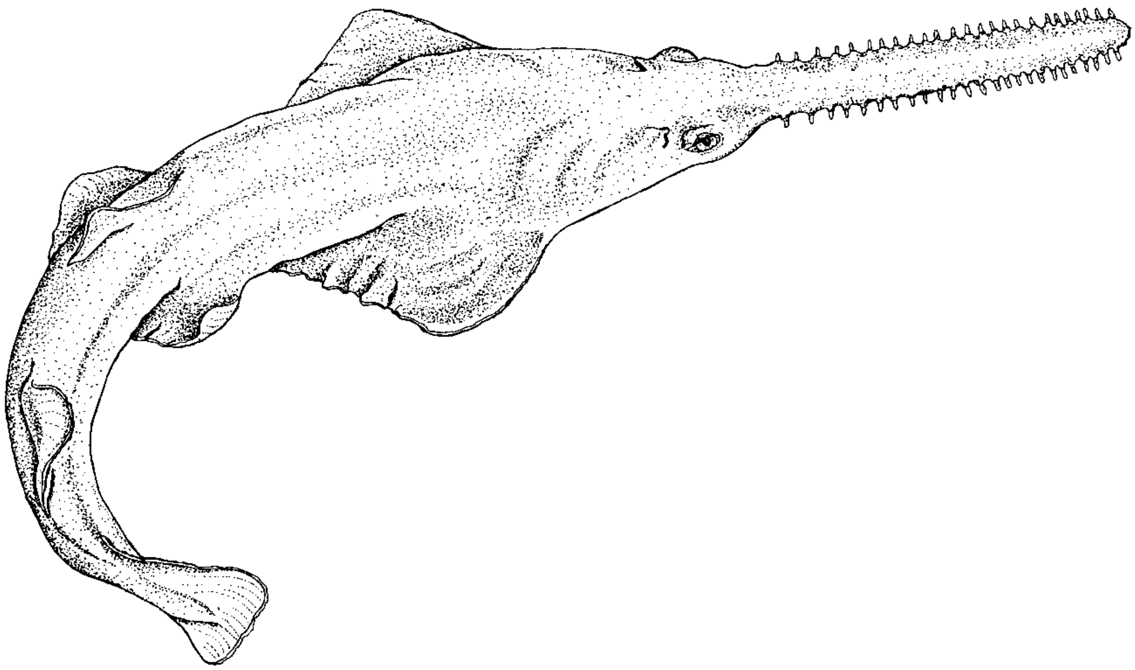
Smalltooth Sawfish
(*Pristis pectinata* Latham)

5-Year Review:
Summary and Evaluation



National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Protected Resources Division
St. Petersburg, Florida

October 2010

5-Year Review
Species reviewed: U.S. Distinct Population Segment (DPS) of Smalltooth Sawfish (*Pristis pectinata* Latham)

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5-Year Review
Smalltooth Sawfish (*Pristis pectinata* Latham)

1. GENERAL INFORMATION

1.1
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1.2 Methodology Used to Complete the Review

The National Marine Fisheries Service (NMFS) of the National Oceanic and Atmospheric Administration (NOAA) initiated a 5-year review of smalltooth sawfish (*Pristis pectinata* Latham) in May 2008. NMFS solicited information from the public through a Federal Register (FR) notice (73 FR 29482, May 21, 2008), as well as through personal and written communications with several educational institutions, Federal, and State governments, and private research organizations. Three public comments were received (Mark Lewis/Biscayne National Park, Joseph Choromanski/Ripleys Aquariums, and Jan Hoover/U.S. Army Engineer Research and Development Center). To complete the review we collected, evaluated, and incorporated all information that has become available on the species since April 2003, the date of the listing, including the species recovery plan which was finalized in January 2009. Thus, the review is based upon the best scientific and commercial data available.

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1.3 Background

1.3.1 FR notice citation announcing initiation of this review

The notice announcing the initiation of this 5-year review and requesting information from the public was published May 21, 2008 (73 FR 29482).

1.3.2 Listing history

On November 30, 1999, NMFS received a petition from The Ocean Conservancy (formerly the Center for Marine Conservation) requesting that NMFS list the North American populations of smalltooth sawfish and largetooth sawfish as endangered under the Endangered Species Act of 1973 (ESA). On March 10, 2000, NMFS published its determination that the petition presented substantial information indicating that listing may be warranted for smalltooth sawfish and initiated a review of the status of this species (65 FR 12959). NMFS also determined that the petition did not present substantial information supporting the listing of largetooth sawfish. The largetooth sawfish is currently included on NMFS' "Species of Concern" list, which highlights its rare status and promotes collection of additional information.

NMFS completed the smalltooth sawfish status review in December 2000 (NMFS 2000). The status review determined that smalltooth sawfish in U.S. waters comprise a distinct population segment (DPS), and that the DPS is in danger of extinction throughout its range. On April 1, 2003, NMFS published a final rule listing this DPS as an endangered species under the ESA.

FR notice: 68 FR 15674
Date listed: April 1, 2003
Entity listed: *Pristis pectinata* Latham
Classification: Endangered

Critical habitat designation
FR notice: 74 CFR 45353
Date designated: September 2, 2009

1.3.3 Associated rulemakings

None

1.3.4 Review history

There are no prior reviews for this species.

1.3.5 Species Recovery Priority Number at start of 5-year review

The smalltooth sawfish has a recovery priority number of seven. The recovery priority number is based on the criteria in the Recovery Priority Guidelines (NMFS 2006). This recovery priority is based on the magnitude of threats being "moderate," recovery potential being "low-moderate," and the potential for economic conflicts while implementing recovery actions.

1.3.6 Recovery plan or outline

National Marine Fisheries Service. 2009. Recovery Plan for Smalltooth Sawfish (*Pristis pectinata*). Prepared by the Smalltooth Sawfish Recovery Team for the National Marine Fisheries Service, Silver Spring, MD.

2. REVIEW ANALYSIS

2.1 Application of the 1996 Distinct Population Segment policy

The ESA defines species as including any subspecies of fish or wildlife or plants, and any DPS of any species of vertebrate wildlife. The status review determined that smalltooth sawfish in U.S. waters comprise a DPS, and that the DPS is in danger of extinction throughout its range.

