

RECENT OCCURRENCE OF SAWFISHES  
(ELASMOBRANCHIOMORPHI: PRISTIDAE) ALONG  
THE SOUTHWEST COAST OF FLORIDA (USA)

JASON C. SEITZ<sup>(1)</sup> AND GREGG R. POULAKIS<sup>(2)1</sup>

<sup>(1)</sup>Collier County Natural Resources Department, 3301 East Tamiami Trail, Naples, Florida 34112

<sup>(2)</sup>Florida Marine Research Institute, Florida Fish and Wildlife Conservation Commission, Charlotte Harbor Field Laboratory, 1481 Market Circle, Unit 1, Port Charlotte, Florida 33953-3815

**ABSTRACT:** *Sawfish were once common in the southeastern United States, but became rare during the twentieth century before they were studied. They are protected from harvest in Florida, are considered "at risk of extinction" in North America by the American Fisheries Society, and listed as "endangered" by the World Conservation Union. Collections and observations of sawfish in southwest Florida from Charlotte Harbor to northern Florida Bay were documented by soliciting information from anyone who would encounter these fish (e.g., scientists, fishing guides, private citizens). We also circulated a poster (e.g., bait and tackle shops, boat ramps, fishing tournaments) that asked for anyone with any information on these fish since 1990 to contact us (by telephone, mail, or e-mail). Posters were distributed beginning in January 1999 and continue to be maintained from Port Charlotte, Florida (Charlotte County) south to Flamingo, Florida (Monroe County). Each person that had information was asked the same series of questions to determine the date and location of the encounter (collection or observation), estimated total length (ETL), and habitat characteristics. A total of 533 sawfish encounters that occurred between 1990 and 2001 were reported to us. Most sawfish encounters consisted of a single fish caught on hook and line, but groups of 2–20 similar-sized individuals were also reported. Neonates, juveniles, and sexually mature sawfish were found throughout the study area. These data indicate that the overall sawfish population is larger than previously thought; however, the majority of sawfish documented by this study were most likely sexually immature (89% < 3 m ETL). Thus, we support continued protection and conservation efforts and hope these efforts will allow the remaining sawfish populations to grow throughout their range. This study is the first survey on sawfish in Florida.*

**Key Words:** Charlotte Harbor, endangered species, Everglades, Florida Bay, largetooth sawfish, nursery, *Pristis pectinata*, *Pristis perotteti*, *Pristis pristis*, ray, smalltooth sawfish, Ten Thousand Islands

SAWFISH belong to a small group of elasmobranchs that usually occur in shallow coastal habitats in tropical and subtropical waters of the world, including estuaries and freshwater (e.g., Bigelow and Schroeder, 1953; Gunter, 1957; Thorson, 1974, 1982a). As the name implies, these fish possess an elongated, blade-like snout (rostrum) that has lateral, tooth-like denticles (rostral teeth). The rostrum (often referred to as the "saw") is easily noticed and is used during feeding and for defense (Breder, 1952; Bigelow and Schroeder, 1953). Sawfish are among the largest of the batoids and can grow to be 7 m long (Last and Stevens, 1994).

<sup>1</sup> Corresponding author. e-mail: poulakis@comcast.net

Two species of sawfish (*Pristis pectinata* Latham, 1794 and *Pristis perotteti* Müller & Henle, 1841) have been historically recognized in the western Atlantic, although worldwide sawfish systematics are currently unsettled (Compagno and Cook, 1995). As currently understood, both western Atlantic species are found in similar habitats (Bigelow and Schroeder, 1953; McEachran and Fehhelm, 1998), but the largetooth sawfish, *P. perotteti* (recently referred to by some authors as *P. pristis*), breeds in and may prefer freshwater habitats (Thorson, 1976; Compagno and Cook, 1995). The ranges of both species have been reported to include Florida (e.g., Briggs, 1958), but there is no evidence that *P. perotteti* ever regularly occurred in the state. To our knowledge, only three specimens of *P. perotteti* have been documented in Florida: one from near Clearwater (Springer and Woodburn, 1960), one from Salerno (reported by S. Springer in Bigelow and Schroeder, 1953), and one from Key West (reported by S. Springer in Baughman, 1943). Thorson (1976) stated that *P. perotteti* "should probably be considered accidental in Florida" with its range typically south and west of the state (Baughman, 1943; Thorson, 1974). The vast majority of published records of sawfish collected in Florida refer to the smalltooth sawfish, *P. pectinata*, with hundreds having been historically reported from both coasts of the state (e.g., Bigelow and Schroeder, 1953).

