal the time of departure from the nursery and the arrival at the wintering grounds.

We had planned to deploy the tags in mid-September 2003 on females caught in the South Carolina nursery, and one in the wintering grounds in winter. Our scheduled September deployment coincided with hurricane Isabelle moving along the East Coast. Our deployment was delayed for two weeks due to unsafe boating conditions off the Carolina coast. We deployed to South Carolina on 26 September 26. A check with several local fishermen in the area revealed that blacktip sharks and sharpnose sharks (*Rhizoprionodon terraenovae*) had disappeared from coastal waters with the onset of hurricane conditions and had not returned. Due to the nature and duration of the project, we elected to proceed with the blacktip fishing, in an attempt to secure at least one or two animals before they departed the area. We fished several areas of Bulls Bay that have always yielded mature blacktip females at that time of the year. We caught only two small blacktips (Table 2) after a whole day of fishing where we have caught dozens in previous trips. The only animal large enough to handle a satellite tag was a 197 cm female sandbar shark (*Carcharhinus plumbeus*). Due to incoming severe weather, and having been advised of the absence of blacktip adult females in the area, we had decided to deploy the tag on a large sandbar or hammerhead female if blacktips were not caught. We implanted a satellite tag on this animal to test retention and our tagging procedures.

The tag was inserted with double attachment darts, one on each side of the body to insure retention, and both deeply inserted into the body musculature. A second attempt to find the blacktip adult females in offshore waters in cooperation with personnel of the South Carolina Department of Natural Resources (Glenn Ulrich and staff) had to be abandoned due to severe weather offshore.

We have been informed that the tag has come off the sandbar shark prematurely and was transmitting properly. The tag came off after about 7-10 days on the fish and started transmitting after floating for four days. It is now floating in the offshore waters off South Carolina. Reasons for the premature release of the tag are unclear. The current satellite tags are proving to be problematic when attached to medium-sized sharks. The tags are designed to be inserted into the musculature of sharks using the plastic darts provided by the manufacturer or other darts provided by the investigator. We used the darts provided by the manufacturer because their design and plastic construction are conducive to retention in the tissues. We did not use metal darts because they tend to cut their way out of the animal's muscles. Metal darts do not adhere to the tissues and their sharp edges, combined with the movements of the muscles and the drag caused by the tag, cause the tags to slowly cut themselves out of the tissues. A common problem to most investigators working with medium size sharks is that the satellite tags tend to come off the animals long before the scheduled self-release time. The reason for this is not known at this time. Analysis of some recovered tags suggests that the shark pulled the tags off, perhaps by rubbing against bottom structures. It appears that these tags create too much drag on relatively small sharks (80-120 pound animals), and are such nuisance or cause such drag that the animals are induced to remove it by whatever means they can use. Because of the high cost of the tags and the extremely small probability of tag retention, we decided to discontinue the use of the satellite tags in this project until a suitable method of anchoring the tag is developed and demonstrated.

Table 2. Blacktip shark (*Carcharhinus limbatus*) tagging data in South Carolina nursery.

Date	Arch. Tag#	Ext. Tag#	STL (cm)	Sex	Location	Notes
4-Jun-02	1679	N/A	165.0	female	off Cape Romain, SC	
4-Jun-02	1706	30	177.5	female	off Cape Romain, SC	
5-Jun-02	1705	01	160.0	female	off Cape Romain, SC	
5-Jun-02	1708	02	141.0	female	off Cape Romain, SC	mating scars
6-Jun-02	1713	03	158.0	female	off Cape Romain, SC	lively release
6-Jun-02	1732	04	152.0	male	off Cape Romain, SC	
6-Jun-02	1597	05	160.0	female	off Cape Romain, SC	
6-Jun-02	1689	06	167.0	female	off Cape Romain, SC	large animal
8-Jun-02	1707	07	180.0	female	off Cape Romain, SC	mating scars
27-Sep-03	1339	08	164.0	female	off Cape Romain, SC	
27-Sep-03	1632	09	175.0	female	off Cape Romain, SC	

B. Reproductive cycle of the shortfin mako shark

The shortfin mako shark, *Isurus oxyrinchus*, is an abundant, widely distributed, pelagic lamnoid shark found in tropical and temperate waters. It is a large species reaching over 340 cm total length and it is one of the top predators in its environment. The shortfin mako is also one of the most economically important species of sharks. It is considered one of the great gamefishes of the world, and its flesh is highly palatable. Thus, the shortfin mako is sought by both recreational and commercial fishermen throughout the world. It is often caught as bycatch in tuna and swordfish fisheries, and it is the only species of shark usually retained in high seas operations. Large numbers of shortfin makos are landed by both commercial and recreational fishermen in the United States as well as throughout the world.