2.1.1 Is the species under review a vertebrate?

__X__ **Yes**
_____ **No**

2.1.2 Is the species under review listed as a DPS?

__X__ **Yes**
_____ **No**

2.1.3 Was the DPS listed prior to 1996?

_____ **Yes**
__X__ **No**

2.1.4 Is there relevant new information for this species regarding the application of the DPS policy?

_____ **Yes**
__X__ **No**

2.2 Recovery criteria

2.2.1 Does the species have a final, approved recovery plan containing objective, measureable criteria?

__X__ **Yes**
_____ **No**

The final recovery plan was published in January of 2009.

2.2.2 Adequacy of recovery criteria

2.2.2.1 Do the recovery criteria reflect the best available and most up-to-date information on the biology of the species and its habitat?

__X__ **Yes**
_____ **No**

The recovery plan incorporates all of the information known about the species up to the date of publication.

2.2.2.2 Are all of the five listing factors that are relevant to the species addressed in the recovery criteria (and no new information is available to consider regarding existing or new threats)?

__X__ **Yes**
_____ **No**

The final listing rule found the species' endangered status resulted from four of the ESA's five causal listing factors (disease or predation was not found to be a factor causing the species' endangered status). Smalltooth sawfish were listed as endangered based on a combination of the following factors, described in section 4(a)(1) of the ESA:

- The present or threatened destruction, modification, or curtailment of habitat or range
- Overutilization for commercial, recreational, scientific, or educational purposes
- Inadequacy of existing regulatory mechanisms
- Other natural or manmade factors affecting its continued existence

New information on threats to juvenile smalltooth sawfish less than 79 inches (in) (or 200 centimeters [cm]) total length (TL) have been identified since the listing of the species in 2003. Current information on juvenile smalltooth sawfish indicates that animals of this size class are vulnerable to predation by lemon (*Negaprion brevirostris*) and bull (*Carcharhinus leucas*) sharks. The latest information on this size class of smalltooth sawfish indicates these animals use red mangroves and shallow euryhaline habitats characterized by water depths less than 3 feet (ft) in nursery areas in southwest Florida. The final recovery plan and the critical habitat rule address the need to protect known nursery habitats for juveniles to promote the conservation and recovery of the species.

2.2.3 List the recovery criteria as they appear in the recovery plan, and discuss how each criterion has or has not been met, citing supporting information.

Objective 1 *– to minimize human interactions, and associated injury and mortality*.

Downlisting Criteria
A. Effective ongoing programs are in place to educate the public about population status and the prohibitions against capturing, harming, or harassing smalltooth sawfish.

Criterion has been partially met through the development and distribution of the *Sawfish Safe Handling and Release Guidelines.* The criterion has not been fully met because large portions of the public are not informed about the species.

B. Safe handling and release guidelines have been developed, adopted, distributed, and are being effectively implemented in all state and Federal fisheries (commercial and recreational) that may interact with smalltooth sawfish within all recovery regions.

Criterion has been partially met through the development and distribution of the *Sawfish Safe Handling and Release Guidelines* that were developed and distributed to commercial fishers and are available in the species' recovery plan for recreational fishers. A sawfish handling and release video and wheelhouse placards were also developed and distributed to Highly Migratory Species (HMS) permit holders and to Aquatic Release Conservation (ARC) for dissemination at training seminars. The Florida Museum of Natural History also maintains a dedicated Web site for smalltooth sawfish that contains information on the species and houses "The National Sawfish Encounter Database" (formerly maintained by Mote Marine Laboratory). The criteria has not been fully met because large portions of the public are not informed about the species and how, if they are caught during fishing, to release them unharmed after they are captured during fishing. Additionally, information on post-release mortality in various fisheries is still unknown. Action items related to this criterion focus on education and outreach efforts.

C. State and/or Federal fishing regulations specific to smalltooth sawfish are in place to ensure that injury and mortality from commercial and recreational fishing is maintained below or at levels that ensure the population increases at the rate, or stabilizes at the levels, described in the criteria identified in Objective 3.

Criterion has not been met.

Delisting Criteria
A. All downlisting criteria continue to be met.

B. State and/or Federal measures (not including those provided under the ESA) are in place to either prohibit harm or possession of smalltooth sawfish, or ensure that impacts are appropriately assessed, authorized, and minimize.

C. State and/or Federal measures (not including those provided under the ESA) are in place to maintain the population at levels at or above those required for delisting.

Delisting criteria will be addressed once downlisting criteria are met.

***Objective 2** – to protect and/or restore smalltooth sawfish habitats*.

Downlisting Criteria
A. At least 95% of mangrove shoreline habitat existing at time of listing is maintained and effectively protected in recovery regions G, H, and I (See figure 9 in the recovery plan for map of Recovery Regions.)

Criterion A has been partially met through the designation of critical habitat in 2009 (74 FR 45353). Critical habitat will protect designated juvenile nursery area habitats.

B. Sufficient mangrove shoreline or alternate scientifically documented non-mangrove nursery habitat are available and accessible to support viable subpopulations of juvenile smalltooth sawfish in recovery regions J and K, and one additional recovery region (apart from G, H, I, J, and K). This level should be a minimum of 25% of the mangrove shoreline habitat that existed in 1940, in each of the above recovery regions. The level of non-mangrove nursery habitat must be determined once specific nursery habitat features are identified.

This criterion has not been met. Ongoing and future studies should provide valuable information that can be used to determine if sufficient nursery habitats are available and accessible for juveniles.

C. Freshwater flow regimes (including timing, distribution, quality, and quantity) into recovery regions G, H, I, J, K, and the one additional regions used to meet the two previous criteria are appropriate to ensure natural behavior (e.g., feeding, resting, and predator avoidance) by maintaining salinities within preferred physiological limits of juvenile smalltooth sawfish.

This criterion has not been met. Ongoing and future studies should provide valuable information that can be used to identify the salinity tolerance and/or preference levels required for the species conservation and recovery.

D. Habitat areas of adult smalltooth sawfish abundance, including those used for aggregation, mating and pupping are identified, mapped, and effectively protected as appropriate.

This criterion has not been met. Ongoing and future studies should provide valuable information that can be used to identify the habitat requirements (e.g. breeding, pupping and salinity preferences) for the species.

Delisting Criteria
A. All habitat-based downlisting criteria continue to be met.

B. Sufficient mangrove shoreline or alternate scientifically documented non-mangrove nursery habitat are available and accessible to support viable subpopulations of juvenile smalltooth sawfish in recovery regions J and K, and one additional recovery region (apart from G, H, I, J, and K). This level should be a minimum of 25% of the mangrove shoreline that existed in 1940, in each of the above recovery regions. The level of non-mangrove nursery habitat must be determined once specific nursery habitat features are identified.