Smalltooth sawfish were once common in Florida waters and were regularly reported in faunal surveys (e.g., Jordan and Swain, 1884; Henshall, 1891, 1895; Lönnberg, 1894; Evermann and Bean, 1898), but because of their morphology were particularly susceptible to fishing gears (e.g., gill nets, trawls) as bycatch (e.g., Henshall, 1895). Concurrent with sawfish population declines, these fishing methods were used extensively throughout the state for decades by commercial fishermen. Sportfishing activities also may have contributed to population declines because sawfish rostrums have historically been a popular curio item. These fishing activities, combined with limited reproductive potential (Simpfendorfer, 2000), probably had a significant negative impact on sawfish populations during the twentieth century (Snelson and Williams, 1981). Although no published studies specifically documented population decline in the United States, western Atlantic sawfish have been protected from harvest in Florida since 1992 (Florida Fish and Wildlife Conservation Commission, 1999), are currently considered "at risk of extinction" in North America by the American Fisheries Society (Musick et al., 2000), and are currently listed as "endangered" by the World Conservation Union (IUCN, 1996). The United States National Marine Fisheries Service (NMFS) was recently petitioned to add North American populations of the smalltooth sawfish to the List of Threatened and Endangered Wildlife under the Endangered Species Act of 1973 (United States National Marine Fisheries Service, 2000, 2001). If approved, *P. pectinata* would be the first elasmobranch to be listed as endangered in the United States.

With the exception of the work of Thomas B. Thorson (e.g., Thorson, 1974, 1976, 1982a, b), virtually nothing is known about sawfish biology anywhere in the world. In Florida, sawfish populations have apparently been extirpated from some estuarine systems (Schmid et al., 1988); however, specimens have been occasionally reported from fisheries surveys along the Gulf of Mexico coast (Adams and Wilson, 1995; G. R. Poulakis unpublished data). Because the location and

size of remaining sawfish population(s) are unknown in Florida, the goals of this study were to document the location of recent (1990–2001) collections and observations of sawfish in southwest Florida and to demonstrate that a reproducing population of sawfish still exists in the United States.

**MATERIALS AND METHODS**—Because of their unusual appearance and relatively large size, sawfish are easily recognizable to both scientists and non-scientists and tend to represent a memorable experience for those who encounter them. Collections and observations of sawfish in southwest Florida from Charlotte Harbor to northern Florida Bay were documented by soliciting information from anyone who would possibly encounter these fish. We also circulated posters ( $n = 72$ ) that displayed an image of a sawfish and asked for anyone with any information on these fish since 1990 to contact us (by telephone, mail, or e-mail). Older information and records from outside the study area were noted, but are not included here (records from the Florida Keys and Florida Bay will be reported in another paper). Posters were distributed beginning in January 1999 and continue to be maintained from Port Charlotte, Florida (Charlotte County) south to Flamingo, Florida (Monroe County). The posters were displayed where anglers and boaters would likely encounter them (e.g., bait and tackle shops, boat ramps, fishing tournaments). In addition to poster distribution, we attempted to obtain information about sawfish by contacting other fish biologists, fishing guides, guide associations, rod and gun clubs, scuba divers, mosquito control districts, and newspapers. Each person that had information was asked the same series of questions about their encounter(s). The survey included determination of the date and location of the encounter (collection or observation), estimated total length (ETL), and habitat characteristics (e.g., water depth, bottom-type). In cases where a person reported a length range for a fish, we used the midpoint of the range. Photographic documentation of encounters was obtained when available. All encounters were plotted on charts as exact points or in general areas depending on the detail of the available information. In most cases, the exact location of the encounter(s) could be determined during the interviews.

**RESULTS**—A total of 533 sawfish encounters that occurred in southwest Florida between 1990 and 2001 were reported to us (Figs. 1–3). We conducted a total of 168 interviews that documented 312 sawfish encounters. Of the sawfish encountered by non-scientists ( $n = 303$ ), 63% were captured with hook and line, 36% were observations, and 1% were captured by cast net. The remaining records came from Everglades National Park (ENP) from fisheries interviews completed by employees at the South Florida Natural Resources Center (SFNRC;  $n = 221$ ). Records provided by the SFNRC came from private sport fishermen or guides interviewed as part of a census developed to evaluate park-wide fishing effort and landings (1990–1999). No specific catch location information or length data was recorded for that census. Scientific records came from gill net and 183 m seine sampling in Charlotte Harbor by scientists at the Florida Marine Research Institute ( $n = 6$ ), longline sampling in ENP by scientists at Mote Marine Laboratory ( $n = 1$ ), gill net sampling in Rookery Bay National Estuarine Research Reserve by scientists at the Florida Department of Environmental Protection ( $n = 1$ ), and gill net sampling in Rookery Bay by visiting scientists ( $n = 1$ ).