In spite of the abundance of the shortfin mako, and the large numbers of shortfin makos caught in our waters every year, the biology of the shortfin mako is poorly known. Several studies have been carried out on the shortfin mako in the U.S. during the last two decades, but these studies have been based solely on juveniles and males. Fishermen in the U.S. seldom catch large mature females or gravid females, and consequently, the large females have seldom been examined by biologists. Thus, some of the critical data needed for management of the species, such as the length of the gestation period and the length or frequency of the reproductive cycle, are missing. These parameters have been estimated recently by Mollet et al. (2000), who estimated that the gestation period of the shortfin mako lasts 15-18 months and that the reproductive cycle lasts two or three years. This study was based on data compiled from the literature and specimens came from around the world (i.e., both hemispheres). The implications of such long gestation period and reproductive cycle are that the reproductive potential of the species is very limited. There are several problems in accepting those parameters. First, no shark species has been demonstrated to have a 15 or 18 month gestation period. Second, the shortfin mako is a fast-growing species, and such sharks usually have gestation periods of a year or less. Third, it is difficult to correlate a 15-18 month gestation period with a two or even a three-year reproductive cycle. Fourth, in spite of the heavy pressures on the species, the population of makos is apparently resilient (Baum et al., 2003). Thus, our purpose was to investigate the reproductive potential of the shortfin mako by empirical methods and actual observation in a specific population of mako sharks, and actually determine the size at maturity for the female, the length of the gestation period, and the length of the reproductive cycle. Such data would be most valuable and have numerous practical applications. The management and conservation of pelagic species have been hindered by the lack of knowledge on their status and the direction of population trends (Baum et al., 2003). The length of the gestation period and the length of the reproductive cycles of other lamnoid sharks (including some protected species) such as the white shark, the porbeagle, the salmon shark, the thresher shark, and the basking shark, are unknown. Knowledge of the parameters is essential for the effective management of the sharks. A determination of the reproductive parameters of the mako shark would provide a model for other lamnoid sharks.

Large mature female makos have seldom been examined by biologists, and there are few records of gravid makos in the literature. These formidable specimens are rarely caught in the Gulf of Mexico and the Bahamas. Two commercial fishermen, Mr. Allen Walker of Gretna, Louisiana and Mr. Ray Perez of Fort Pierce, Florida, agreed to help with this project. In the past, both of these fishermen have caught large female makos (over 350 pounds) in winter off Louisiana and throughout the year in the Bahamas. Usually these large fishes are either gutted at sea or sometimes discarded. We obtained two specimens during the project period. One specimen was a 325 cm gravid female caught off Natal, Brazil, and obtained for us by Mr. Nelson Beiderman of Blue Water Fishermen's Association. This specimen was in the early stages of gestation, and carried 8.5 cm embryos, being in the ovulatory phase (Fig. 7). We believe that this is one of only two makos ever examined in this stage. A second specimen was obtained thought the efforts of Mr. Alan Walker, a Louisiana sportfishing captain who has been cooperating with us. This specimen was captured by harpoon off Venice, Louisiana. It measured 335 cm and weighed 271 kg (604 pounds). This specimen is of considerable interest because it appears to be immature (Figs. 8 and 9). This suggests that the shortfin mako may mature between 320 and 330 cm TL.