C. Freshwater flow regimes (including timing, distribution, quality and quantity) into recovery regions G, H, I, J, K and the four additional used to meet the previous delisting criteria appropriate to ensure natural behavior (e.g. feeding, breeding, and pupping) by maintaining salinities within preferred physiological limits of juvenile smalltooth sawfish.

Delisting criteria will be addressed once downlisting criteria are met.

***Objective 3** – to ensure smalltooth sawfish abundance increases substantially and the species reoccupies areas from which it had been previously extirpated.*

Downlisting Criteria
A. In recovery regions G, H, I, J, and K and at least one other recovery region the relative abundance of small juvenile smalltooth sawfish (<200 cm) either has increased at an average annual rate of at least 5% over a 27-year period with greater than 95% certainty or is at greater than 80% of carrying capacity .

B. Relative abundance of adult smalltooth sawfish in combined recovery regions J through L (east coast of Florida) has increased to a level at least 15-times higher than the level at the time of listing with greater than 95% certainty that abundance at this level has been sustained for a period of at least 14 years.

C. Relative abundance of adult smalltooth sawfish in combined recovery regions F through H (west coast of Florida) has increased to a level at least 15-times higher than the baseline level determined in Action 3.2.4 with greater than 95% certainty that abundance at this level has been sustained for a period of at least 14 years.

D. Verified records of adult smalltooth sawfish are observed in 12 out of 14 years, with consecutive records occurring in the last 3 years in recovery regions M or N, and in at least one of recovery regions A, B, C, or D.

The criteria listed under Objective 3 will require long-term recovery actions. Protocols have been developed to monitor the relative abundance of juvenile smalltooth sawfish in southwest Florida (Wiley and Simpfendorfer 2007c) and monitoring of sawfish abundance has begun in eastern Florida. Implementation and the continuation of ongoing relative abundance surveys are necessary to ensure this recovery criterion is met and to monitor increases in smalltooth sawfish abundance. Continued long-term collection and addition of public sawfish encounter reports to the National Sawfish Encounter Database (formerly maintained by Mote Marine Laboratory and currently maintained by the Florida Museum of Natural History) and ongoing research efforts should identify any changes in the distribution of the species.

Delisting Criteria
A. In recovery regions G, H, I, J, and K and at least 4 other recovery regions, one of which must be west of Florida, the relative abundance of small juvenile smalltooth sawfish (<200 cm) is stable or increasing over a period of 14 years following downlisting.

B. Relative abundance of adult smalltooth sawfish (>340 cm) in combined recovery regions J through L (east coast of Florida) is at least 20-times higher than the baseline level with greater than 95% certainty that abundance at this level has been sustained for a period of at least 14 years.

C. Relative abundance of adult smalltooth sawfish (>340 cm) in combined recovery regions F through H (west coast of Florida) is at least 20-times higher than the baseline level with greater than 95% certainty that abundance at this level has been sustained for a period of at least 14 years.

D. Verified records of adult smalltooth sawfish are observed in 12 out of 14 years, with consecutive records in the last 3 years, in recovery regions M or N, and in at least one of recovery regions A, B, C, or D.

E. In addition to the 6 downlisting recovery regions (G, H, I, J, and K and one additional region), the relative abundance of small juvenile smalltooth sawfish (<200 cm) in 3 other recovery regions, at least one of which must be west of Florida, is either increasing at an average annual rate of at least 5% over a 27-

year period with greater than 95% certainty or at greater than 80% of carrying capacity.

Delisting criteria will be addressed once downlisting criteria are met.

2.3 Updated Information and Current Species Status

Although the recovery criteria have not been met and therefore we recommend the DPS remain listed as is, the following is additional information on the current status of the species and is not strictly new for this 5-year review.

2.3.1 Biology and habitat

2.3.1.1 Reproduction

As with all elasmobranchs, fertilization in smalltooth sawfish is internal. Development in sawfish is believed to be ovoviviparous. The embryos of smalltooth sawfish, while still bearing the large yolk sac, already resemble adults relative to the position of their fins and absence of the lower caudal lobe. During embryonic development the rostral blade is soft and flexible. The rostral teeth are also encapsulated or enclosed in a sheath until birth. Shortly after birth, the teeth become exposed and attain their full size proportionate to the size of the saw. The sawfish size at birth is approximately 31 in (80 cm) TL, with the smallest free-living specimens reported during field studies in Florida being 30–33 in (69–84 cm) (Simpfendorfer *et al*. 2008). Bigelow and Schroeder (1953) reported gravid females carry 15–20 embryos. However, the source of their data is unclear and may represent an over-estimate of litter size. Studies of largetooth sawfish in Lake Nicaragua (Thorson 1976) report brood sizes of 1–13 individuals, with a mean of 7.3 individuals. The gestation period for largetooth sawfish is approximately 5 months and females likely produce litters every second year. Although there are no studies on smalltooth sawfish reproductive traits, its similarity to the largetooth sawfish implies that their reproductive biology may be similar, but reproductive periodicity has not been verified for either sawfish species.

2.3.1.2 Life history and population biology

Smalltooth sawfish are approximately 31 in (80 cm) TL at birth (Simpfendorfer 2002) and may grow to a length of 18 feet (540 cm) or greater (Bigelow and Schroeder 1953). A recent study by Simpfendorfer *et al*. (2008) suggests rapid juvenile growth for smalltooth sawfish for the first 2 years after birth. The growth rates of juvenile smalltooth sawfish collected in Florida waters between 1999 and 2006 were investigated using length-frequency and tag-recapture data. Stretched total length (L_{ST}) data from 144 smalltooth sawfish (690–4,960 millimeters [mm]) and 28 recaptures (775–2,150 mm) were used for the analyses. The L_{ST} increased by 650–850 mm in the first year and by 480–680 mm in the second year. Data for animals >2,200 mm were limited, so growth beyond 2 years of age is uncertain. The von Bertalanffy growth parameters estimated from L_{ST} frequency data were L_∞= 6,000 mm, K= 0·140 per year, and t_0=-0·863 years. Growth rates over the size range for which tag-recapture data were available were similar to that from L_{ST} frequency data. The growth rates reported are substantially faster than those previously assumed for this species and may have important implications for its recovery. There are conflicting data regarding the growth rates of older *Pristis pectinata* that need to be resolved with more data from wild population before a complete understanding of the conservation implications can be obtained. Simpfendorfer *et al*. (2008) reported that males appear to mature between 253 and 381 cm TL, and unpublished data from Mote Marine Laboratory and NMFS indicates males do not reach maturity until at least 340 cm total length. Accurate estimates of size or age at maturity for females are unavailable at this time, but if they follow the pattern demonstrated by most elasmobranchs they are likely to be larger than for males (Simpfendorfer *et al*. 2008). Simpfendorfer (2000) estimated age at maturity between 10 and 20 years, and a maximum age of 30 to 60 years. Overall, much uncertainty still remains in estimating life history parameters for smalltooth sawfish since very little information exists on size classes other than juveniles and no aging studies have been performed.