Of the encounters where species was determined ( $n = 25$ ), all were *P. pectinata*. One specimen had rostral tooth counts between those typically used to separate *P. pectinata* and *P. perotteti* (21L, 22R). Unfortunately, the photographs of this specimen did not allow determination of fin placement or the presence of a lower caudal fin lobe.

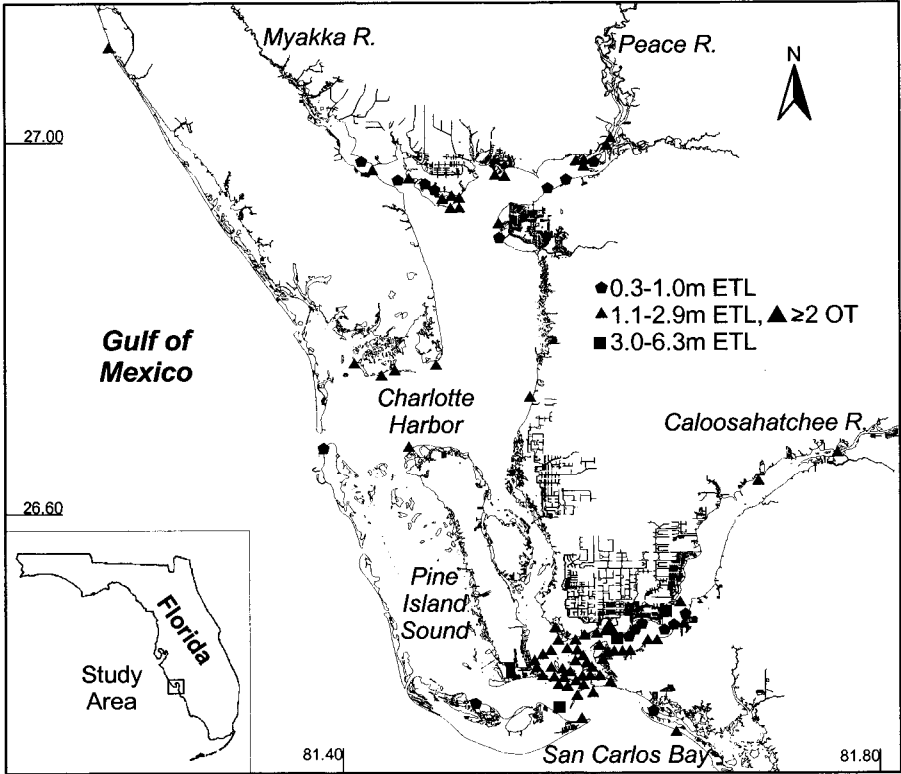


FIG. 1. Map of the greater Charlotte Harbor section of the southwest Florida study area where at least 100 sawfish were encountered between 1990 and 2001. Each small symbol indicates an encounter (catch or observation) with a single sawfish and each large symbol indicates  $\geq 2$  sawfish observed together (OT) in an estimated total length (ETL) size class. Eleven sawfish were reported from this section of the coast without specific location information.

Although size at maturity information is currently unavailable for *P. pectinata*, if we speculate that *P. pectinata* matures at approximately the same size as *P. perotteti* (ca. 3 m total length (TL) for both sexes; Thorson, 1976) or larger, the majority of the sawfish documented by this study probably had not reached sexual maturity when they were encountered (89% < 3 m ETL; Fig. 4). A total of 57 sawfish were very small, potentially young-of-the-year (0.3–1.0 m ETL) and a total of 35 were probably mature or nearly so ( $\geq 3.0$  m ETL).

Most sawfish encounters were reported as single fish being caught on hook and line, but there were several reports of multiple sawfish observed together. Small groups of 2–4 similar-sized individuals (0.9–2.7 m ETL) as well as larger groups of up to 20 similar-sized individuals (0.7 m ETL) were reported.