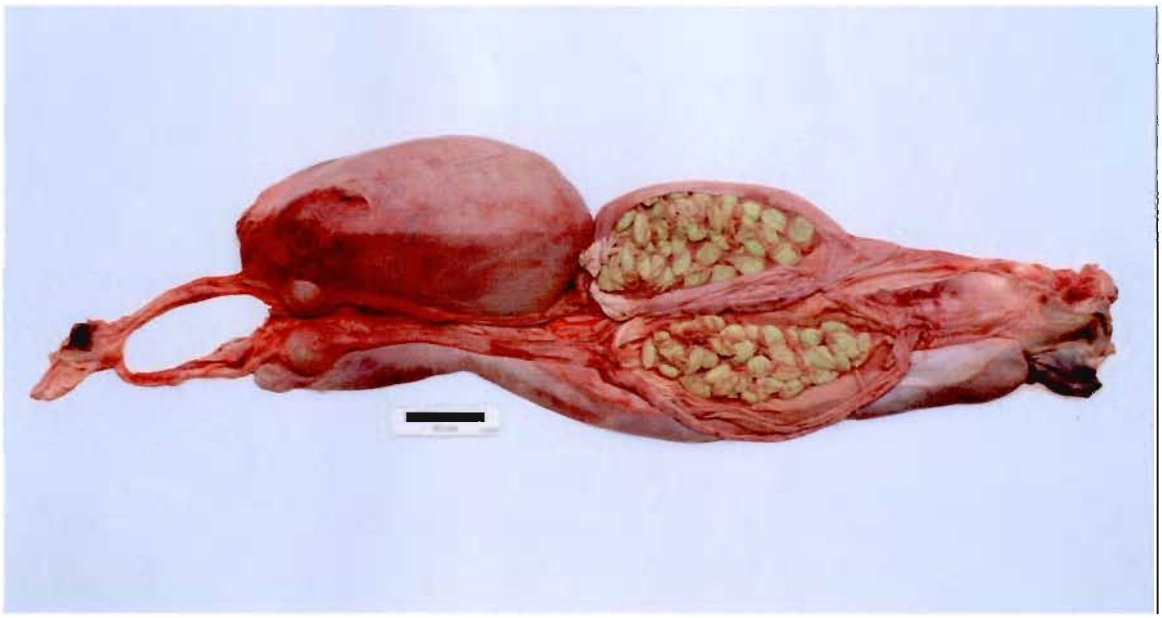

Figure 7. Reproductive tract from gravid 325 cm female shortfin mako shark (*Isurus oxyrinchus*) from Brazil.

Figure 8. 335 cm female mako shark from off Louisiana.

Figure 9. Reproductive tract from 335 cm female mako shark from off Louisiana.

C. Other cooperative research with commercial fishermen

We have received other invaluable help in this cooperative research project from the commercial and recreational fishing communities and some very valuable and interesting specimens. These specimens include a 375 cm sixgill shark, *Hexanchus griseus* (Fig. 10), from commercial fisherman Jay Lamme of Key West Florida. Fishing guide Ron Schatman helped immensely with the planning and execution of a shark research cruise on board R/V Suncoaster (of the Florida Institute of Oceanography). During this cruise we fished at depths of 300-400 m and obtained rare and little known sharks. Mark Quartriano, who has a recreational fishing business in Miami, has offered to collect data and specimens for us. He has been saving selected specimens for us. Mr.Quartiano recently saved for us a 326 cm, 202 kg (445 pounds) scalloped hammerhead, *Sphyrna lewini* (Fig. 11). We believe this to be the largest scalloped hammerhead ever authenticated. Mr. Quartiano is also planning to fish for very deep water sharks in 1,000-4,000 ft. depths and will be saving for us whatever unusual sharks he gets.

Assistant April Cook worked assiduously on the logistical preparations for the deepwater cruise. April also prepared and distributed posters requesting the return of tags to Mote Marine Laboratory. These posters were placed at, or sent to, fish houses in the southeastern states.

Fig. 10. Sixgill shark (*Hexanchus griseus*) collected off Key West, Florida by commercial fisherman.

Figure 11. 326 cm female scalloped hammerhead (*Sphyrna lewini*) collected by commercial fisherman off Miami Beach, Florida.