Using a demographic approach and life history data for smalltooth sawfish and similar species from the literature, Simpfendorfer (2000) estimated intrinsic rates of natural population increase as 0.08 to 0.13 per year and population doubling times from 5.4 years to 8.5 years. These low intrinsic rates of population increase are associated with the life history strategy known as “k-selection.” K-selected animals are usually successful at maintaining relatively small, persistent population sizes in relatively constant environments. Consequently, they are not able to respond rapidly to additional and new sources of mortality resulting from changes in their environment. Musick (1999) and Musick *et al*. (2000) noted that intrinsic rates of increase less than ten percent were low, and species with such rates of increase are particularly vulnerable to excessive mortality and rapid population declines, after which recovery may take decades. As such, smalltooth sawfish populations will recover slowly from depletion, confounding recovery efforts. Simpfendorfer (2000) concluded that recovery is likely to take decades or longer depending on how effectively sawfish can be protected. However, if ages at maturity for both sexes prove to be lower than those previously used in demographic assessments, then population growth rates are likely to be greater and recovery times shorter (Simpfendorfer et al. 2008).

2.3.1.3 Physiological ecology

Results from collaborative studies performed by Mote Marine Laboratory and Florida Fish and Wildlife Conservation Commission (2005-2007) in Charlotte Harbor's Caloosahatchee River will provide insight about some physiological characteristics of smalltooth sawfish. These studies used an array of acoustic receivers deployed within the Caloosahatchee River to passively track movements of sawfish. The receivers recorded time, date, and depth information on 41 sawfish fitted with acoustic transmitters that swam within the range of the array. The data gathered during this study are currently being analyzed to determine the time of year and duration of time spent in the river, habitats used, home ranges, salinity preferences, temperature preferences, and dissolved oxygen level preferences for the animals. Future research, including captive studies, is needed to address additional physiological aspects of smalltooth sawfish, such as the salinity and temperature preference and tolerance of juveniles of all size classes.

2.3.1.4 Genetics and phylogeny

Rostral tooth counts of *Pristis pectinata* specimens from museum collections, research surveys, and fisheries activities were examined for information on sexual dimorphism and bilateral asymmetry, and to aid in the resolution of the taxonomic uncertainty that surrounds the Pristidae (Wiley *et al* 2008). Counts were taken from 105 smalltooth sawfish captured in Florida and Georgia from 1834 to 2007. The number of rostral teeth ranged from 22 to 29 per side and 45 to 56 bilaterally. Ranges of tooth counts were more constrained, and mean values lower, than historically reported for this species in the literature due to mixed species samples utilized in some earlier studies. *Pristis pectinata* rostral tooth counts exhibited sexual dimorphism, with males on average having more rostral teeth than females. Bilateral asymmetry in rostral tooth counts was displayed in 73 percent of individuals, with no consistent side on which the greatest count occurred. No significant difference between left and right side rostral tooth counts was found.

The coastal habitat of sawfish suggests that their biology may favor the isolation of populations that may be unable to traverse large expanses of deep water or otherwise unsuitable habitat (Faria 2007). Understanding the geographical structuring of populations is relevant for management because it may identify evolutionarily independent units that are important for conservation. Faria (2007) investigated patterns of geographical structuring of the five most widespread sawfish species based on mitochondrial DNA sequences and rostral tooth counts. Two haplotypes were observed for 59 West Atlantic specimens. The only haplotype observed for two East Atlantic specimens was common to West Atlantic. Therefore, no geographical structure of *P. pectinata* populations was revealed and West and East Atlantic populations of *P. pectinata* may represent separate units for conservation purposes.

Given the magnitude of decline observed in the U.S. DPS of *Pristis pectinata* and the well established link between genetic diversity and population viability, there is some concern about the genetic health of smalltooth sawfish in Florida (Chapman *et al* 2008). It is also important to better understand the level of connectivity between different sawfish breeding grounds in Florida to effectively scale management actions. A suite of eleven microsatellite DNA markers (10–46 alleles per locus, average heterozygosity 0.84) have been developed from the *Pristis pectinata* genome and have proven useful for addressing these issues (Chapman *et al* 2008). Tissue samples have been collected from more than 100 individual sawfish, ranging from Panama City to the Lower Florida Keys, and have been genotyped at these markers. These analyses have shown that (1) robust genetic variation persists in the Florida smalltooth sawfish population and there is no signature of a genetic bottleneck arising from the recent large decline in their numbers; (2) different Southwest Florida breeding[1] grounds are genetically connected, indicating that they should be managed as a single interbreeding unit; and (3) pairs or groups of juvenile sawfish captured together in shallow habitats are often siblings (Chapman *et al* 2008). When combined with tagging and tracking data, this postnatal association of littermates indicates that juvenile sawfish stay close to the place they were born for long periods and such habitats can be considered primary nursery areas.

A polymerase chain reaction (PCR)-based genetic assay has been developed to distinguish body parts (e.g., fins, meat, or cartilage) of *Pristis pectinata* from those of all other elasmobranchs (Chapman *et al*, in prep). This assay has been shown to generate a diagnostic DNA "fingerprint" for *Pristis pectinata* that can be visually distinguished from similar fingerprints that are simultaneously generated for at least 30 commercially-important shark species. Moreover, a DNA barcode based on a portion of the cytochrome b gene can resolve all of the extant sawfish species. These genetic tools can provide robust confirmation of species identity in law-enforcement cases and for monitoring fisheries landings and trade for the species.

2.3.1.5 Distribution and abundance

The smalltooth sawfish is a tropical marine and estuarine elasmobranch fish that has been reported to have a circumtropical distribution (Figure 1). In the western Atlantic, the smalltooth sawfish has been reported from Brazil through the Caribbean and Central America, the Gulf of Mexico, and the Atlantic coast of the United States. The smalltooth sawfish has

[1] The number and location of smalltooth sawfish breeding grounds is currently unknown.

also been recorded from Bermuda (Bigelow and Schroeder 1953). Forms of smalltooth sawfish have been reported from the eastern Atlantic in Europe and West Africa, the Mediterranean, South Africa, and the Indo-West Pacific, including the Red Sea, India, Burma, and the Philippines (Bigelow and Schroeder 1953; Van der Elst 1981; Compagno and Cook 1995). Whether populations outside the Atlantic are truly smalltooth sawfish or closely related species is unknown (Adams and Wilson 1995). Pacific coast records of smalltooth sawfish off Central America need confirmation (Bigelow and Schroeder 1953; Compagno and Cook 1995).