Water depths and bottom types were reported in many of the interviews we conducted. Of the interviews where water depth was estimated ( $n = 252$ ), fish from the smallest size class (0.3–1.0 m ETL) were found at an average depth of 1.1 m

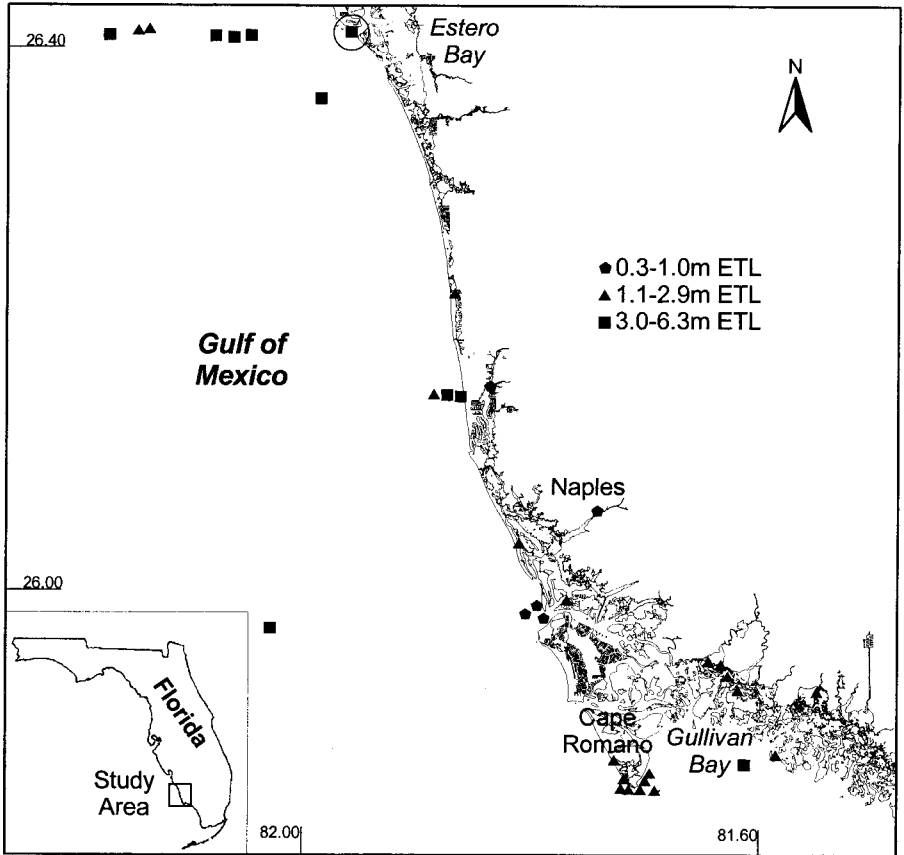


FIG. 2. Map of the Estero Bay to Cape Romano Island section of the southwest Florida study area where at least 35 sawfish were encountered between 1990 and 2001. Each symbol indicates an encounter (catch or observation) with a single sawfish in an estimated total length (ETL) size class. The circle indicates Big Carlos Pass where a 3.5 m ETL sawfish was caught six times (identified by its unique broken rostrum) from 18 August 1999 to 15 September 1999.

(range = 0.2–4.5 m), fish from the most commonly encountered size class (1.1–2.9 m ETL) were found at an average depth of 1.2 m (range = 0.2–8.5 m), and fish from the largest size class (3.0–6.3 m ETL) were found at an average depth of 3.5 m (range = 0.6–10.6 m). Of the interviews where bottom-type was noted ( $n = 255$ ), mud (60%), sand (30%), seagrass (6%), oysters (2%), and hard-bottom (2%) were reported. One encounter was reported near a freshwater upwelling.

*Greater Charlotte Harbor*—The greater Charlotte Harbor section of the coast spanned from ca. 27° 00' N to 26° 50' N and included Charlotte Harbor proper, Gasparilla Sound, Bull Bay, Turtle Bay, Matlacha Pass, Pine Island Sound, San Carlos Bay, and the Myakka, Peace, and Caloosahatchee Rivers (Fig. 1). A total of 100 sawfish encounters were reported to us from the greater Char-