III. Sawfish essential habitat and population dynamics (Dr. Colin Simpfendorfer, Principal Investigator)

Methods:

Surveys for smalltooth sawfish (*Pristis pectinata*) were carried out using a variety of gear types – longline, set line, set net and rod and reel. Longlines were the most commonly used, with 246 sets, all other gear types where infrequently used (rod and reel 36 sets, set net 10 sets and set line 6 sets). Sampling occurred from September 2001 through November 2002 in the region from Tampa Bay to the Marquesas Keys, Florida (Fig. 12). Environmental parameters (water temperature, salinity, dissolved oxygen content, depth and vegetation type were recorded at each sampling site. Sawfish captured were sexed, measured and tagged with conventional plastic fin tags. In addition a subset of individuals were fitted with acoustic or satellite telemetry tags. Acoustically tracked individuals were fitted with Vemco V16 or V8 tags, and followed in a boat using a Vemco VR60 receiver. The location of the sawfish was determined from the direction and strength of the signal and recorded every 15 minutes, or whenever it moved to a new location. Environmental parameters were recorded every hour during acoustic tracks. Sawfish were also tracked by fitting individuals with Wildlife Computers PAT tags. These tags store data on light (for geolocation), depth and temperature. The PAT tags were programmed to detach from the sawfish and transmitted stored data at a pre-determined date and time.

Results:

A total of 298 sampling events occurred during the study period and resulted in the capture 15 sawfish (Fig. 12). Captured sawfish ranged in size from 81.5 cm to 467 cm. Sawfish were capture close to the mangrove shorelines within the Everglades National Park, except for four adults captured on an offshore bank in Florida Bay and one individual captured in the Caloosahatchee River.

Acoustic telemetry

1. Caloosahatchee River

A 153 cm STL smalltooth sawfish was captured on 17 July 2002, at Palmetto Point on the Caloosahatchee River. It was fitted with an acoustic tag and released. It was not immediately tracked due to the presence of a severe thunderstorm. However, it was relocated two days later, 1.5 km downstream in the St Andrew's Marina, and tracked for 24 hours. This animal was subsequently relocated and tracked on three other occasions between July and September.