The range of the smalltooth sawfish in the Atlantic has contracted markedly over the past century. The northwestern terminus of their Atlantic range is located in the waters of the eastern United States. Historic capture records within the United States range from Texas to New York (Figure 2). Water temperatures lower than 16–18 °C and the lack of appropriate coastal habitat serve as the major environmental constraints limiting the northern movements of smalltooth sawfish in the western North Atlantic. As a result, most records of this species from areas north of Florida occur during spring and summer periods (May to August) when inshore waters reach appropriately high temperatures. Most specimens captured along the Atlantic coast north of Florida have also been large (>10 ft or 3 meters [m]) adults and likely represent seasonal migrants, wanderers, or colonizers from a historic Florida core population(s) to the south rather than being members of a continuous, even-density population (Bigelow and Schroeder 1953). There is only one winter record from the Atlantic coast north of Florida.

The Status Review Team (NMFS 2000) collected and compiled literature accounts, museum collection specimens, and other records of the species to document the changes in distribution and abundance. Two other groups of researchers, Mote Marine Laboratory and the Florida Fish and Wildlife Conservation Commission, have been collecting reports of sawfish encounters and captures in Florida to assess the current distribution of this species. On the basis of the Status Review (NMFS 2000) and the more recent encounter database research (Seitz and Poulakis 2002; Poulakis and Seitz 2004; Simpfendorfer and Wiley 2005a), the historic and current distributions of the U.S. DPS of the smalltooth sawfish in four regions of the eastern United States are described below.

New York to Virginia
The northernmost U.S. record of the smalltooth sawfish is based upon a 15 ft (4.5 m) specimen from New York taken in July 1782 (Schopf 1788). This is the only record of smalltooth sawfish from New York waters. There is always concern with early reports of any species from “New York” because those reports often were based on market specimens that were shipped to New York from other areas. Documented reports of the species from the bordering State of New Jersey, however, and the

historical presence of many large, inshore, tropical species in the New York region prior to human-induced environmental degradation suggest the New York record may be valid. Records of smalltooth sawfish from the mid-Atlantic are only from the late 1800s and early 1900s. There are two records from New Jersey. Shields (1879) reported a 16 ft (4.8 m), 700 pound (lb) (311 kilogram [kg]) specimen in Grassy Sound near Cape May, and Fowler (1906) noted the occurrence of two sawfish in the ocean off Cape May in or about August 1900. References to smalltooth sawfish in Maryland and Virginia are similarly dated. Uhler and Lugger (1876) reported that it "occasionally enters Chesapeake Bay," and Fowler (1914) and Truitt and Fowler (1929) reported on a 10 ft (3.0 m) Ocean City specimen. Hildebrand and Schroeder (1928) later noted that it was rarely taken in lower Chesapeake Bay, "sometimes one or two fish a year and sometimes none." There have been no reports of smalltooth sawfish in New Jersey, Maryland, or Virginia since Hildebrand and Schroeder (1928).

North Carolina to Georgia

Lawson's (1709) early reference to a "sword-fish" in North Carolina undoubtedly applied to a sawfish since he was primarily describing inshore fishes. There are multiple reports of sawfish in North Carolina waters from the late 1800s and early 1900s, some being reiterations of earlier reports: Yarrow (1877: Core Sound, Bogue Sound, New River), Jenkins (1885: Beaufort), Wilson (1900: Beaufort), Smith (1907: Core Sound, Bogue Sound, New River, Beaufort, Cape Lookout), Gudger (1912: Cape Lookout), Coles (1915: Cape Lookout), Radcliffe (1916: Cape Lookout), and Gudger (1933: Cape Lookout). Yarrow (1877) indicated the sawfish was "abundant in brackish waters emptying into Bogue and Cove [= Core] Sounds" and that they were "frequently taken in the New River." Wilson (1900) also noted that it "is frequently taken" in North Carolina. Smith (1907) later reported that "this fish is not rare in the sounds and brackish waters of North Carolina" and that "in the Beaufort region and at Cape Lookout the species is observed almost every year, and some seasons is common." Since 1915 there have been only three published records of captures in North Carolina: one in 1937 (Fowler 1945), one in 1963 (Schwartz 1984), and a recent report from 1999 (Schwartz 2003). Records from South Carolina and Georgia are sparse. Jordan and Gilbert (1882) and True (1883) were the first publications to report sawfish in South Carolina waters, but there are records of the species in State waters from as early as 1817. The species was taken with some regularity, based on multiple State museum and newspaper records, until about 1938, with the last reported capture in 1958. The single published Georgia record of sawfish, a 3 ft (0.91 m) juvenile, was from March 1908 (Fowler 1945). The only capture since 2002 came from a bottom longline fishery observer who documented the capture of a second Georgia specimen, an estimated 13 ft (4.0 m) adult from depths of 152–242 ft (45.6–72.6 m) (G. Burgess, unpublished data).

Peninsular Florida

Peninsular Florida has been the U.S. region with the largest numbers of capture records of smalltooth sawfish and apparently is the main area that historically hosted the species year round. The region's subtropical to tropical climate and availability of desirable habitat, including large expanses of lagoons, bays, mangroves, and nearshore reefs are suitable for the species. Although no longer common, smalltooth sawfish were once characteristic and prominent elements of the inshore Florida ichthyofauna. Recent records of smalltooth sawfish indicate there is a resident reproducing population of smalltooth sawfish in south Florida (Seitz and Poulakis 2002; Poulakis and Seitz 2004; Simpfendorfer and Wiley 2005a). Many of the summer-caught smalltooth sawfishes taken along the U.S. East Coast north of Florida and possibly those from Texas to the Florida panhandle may have originated from this group, but supporting data are lacking.