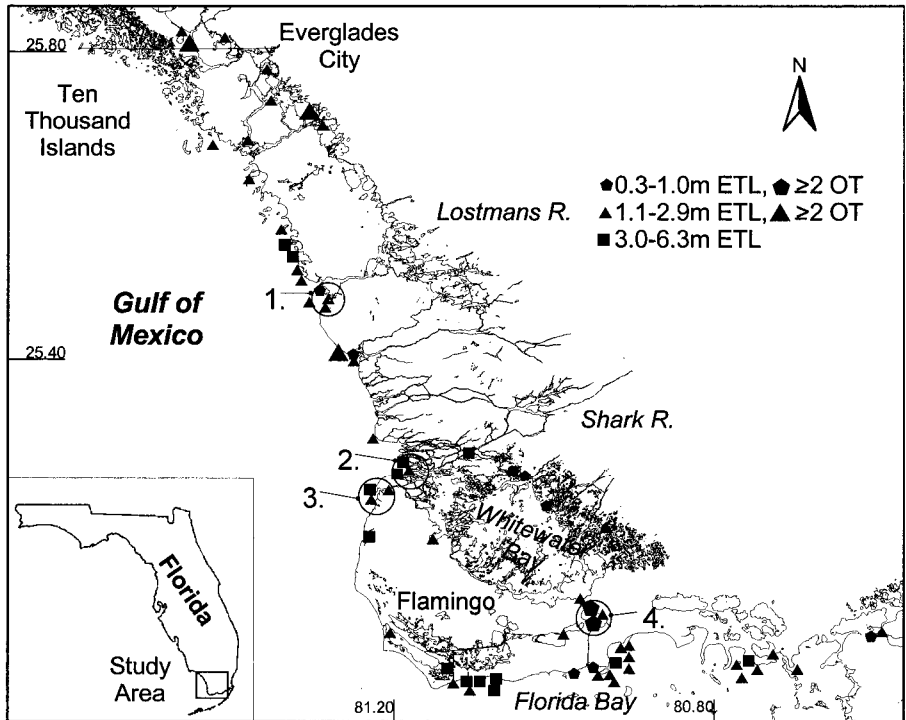


FIG. 3. Map of the greater Ten Thousand Islands section of the southwest Florida study area where at least 398 sawfish were encountered between 1990 and 2001. A total of 177 sawfish were reported from our interviews (1 without a specific location) and those data are represented here. Each small symbol indicates an encounter (catch or observation) with a single sawfish and each large symbol indicates  $\geq 2$  sawfish observed together (OT) in an estimated total length (ETL) size class. Note that the Everglades National Park boundary extends beyond this figure. 1 = The mouth of the Lostmans River where 63 sawfish have been caught from 1997 to 2001. 2 = The mouth of the Shark River where 16 sawfish have been caught from 1997 to 2001. 3 = The mouth of the Little Shark River where seven sawfish have been caught from 1997 to 2001. 4 = Coot Bay where ca. 23 sawfish have been encountered, including ca. 20 observed on one occasion.

lotte Harbor section of southwest Florida. The majority of the encounters reported in this section of the coast occurred near the mouth of the Caloosahatchee River (47%). The average size of sawfish encountered in the greater Charlotte Harbor section of the coast was 1.6 m ETL (range = 0.4–4.2 m ETL).

*Estero Bay to Cape Romano Island*—The Estero Bay to Cape Romano Island section of the coast spanned from ca. 26° 40' N to 25° 90' N (Fig. 2). A total of 35 sawfish encounters were reported to us from the Estero Bay to Cape Romano Island section of southwest Florida. The smallest number of sawfish encounters occurred in this section of the coast (7% of total), but the largest individual of the study was encountered in the Gulf of Mexico off Naples in June 1998 (6.3 m ETL). One 3.5 m ETL sawfish was captured at least six times near Big Carlos Pass

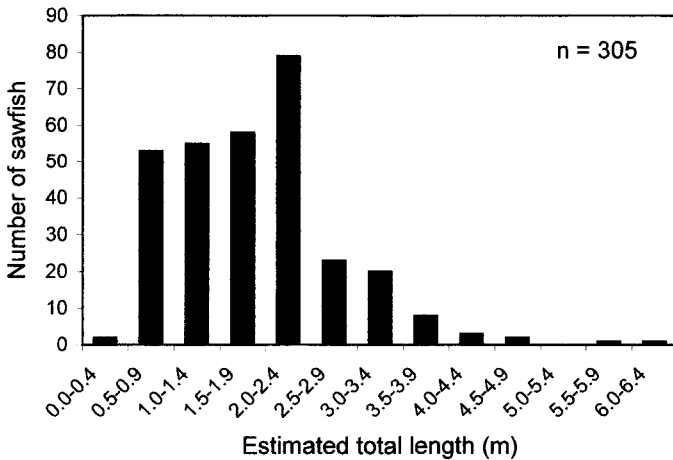


FIG. 4. Length frequency histogram of the estimated total lengths (ETL) of all sawfish reported with length data during the study ( $n = 305$ ). The 3.5 m ETL sawfish that was captured six times was included once. Seven sawfish were reported without length estimates.

from 18 August 1999 to 15 September 1999 and was identified by its unique broken rostrum. The average size of sawfish encountered in the Estero Bay to Cape Romano Island section of the coast was 2.4 m ETL (range = 0.8–6.3 m ETL).