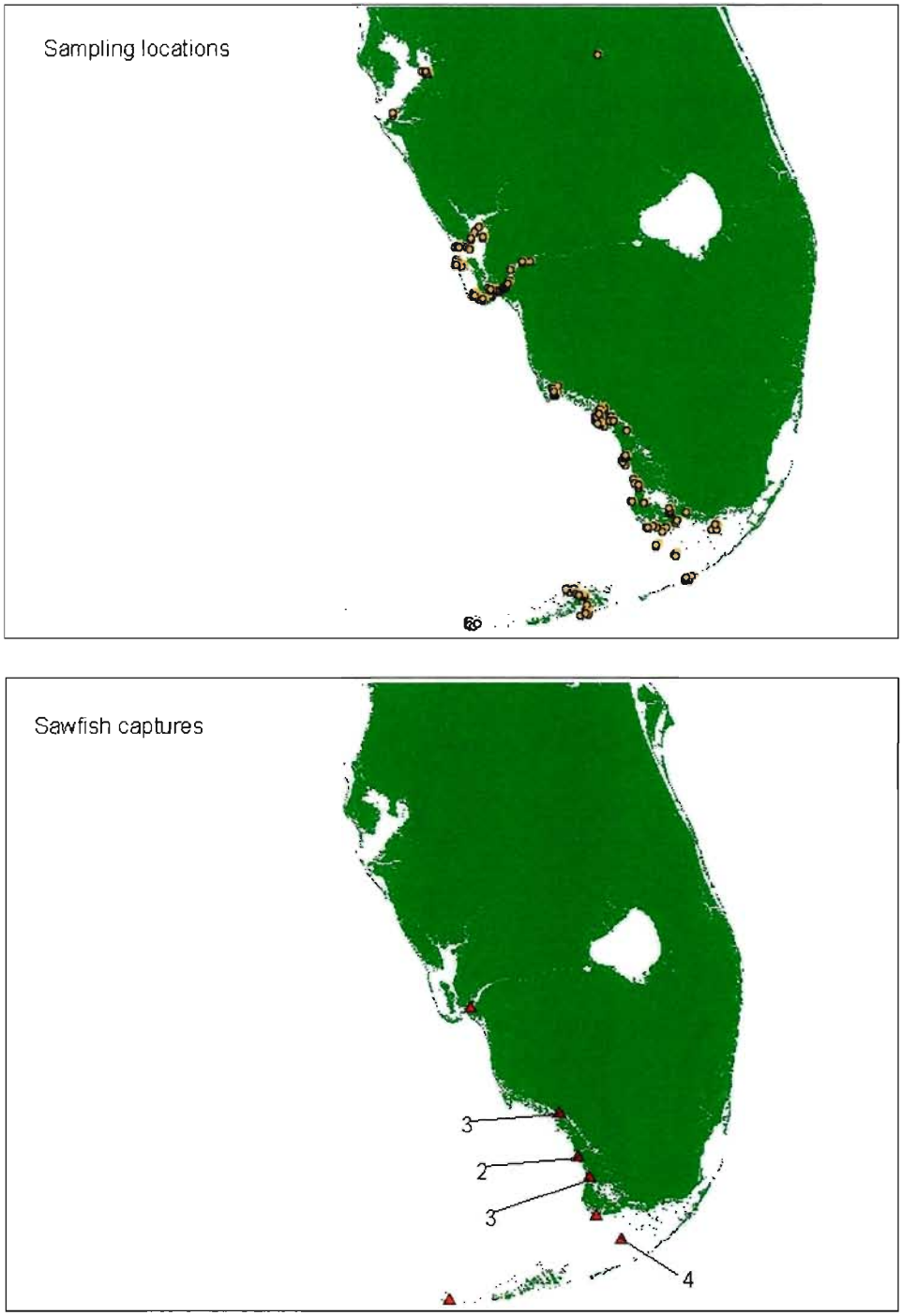

Figure 12. Smalltooth sawfish sampling locations (top) and capture locations (bottom). Numbers on capture panel indicate numbers of sawfish caught at locations where data points are very close together.

This animal was always relocated within the same 1.5 km stretch of the southern shore of the Caloosahatchee River (Fig. 13), indicating that it had a high level of site fidelity over this period. The home range size, based on all positions over the two months it was tracked, was 1.2 km^2. Home range sizes for individual tracking days were much smaller, ranging from 0.036 km^2 to 0.35 km^2. This indicates that its daily activity space is relatively small, but that it moved within a larger, but still restricted, area over the longer period. The majority of the time that the animal was tracked it was located in a strip of shallower water (< 1 m) along the south shore of the river. In this habitat the sawfish spent most of its time lying motionless on the bottom, or swimming slowly for short distances (50 – 100 m). The only tracking event where it was outside of the shallow nearshore habitat for any length of time was on 20 September, when it was tracked swimming in deeper water just north of the shallow habitat. During the time it was moving continually and covered a relatively large area. This change in behavior may have been a result of the sawfish hunting for food, or not wanting to lie on the bottom in an area where larger predators (e.g. bull sharks) may be a threat.

The Caloosahatchee River is a highly modified environment, with development (canals, marinas, docks, dredged channels, etc.) along most of the south bank where this sawfish occurred. During the tracking events, the sawfish spent much of its time closely associated with man-made features, including canal mouths, docks and inside a marina. Thus it appears that although the river habitat has been modified, sawfish are still able to occupy it. However, it is not known if the modifications change the carrying capacity of the river, and so present a limitation to the population.

Figure 13. Track of a 153 cm STL smalltooth sawfish in the Caloosahatchee River. Different colored dots indicate tracks from separate days. Almost all of the time, except for 20 September (olive green dots), was spent in the shallow waters on the south side of the river (the pale blue strip).

2. Shark River

A small smalltooth sawfish was sighted on 11 November 2002, during a longline set on which a larger sawfish was captured (see winter habitat use section). This small animal could not be captured at the time. The same spot was visited two weeks later with a seine net, and the sawfish was still located on the same bank on which it was originally sighted. The sawfish was 81.5 cm STL and was fitted with an acoustic tag and released onto the same shallow bank (Fig. 14). After release the animal was tracked for 3.5 hours (Fig. 15). During this period it remained within 2 m of the waters edge along a shallow mud bank in depths less than 50 cm. The mud bank extended about 150 m along the edge of a mangrove island and the sawfish swam slowly along the bank, or lay motionless on the bottom. The sawfish could be visually observed at times, and this was used to confirm the tracking data. After 3.5 hours of tracking, with the tide rising, this sawfish swam up a narrow mangrove creek (Fig. 15) that drained the mangrove forest on the island.