The earliest record of smalltooth sawfish from Florida is an 1834 museum specimen from Key West. Published reports of the species in Florida were common over the next 100 years: Goode (1879a: FL; 1879b: east coast FL; 1884: Indian River, St. Johns River, Everglades, St. Andrews Bay), Jordan and Swain (1884: Cedar Keys), Henshall (1891: Big Gasparilla, FL west coast), Bean (1892: San Carlos Bay), Lönnberg (1894: Punta Gorda), Henshall (1895: Tampa), McCormick in Smith (1896: Biscayne Bay), Evermann and Bean (1898: Eau Gallie, Eden, Stuart in Indian River), Smith (1896: Biscayne Bay), Jordan and Evermann (1900: Pensacola), Evermann and Kendall (1900: east FL), Evermann and Marsh (1900: Indian River), Fowler (1906: FL Keys; 1915: Ft. Pierce), Radcliffe (1916: FL), Nichols (1917: Sandy Key), and Fowler (1945: Plantation Key). Museum records from this time period are also reasonably common. Historically, the Indian River Lagoon (IRL) on the east coast of Florida was an area of smalltooth sawfish abundance. Goode (1884) reported that in "the Indian River and its tributaries the Saw-fish is said to be very common" and Evermann and Bean (1898) noted the sawfish was "an abundant species," with a single commercial fisher having captured 300 smalltooth sawfish in a single fishing season. Published and museum records of sawfish are plentiful from the lagoons south of Cape Canaveral throughout this time period. Records also exist from more northerly (off Daytona Beach and Jacksonville) and southerly (Biscayne Bay) peninsular east coast localities during the late 1800s. Goode (1884) reported that in "the St. John's River individuals of all sizes…are taken as high up as Jacksonville." Post-1907 records from this region, however, have been far more limited and occurrences north of the Florida Keys are noteworthy events these days. During a 1973–1976 Florida Bay fish survey Schmidt (1979) reported three juvenile and adult specimens captured along the northern Florida Bay shoreline. Snelson and Williams (1981) did not capture any sawfish in an extensive multi-year study of the IRL system. They speculated that the species' absence was caused by "heavy mortality associated with incidental captures by commercial fishermen" since the decline seemed to pre-date most of the man-made habitat alterations of the area. Current records from the east coast of Florida remain relatively scarce compared to the west coast, Florida Bay, and the Florida Keys (Figure 3). Most of the encounter records for the east coast are for larger sized animals occurring along the beaches and at offshore reefs, but more recently a few smaller juvenile-sized individuals have been reported inside the IRL system (Simpfendorfer and Wiley 2005a; Wiley and Simpfendorfer 2007a). Smalltooth sawfish are rarely, if ever, observed within Biscayne National Park (Lewis 2008), on Florida's southeast coast. The park's wildlife observation database does not contain any documented observations of the species, although there have been unconfirmed, anecdotal reports from around the Arsenicker Keys, the "Safety Valve" area (just south of Key Biscayne) and southeast of Soldier Key. The lack of documented occurrences of smalltooth sawfish within Biscayne National Park is likely due to a combination of naturally low numbers of the species in the area and infrequent efforts to examine the species' distribution within the park (Lewis 2008). Furthermore, efforts by resource management and law enforcement personnel to complete weekly creek surveys of recreational fishers in the park have indicated that recreational fishermen are neither catching smalltooth sawfish on hook and line nor encountering smalltooth sawfish in the water (Lewis 2008).

The U.S. region that has always harbored the largest numbers of smalltooth sawfish lies in south and southwest Florida from Charlotte Harbor through the Dry Tortugas. Goode (1884) stated that in "the Everglades these fish are said to be exceedingly abundant." There has been a continuous and frequent record of sawfish occurrences in the Everglades since the first report in 1834, and the vicinity now serves as the last U.S. stronghold for the species (Seitz and Poulakis 2002; Poulakis and Seitz 2004; Simpfendorfer and Wiley 2005a).

Smalltooth sawfish also occur on the west coast of Florida north of Charlotte Harbor, but historically appear to never have been as common in this region as in the east coast lagoons and south Florida. One of the earliest published records from the west coast was reported in 1883 from the Cedar Keys off the northwestern Florida peninsula. Other 1800s' captures were documented in Tampa Bay and in the southwest coast off Charlotte Harbor and San Carlos Bay. Henshall (1895) relates reports of hundreds occurring on the Gulf coast of peninsular Florida. Records of capture since that time period have been limited. There are few documented captures of sawfish from the area north of Charlotte Harbor. The recent work to document sawfish encounters has increased the numbers of reported occurrences in the upper half of the west coast of the Florida Peninsula (Figure 3) and in the area north of Charlotte Harbor.

Texas to the Florida Panhandle
Records of smalltooth sawfish in the Gulf of Mexico from Texas to the Florida Panhandle exhibit a similar seasonal pattern of occurrence—more than two-thirds of the records are from April through August. While less common, winter records from the northern Gulf of Mexico (including juveniles) do suggest that at least a portion of the population may have been resident year-round in the region. However, many of the sawfish that occurred in this region may have originated from Peninsular Florida and possibly Mexico. While smalltooth sawfish historically occurred in Mexican waters, there is no information to suggest that there is currently a resident population remaining in Mexican waters. Smalltooth sawfish were described as "abundant" by Jordan and Evermann (1896) and "common" by Breder (1952) in the Gulf of Mexico. These authors may have been a bit generous in attributing these levels of abundance, as the records of smalltooth sawfish in this area are substantially fewer than in waters off peninsular Florida. Nevertheless, smalltooth sawfish apparently were more common in the Texas and northern Gulf region than in the Atlantic area north of Florida.

The smalltooth sawfish was first recorded within this region by Rafinesque (1820) in the lower Mississippi River upstream as far as the Red River in Arkansas (his report of the species in the Ohio River is thought to be erroneous). Numerous records of smalltooth sawfish exist from the Gulf of Mexico: Goode and Bean (1882), Jordan and Gilbert (1883), Jordan (1886), Evermann and Kendall (1894: Galveston), Jordan and Evermann (1900: Pensacola), Gowanloch (1932: LA), Gunter (1936: LA), Baughman (1943: TX), and Boschung (1957, 1992: AL). Baughman (1943) reported that smalltooth sawfish were "frequently taken" and "plentiful" in Texas waters. Bigelow and Schroeder (1953) later regarded smalltooth sawfish as "abundant" in Texas. As recently as the late 1950s sawfish were characterized as being "not uncommon" in Alabama waters (Boschung 1957), and recreational fishers reportedly took "many sawfish" prior to the 1960s in Texas (Caldwell 1990). However, smalltooth sawfish in the northern and western Gulf of Mexico have become rare in the last 30 years. Since 1971, there have been only three published or museum reports of smalltooth sawfish captured from this region, and all have been from Texas (1978, 1979, 1984—see NMFS 2000). Recent studies to document encounters with smalltooth sawfish since 1990 have yielded only a handful of records. The National Sawfish Encounter Database (formerly housed at Mote Marine Laboratory and currently maintained by the Florida Museum of Natural History) contains single verified records from Texas, Georgia, Louisiana, and Alabama, and several from the

Florida Panhandle (Simpfendorfer and Wiley 2005a; NSED). Most records from the Panhandle are juveniles, from all times of the year.