*Greater Ten Thousand Islands*—The greater Ten Thousand Islands section of the coast spanned from ca. 25° 80' N to northern Florida Bay (ca. 25° 10' N) and included Whitewater Bay and ENP (Fig. 3). A total of 398 sawfish encounters were reported to us from the greater Ten Thousand Islands section of southwest Florida. Of the encounters reported in this section of the coast from our interviews ( $n = 177$ ), 58% occurred between the Huston River and the Little Shark River. Between 1997 and 2001, 63 sawfish have been captured at the mouth of the Lostmans River. The smallest sawfish encountered during the study (0.3 m ETL) was observed in Little Madeira Bay (northern Florida Bay) in April 2000. The average size of sawfish from our interviews in the greater Ten Thousand Islands section of the coast was 1.8 m ETL (range = 0.3–3.9 m ETL).

DISCUSSION—Literature from coastal fishery surveys, records from state fisheries management agencies, and records from institutions with marine holdings were examined by Adams and Wilson (1995) to determine the status of *P. pectinata* in the United States. They reported only 15 records from New York to Texas from 1953 to 1994 using this method. Not surprisingly, they suggested that “the species can no longer be considered a functional member of the nearshore coastal community of the northwest Atlantic.” The interview method used here provided substantially more information (and covered only a small part of the known range of sawfish in the United States) and minimally suggests that sawfish (probably *P. pectinata*) can be considered functional members of the nearshore

fish community in southwest Florida. Furthermore, this paper demonstrates that a reproducing sawfish population exists in the United States because neonates, juvenile, and sexually mature individuals have been recently encountered.

The interview method used here to document the occurrence of sawfish in southwest Florida produced valuable data, but had some obvious limitations. Not unexpectedly, very little detailed information such as confirmation of species or sex could be obtained as most of the records came from non-scientists. It was also impossible to determine recaptures unless a given fish was uniquely damaged (e.g., broken rostrum). However, documentation of the encounters, along with the location and size estimate data was useful for confirming the presence of these fish in the study area and establishing a baseline for future comparisons.

Although size at maturity information is currently unavailable for *P. pectinata*, Thorson (1976) found that male and female *P. perotteti* reached sexual maturity at ca. 3 m TL. If we speculate that *P. pectinata* has a similar or larger size at maturity, the vast majority of the sawfish encountered throughout the study area were immature. In addition, 57 of these immature fish (0.3–1.0 m ETL) were potentially young-of-the-year encountered near rivermouths (Myakka, Peace, Caloosahatchee) or well inside protected bays (e.g., Whitewater Bay). These observations suggest that coastal and protected estuarine habitats function as nursery areas for sawfish in southwest Florida. The presence of neonates also suggests that parturition occurred nearby. Thorson (1982a) reported that four immature sawfish (undetermined species) were taken in open waters of the Atlantic Ocean at depths as deep as 175 m, so some juveniles may also reside offshore as they grow to maturity.

Many larger shark species seasonally use estuarine or coastal habitats as nursery grounds to reduce neonate natural mortality and increase food availability for their young (Branstetter, 1990; Castro, 1993). Our data suggest that sawfish employ the same strategy in southwest Florida. Thirty-five potentially sexually mature sawfish were reported from the study area and most of these larger fish were caught in or closely associated with the deeper, open waters of the Gulf of Mexico. Because the largest individuals were rarely encountered by anglers that fished primarily inshore, mature sawfish may be very rare or present inshore only occasionally (perhaps to mate or pup). Future confirmation of the location of gravid females as well as more free swimming neonates will help improve our understanding of sawfish life-history in Florida.

Site fidelity has been documented for *P. perotteti* in Lake Nicaragua by tag-recapture data and site fidelity and use of a home range that expands with ontogeny has been documented for the lemon shark, *Negaprion brevirostris*, using telemetry (Thorson, 1982a; Gruber et al., 1988; Morrissey and Gruber, 1993). About 37% of the *P. perotteti* tagged by Thorson (1982a) were recaptured at the site where initial tagging took place, and large adult females moved the greatest distances away from the tagging site. In the present study, one 3.5 m ETL sawfish (identified by its broken rostrum) exhibited some site fidelity as it was captured near Big Carlos Pass (Estero Bay) on at least six occasions. Future tag-recapture, telemetry, or satellite tracking studies are needed to provide more information about the short- and long-term movements of sawfish in Florida.



Although most of the sawfish encounters documented by this study were reports of single fish being caught on hook and line, there were several reports of multiple sawfish observed together. Documentation of these social groups is further evidence that sawfish populations are larger than previously thought. Recent state protection and suitable remote habitats (e.g., Ten Thousand Islands, Everglades National Park) have probably contributed to the survival of *P. pectinata* in southwest Florida.