The following day the animal was reacquired at low tide on the same mud bank and tracked until it again swam up the narrow mangrove creek. This time a canoe was employed to continue tracking the sawfish as it swam up the creek. It was relocated inside the creek and spent most of its time as far up the creek as possible, resting for most of the high tide among mangrove roots. As the tide dropped it swam out of the creek and resumed its use of the margin of the mud bank. This pattern was observed over several more tidal cycles, and occurred both during the day and at night. It is hypothesized that the use of the mangrove creek at high tide reduced the risk of predation from larger sharks that are common in this area.

Figure 14. Habitats used by an 81.5 cm STL smalltooth sawfish at the mouth of the Shark River. The shallow bank adjacent to the mangrove island (left) was used at lower tidal levels, while the mangrove drainage creek (right) was used at higher tidal levels.

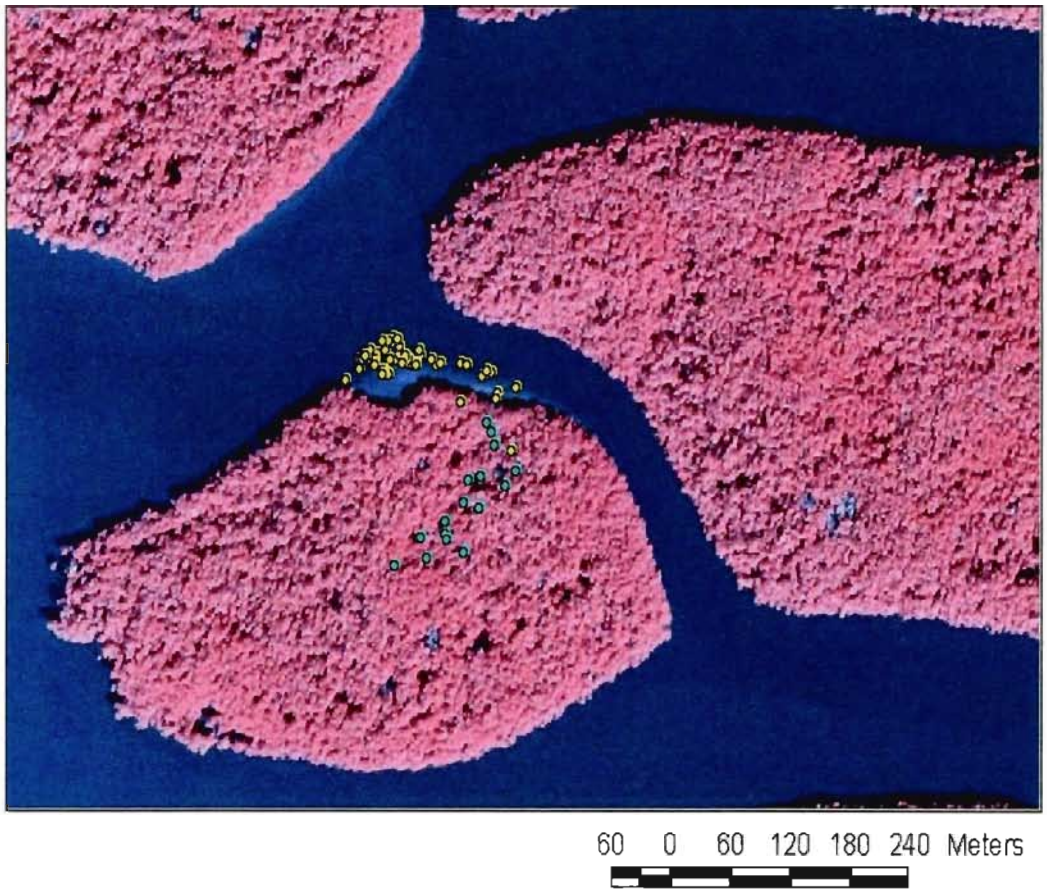

Figure 15. Track of 81.5 cm STL smalltooth sawfish at the mouth of the Shark River. The animal was tracked over several consecutive days and was always found on the shallow bank (yellow dots) or in the same mangrove drainage creek (green dots). The locations within the mangrove forest were based on visual navigation and not GPS fixes as the canopy obscured the signal from the satellites.