That sawfish were once common inhabitants of most of these areas is clear from these descriptions. It is also clear that the abundance of smalltooth sawfish in U.S. waters has decreased dramatically over the past century. There is currently no estimate of smalltooth sawfish abundance throughout its range.

There are few long-term abundance data sets that include smalltooth sawfish. One data set from shrimp trawlers off Louisiana from the late 1940s through the 1970s (Figure 4) suggests a rapid decline in the species from the period 1950–1964. However, this data set has not been validated nor subjected to statistical analysis to correct for factors unrelated to abundance.

The Everglades National Park (ENP) has established a fisheries monitoring program based on sport fisher dock-side interviews since 1972 (Schmidt *et al*. 2000). An analysis of these data using a log-normal generalized linear model to correct for factors unrelated to abundance (e.g., change in fishing practices) indicate a slight increasing trend in abundance for smalltooth sawfish in the ENP in the past decade (Carlson *et al*. 2007). From 1989 to 2004, smalltooth sawfish relative abundance increased by about 5 percent per year (Figure 5).

Continued long-term collection of public sawfish encounter reports for the National Sawfish Encounter Database will be an excellent source of information regarding any changes in the distribution of the species.

Protocols have been developed to monitor the relative abundance of juvenile smalltooth sawfish in southwest Florida (Wiley and Simpfendorfer 2007c). Implementation of relative abundance surveys is necessary to ensure the recovery criterion is met and to monitor the increase of smalltooth sawfish abundance.

2.3.1.6 Habitat

At the time of listing the status review document (NMFS 2000) summarized smalltooth sawfish's habitat use in the following way:

> Sawfish in general inhabit the shallow coastal waters of most warm seas throughout the world. They are found very close to shore in muddy and sandy bottoms, seldom descending to depths greater than 32 ft (10 m). They are often found in sheltered bays, on shallow banks, and in estuaries or river mouths.

In the years since the status review, additional research on habitat use by smalltooth sawfish has been undertaken. This research has revealed a more complex pattern of habitat use than previously known, with different life history stages having different patterns of habitat use. Ongoing research will undoubtedly inform recovery efforts in the future.

A variety of methods have been applied to studying habitat use patterns of smalltooth sawfish, including acoustic telemetry (Simpfendorfer 2003), acoustic monitoring (Wiley and Simpfendorfer 2007b), public encounter databases (Seitz and Poulakis 2002; Poulakis and Seitz 2004; Simpfendorfer and Wiley 2005a), and satellite archival tagging (Simpfendorfer and Wiley 2005b). The majority of this research has been targeted at juvenile sawfish, but some information on adult habitat use has also been obtained.

General habitat use observations

Encounter databases have provided some general insight into the habitat use patterns of smalltooth sawfish. Poulakis and Seitz (2004) reported that where the substrate type of encounters was known 61 percent were mud, 11 percent sand, 10 percent seagrass, 7 percent limestone, 4 percent rock, 4 percent coral reef, and 2 percent sponge. Simpfendorfer and Wiley (2005a) reported closer associations between encounters and mangroves, seagrasses, and the shoreline than expected at random. Encounter data have also demonstrated that smaller smalltooth sawfish occur in shallower water, and larger sawfish occur regularly at depths greater than 32 ft (10 m). Poulakis and Seitz (2004) reported that almost all of the sawfish <10 ft (3 m) in length were found in water less than 32 ft (10 m) deep and 46 percent of encounters with sawfish >10 ft (3 m) in Florida Bay and the Florida Keys were reported to occur at depths between 200 to 400 ft (70 to 122 m). Simpfendorfer and Wiley (2005a) also reported a substantial number of larger sawfish in depths greater than 32 ft (10 m). They demonstrated a statistically significant relationship between the estimated size of sawfish and depth (Figure 6), with smaller sawfish on average occurring in shallower waters than large sawfish. There are few verified depth encounters for adult smalltooth sawfish and more information is needed to verify the depth distribution for this size class of animals.

Encounter data has also identified river mouths as areas where many people observe sawfish. Seitz and Poulakis (2002) noted that many of the encounters occurred at or near river mouths in southwest Florida. Simpfendorfer and Wiley (2005a) reported a similar pattern of distribution along the entire west coast of Florida. Whether this observation represents a preference for river mouths because of physical characteristics (e.g., salinity) or habitat (e.g., mangroves or prey) factors or both is unclear.

Juvenile habitat use

<u>Very small juveniles < 39 in (100 cm) in length</u>

Very small sawfish are those that are less than 39 in (100 cm), and are young-of-the-year. Like all elasmobranchs of this age, they are likely to experience relatively high levels of mortality due to factors such as predation (Heupel and Simpfendorfer 2002) and starvation (Lowe 2002). Many elasmobranchs utilize specific nursery areas that have lower numbers of predators and abundant food resources (Simpfendorfer and Milward 1993). Acoustic tracking results for very small smalltooth sawfish indicate that shallow depths and red mangrove root systems are likely important in helping them avoid predators (Simpfendorfer 2003). At this size smalltooth sawfish spend the vast majority of their time on shallow mud or sand banks that are less than 1 ft (30 cm) deep. Since water depth on these banks varies with the tide, the movement of the very small sawfish appears to be directed towards remaining in shallow water. It is hypothesized that by staying in these very shallow areas the sawfish are inaccessible to their predators (mostly sharks) and so increase survival. The dorso-ventrally compressed body shape helps them in inhabiting these shallow areas, and they can often be observed swimming in only a few inches of water.

The use of red mangrove prop root habitat is also likely to aid very small sawfish in avoiding predators. Simpfendorfer (2003) observed very small sawfish moving into prop root habitats when shallow habitats were less available (especially at high tide). One small animal tracked over three days moved into a small mangrove creek on high tides when the mud bank on which it spent low tide periods was inundated at depths greater than 1 ft (30 cm). While in this creek it moved into areas with high prop root density. The complexity of the prop root habitat likely restricts the access of predators and so protects the sawfish.