Like many elasmobranchs, sawfish have been vulnerable to overexploitation because they are long-lived and slow to reach sexual maturity (Thorson, 1982b; Hoenig and Gruber, 1990). Even when mature, female sawfish may only reproduce every other year and give birth to a small number of young. As a result, demographic analyses have indicated that significant population growth may take several decades (Simpfendorfer, 2000). Thus, both western Atlantic sawfish species are currently protected from harvest in Florida and concern about their future by the American Fisheries Society and the World Conservation Union is justified (IUCN, 1996; Musick et al., 2000). We recommend and support continued sawfish protection and conservation efforts and hope these efforts will allow the remaining sawfish populations to grow throughout their range. Preliminary data indicate that sawfish are using the habitats of the Florida Keys and nearby Florida Bay. The authors are presently assessing the extent of sawfish encounters in these areas using the methods described in this paper.

ACKNOWLEDGMENTS—Special thanks to all of the individuals that voluntarily responded to our request for information on sawfish, especially Frank Hommema (a.k.a. Fishin' Frank), Robert Lugiewicz, Capt. Dave Prickett, Capt. Bob LeMay, John Zukaitin, Aaron Sander, Capt. Chris Leetz, Capt. Steve Jones, Jerry Geyer, and William Kerrigan who responded multiple times. Thanks to all of the businesses that allowed us to keep our poster up at their establishments. José Castro, Tom Schmidt, Pat O'Donnell, Marcel Michel, Pascale Steiner, and Colin Simpfendorfer shared their data with us. Mac Hatcher provided invaluable assistance in the production of the maps. Jody Poulakis and Rebecca Hensley provided support during the project. José Castro critically reviewed the manuscript. Opinions, findings, conclusions, or recommendations expressed in this report are those of the authors and do not reflect the views of the State of Florida unless so designated by other authorized documents.

#### LITERATURE CITED

- ADAMS, W. F. AND C. WILSON. 1995. The status of the smalltooth sawfish, *Pristis pectinata* Latham 1794 (Pristiformes: Pristidae) in the United States. *Chondros* 6:1-5.
- BAUGHMAN, J. L. 1943. Notes on sawfish, *Pristis perotteti* Müller and Henle, not previously reported from the waters of the United States. *Copeia* 1943:43-48.
- BIGELOW, H. B. AND W. C. SCHROEDER. 1953. Sawfishes, guitarfishes, skates and rays. *Fishes of the Western North Atlantic*. Mem. Sears Found. Mar. Res. 1:1-514.
- BRANSTETTER, S. 1990. Early life-history implications of selected carcharhinoid and lamnoid sharks of the northwest Atlantic. Pp. 17-28. In: PRATT, H. L., JR., S. H. GRUBER, AND T. TANIUCHI (eds.), *Elasmobranchs as Living Resources: Advances in the Biology, Ecology, Systematics and the Status of the Fisheries*, NOAA Technical Report NMFS 90.
- BREDER, C. M., JR. 1952. On the utility of the saw of the sawfish. *Copeia* 1952:90-92.
- BIGGS, J. C. 1958. A list of Florida fishes and their distribution. *Bull. Fl. St. Mus. Biol. Sci.* 2: 223-318.