Satellite archival tagging

Four large sawfish were fitted with Wildlife Computers PAT tags. Only one of these tags reported successfully. It was fitted to a 450 cm sawfish near East Cape Sable in November 2001. The tag detached as programmed in early January 2002 south of the Marquesas Keys. The hypothesized track of this animal based on geolocation data is shown in Figure 16. Depth data transmitted from the tag also showed that the animal spent the majority of the 52 days the tag was attached in relatively shallow water (<10m), but in late December started to make excursions into deeper water south of the Florida Keys, reaching at least 60m (Fig. 16).

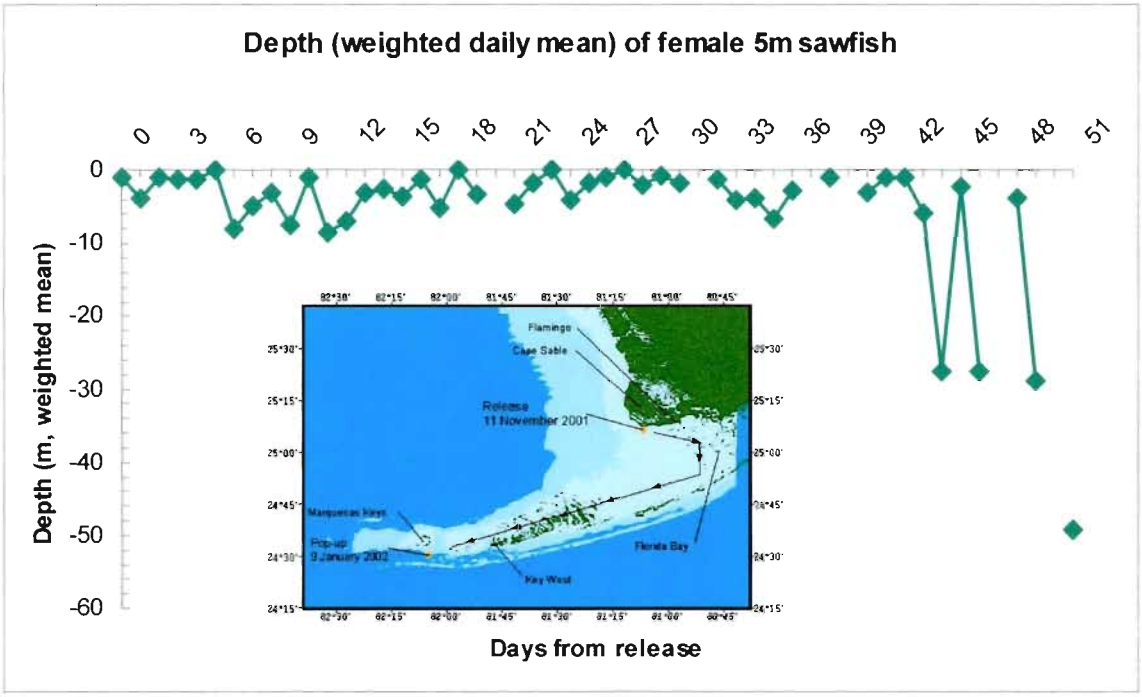

Figure 16. Results of a Wildlife Computers PAT tag attached to a 450 cm sawfish. Hypothesized track (inset) and depth profile.

Sawfish essential habitat

The results of the surveys and acoustic and satellite telemetry have provide important new information on the essential habitat requirements of smalltooth sawfish. This includes information specific to juveniles (especially the very young animals) and adults.

Juveniles: The data presented indicate that the youngest sawfish have a high level of dependence on very shallow mud banks where they occupy areas with water depths less than 30 cm. Utilization of habitats within these areas appear to be driven by tides such that individuals attempt to remain in the shallowest areas possible. We hypothesize that this behavior reduces the predation risk from larger sharks that occupy adjacent deeper habitats. There was also evidence that small sawfish utilize mangrove drainage and root habitats for the same purpose.

Adults: Data from the single PAT tag that returned data indicated that adult sawfish move southwards into the Florida Keys for the winter. While in this area they can utilize a wide variety of water depths, moving between shallow and deep habitats. The factors that drive these changes in depth are not known, but it may be that the movement of cold fronts through the region cools surface waters forcing animals to refuge in deeper water. Further research on the utilization of deep water habitats by sawfish is required further understand this phenomenon.

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