- CASTRO, J. I. 1993. The shark nursery of Bulls Bay, South Carolina, with a review of the shark nurseries of the southeastern coast of the United States. *Env. Biol. Fish.* 38:37–48.
- COMPAGNO, L. J. V. AND S. F. COOK. 1995. The exploitation and conservation of freshwater elasmobranchs: status of taxa and prospects for the future. *J. Aquacult. Aquat. Sci.* 7:62–90.
- EVERMANN, B. W. AND B. A. BEAN. 1898. Indian River and its fishes. *U. S. Comm. Fish Fish.* 22: 227–248.
- FLORIDA FISH AND WILDLIFE CONSERVATION COMMISSION. 1999. Protected species: sawfishes, basking shark, whale shark, white shark, sand tiger shark, bigeye sand tiger shark, manta ray, and spotted eagle ray; prohibition of harvest, landing, and sale. Chapter 68B-44.008 (formerly 46-44.008) Florida Administrative Code Rule 11:1222.
- GRUBER, S. H., D. R. NELSON, AND J. F. MORRISSEY. 1988. Patterns of activity and space utilization of lemon sharks, *Negaprion brevirostris*, in a shallow Bahamian lagoon. *Bull. Mar. Sci.* 43: 61–76.
- GUNTER, G. 1957. Predominance of the young among marine fishes found in fresh water. *Copeia* 1957:13–16.
- HENSHALL, J. A. 1891. Report upon a collection of fishes made in southern Florida during 1889. *Bull. U. S. Fish Comm.* 9:371–389.
- . 1895. Notes on fishes collected in Florida in 1892. *Bull. U. S. Fish Comm.* 14:209–221.
- HOENIG, J. M. AND S. H. GRUBER. 1990. Life-history patterns in the elasmobranchs: implications for fisheries management. Pp. 1–16. *In: PRATT, H. L., JR., S. H. GRUBER, AND T. TANIUCHI (eds.), Elasmobranchs as Living Resources: Advances in the Biology, Ecology, Systematics and the Status of the Fisheries*, NOAA Technical Report NMFS 90.
- IUCN. 1996. 1996 IUCN Red List of Threatened Animals. IUCN, Gland, Switzerland and Cambridge, UK. 448 pp.
- JORDAN, D. S. AND J. SWAIN. 1884. Notes on fishes collected by David S. Jordan at Cedar Keys, Florida. *Proc. U. S. Nat. Mus.* 7:230–234.
- LAST, P. R. AND J. D. STEVENS. 1994. Sharks and Rays of Australia. CSIRO Australia. 513 pp.
- LÖNNBERG, E. 1894. List of fishes observed and collected in south-Florida. *Öfversigt af Kongl. Vetenskaps-Akademiens Förhandlingar* 3:109–131.
- MCEACHRAN, J. D. AND J. D. FECHHELM. 1998. Fishes of the Gulf of Mexico. Volume 1: Myxiniiformes to Gasterosteiformes. University of Texas Press, Austin, TX. 1112 pp.
- MORRISSEY, J. F. AND S. H. GRUBER. 1993. Home range of juvenile lemon sharks, *Negaprion brevirostris*. *Copeia* 1993:425–434.
- MUSICK, J. A., M. M. HARBIN, S. A. BERKELEY, G. H. BURGESS, A. M. EKLUND, L. FINDLEY, R. G. GILMORE, J. T. GOLDEN, D. S. HA, G. R. HUNTSMAN, J. C. MCGOVERN, S. J. PARKER, S. G. POSS, E. SALA, T. W. SCHMIDT, G. R. SEDBERRY, H. WEEKS, AND S. G. WRIGHT. 2000. Marine, estuarine, and diadromous fish stocks at risk of extinction in North America (exclusive of Pacific salmonids). *Fisheries* 25:6–30.
- SCHMID, T. H., L. M. EHRHART, AND F. F. SNELSON, JR. 1988. Notes on the occurrence of rays (Elasmobranchii, Batoidea) in the Indian River Lagoon system, Florida. *Florida Scient.* 51:121–128.
- SIMPFENDORFER, C. A. 2000. Predicting population recovery rates for endangered western Atlantic sawfishes using demographic analysis. *Env. Biol. Fish.* 58:371–377.
- SNELSON, F. F., JR. AND S. E. WILLIAMS. 1981. Notes on the occurrence, distribution, and biology of elasmobranch fishes in the Indian River Lagoon system, Florida. *Estuaries* 4:110–120.
- SPRINGER, V. D. AND K. D. WOODBURN. 1960. An ecological study of the fishes of the Tampa Bay area. *Fl. St. Board Conserv. Mar. Lab. Prof. Pap. Ser. No. 1*, St. Petersburg, FL. 104 pp.
- THORSON, T. B. 1974. Occurrence of the sawfish, *Pristis perotteti*, in the Amazon River, with notes on *P. pectinatus*. *Copeia* 1974:560–564.
- . 1976. Observations on the reproduction of the sawfish, *Pristis perotteti*, in Lake Nicaragua, with recommendations for its conservation. Pp. 641–650. *In: THORSON, T. B. (ed.), Investigations of the Ichthyofauna of Nicaraguan Lakes*, School of Life Sciences, University of Nebraska-Lincoln, Lincoln, Nebraska.

- . 1982a. Life history implications of a tagging study of the largemouth sawfish, *Pristis perotteti*, in the Lake Nicaragua-Río San Juan system. *Env. Biol. Fish.* 7:207–228.
- . 1982b. The impact of commercial exploitation on sawfish and shark populations in Lake Nicaragua. *Fisheries* 7:2–10.
- UNITED STATES NATIONAL MARINE FISHERIES SERVICE. 2000. Endangered and threatened wildlife and plants; 90-day findings for a petition to list North American populations of smalltooth sawfish and largemouth sawfish as endangered under the Endangered Species Act. *Federal Register* 65:12959–12962.
- . 2001. Endangered and threatened species; proposed endangered status for a distinct population segment of smalltooth sawfish (*Pristis pectinata*) in the United States. *Federal Register* 66:19414–19420.

Florida Scient. 65(4): 256–266. 2002

Accepted: April 2, 2002