Very small sawfish show high levels of site fidelity, at least over periods of days and potentially for much longer. Acoustic tracking studies have shown that at this size sawfish will remain associated with the same mud bank over periods of several days. These banks are often very small and daily home range sizes can be of the magnitude of 100–1,000 m^2 (Simpfendorfer 2003). Acoustic monitoring studies have shown that juveniles have high levels of site fidelity for specific nursery areas for periods up to almost 3 months (Wiley and Simpfendorfer 2007b). The combination of tracking and monitoring techniques used expanded the range of information gathered by generating both short- and long-term data (Wiley and Simpfendorfer 2007b) and further analysis of these data is currently underway.

Small juveniles 39–79 in (100–200 cm) in length

Small juveniles have many of the same habitat use characteristics seen in the very small sawfish. Their association with very shallow water (< 1 ft deep) is weaker, possibly because they are better suited to predator avoidance due to their larger size and greater experience. They do still have a preference for shallow water, remaining in depths mostly less than 3ft (90 cm). They will, however, move into deeper areas at times. One small sawfish acoustically tracked in the Caloosahatchee River spent the majority of its time in the shallow waters near the riverbank, but for a period of a few hours it moved into water 4–6 ft deep (Simpfendorfer 2003). During this time, it was constantly swimming, a stark contrast to active periods in shallow water that lasted only a few minutes before resting on the bottom for long periods.

Site fidelity has been studied in more detail in small sawfish. Several sawfish approximately 59 in (150 cm) in length fitted with acoustic tags have been relocated in the same general areas over periods of several months, suggesting a high level of site fidelity (Simpfendorfer 2003). The daily home ranges of these animals are considerably larger (1–5 km^2) than for the very small sawfish and there is less overlap in home ranges between days. The recent implementation of acoustic monitoring systems to study the longer-term site fidelity of sawfish has confirmed these observations, and also identified that changes in environmental conditions (especially salinity) may be important in driving changes in local distribution and, therefore, habitat use patterns (Simpfendorfer, unpublished data).

Nursery areas for juveniles ≤200 cm in length

Using the Heupel *et al*. (2007) framework for defining nursery areas for sharks and related species such as sawfish, and juvenile smalltooth sawfish encounter data, NMFS identified two nursery areas (Charlotte Harbor Estuary and Ten Thousand Islands/Everglades Units) for juvenile smalltooth sawfish in south Florida. Heupel *et al*. (2007), argue that nursery areas are areas of increased productivity, which can be evidenced by natal homing or philopatry (use of habitats year after year), and that juveniles in such areas should show a high level of site fidelity (remain in the area for extended periods of time). Heupel *et al*. (2007) proposed that shark nursery areas can be defined based on three primary criteria: 1) juveniles are more common in the area than other areas, i.e., density in the area is greater than the mean density over all areas; 2) juveniles have a tendency to remain or return for extended periods (weeks or months), i.e., site fidelity is greater than the mean site fidelity for all areas; and 3) the area or habitat is repeatedly used across years whereas other areas are not. NMFS analyzed juvenile smalltooth sawfish encounter data and mapped the location of the areas that met the Heupel *et al*. (2007) criteria for defining a nursery area. Two nursery areas were identified as meeting these criteria and were included in a critical habitat designation in 2009 (cite). The northern nursery area is located within the Charlotte Harbor Estuary and the southern nursery area is located in the Ten Thousand Islands area south into the ENP. The habitats within the nursery areas are characterized as having red mangroves and shallow euryhaline habitats with water depths less than 3 ft in depth.

Large juveniles >79 in (200 cm) in length

There are few data on the habitat use patterns of large juvenile sawfish. No acoustic telemetry or acoustic monitoring studies have examined this size group. Thus there is no detailed tracking data to identify habitat use and preference. However, some data are available from the deployment of pop-up archival transmitting (PAT) tags. These tags record depth, temperature, and light data, which is stored on the tag until it detaches from the animal, floats to the surface, and sends data summaries back via the ARGOS satellite system. More detailed data can be obtained if the tag is recovered. A PAT tag deployed on a 79 in (200 cm) sawfish in the Marquesas Keys collected 120 days of data. The light data indicated that the animal had remained in the general vicinity of the outer Keys (more detailed location data are not available) for this entire period. Depth data from the tag indicated that this animal remained in depths less than 17 ft (5 m) for the majority of this period, making only two excursions to water down to 50 ft (15 m) in depth (Figure 7). There is no information on site fidelity in this size class of sawfish. More data is needed from large juveniles before conclusions about their habitat use and preferences can be made.

Adult habitat use

Information on the habitat use of adult smalltooth sawfish comes from encounter data, observers onboard fishing vessels, and from PAT tags. The encounter data suggest that adult sawfish occur from shallow coastal waters to deeper shelf waters. Poulakis and Seitz (2004) observed that nearly half of the encounters with adult-sized sawfish in Florida Bay and the Florida Keys occurred in depths from 200 to 400 ft (70 to 122 m). Simpfendorfer and Wiley (2005a) also reported encounters in deeper water off the Florida Keys, noting that these were mostly reported during winter. Observations on commercial longline fishing vessels and fishery independent sampling in the Florida Straits report large sawfish in depths up to 130 ft (~40 meters) (NSED). Little information is available on the habitat use patterns of the adults from the encounter data.

PAT tags have been successfully deployed on several sawfish and have provided some data on movements and habitat use. One large mature female was fitted with a tag near East Cape Sable in November 2001. The tag detached from this animal 60 days later near the Marquesas Keys, a straight-line distance of 80 nautical miles (148 km). The data from this tag indicated that the fish most likely traveled across Florida Bay to the Florida Keys and then along the island chain until it reached the outer Keys. The depth data indicated that it spent most of its time at depths less than 30 ft (10 m), but that once it arrived in the outer Keys it made excursions (1–2 days) into water as deep as 180 ft (60 m).

Limited data are available on the site fidelity of adult sawfish. Seitz and Poulakis (2002) reported that one adult-sized animal with a broken rostrum was captured in the same location over a period of a month near Big Carlos Pass suggesting that they may have some level of site fidelity for relatively short periods. However, the occurrence of seasonal migrations along the U.S. east coast also suggests that adults may be more nomadic than the juveniles with their distribution controlled, at least in part, by water temperatures.

2.3.2 Five Factor Analysis

2.3.2.1 Present or threatened destruction, modification, or curtailment of its habitat or range:

Smalltooth sawfish habitat has been degraded or modified throughout the southeastern U.S. from agriculture, urban development, commercial activities, channel dredging, boating activities, and the diversion of freshwater runoff. While the degradation and modification of habitat is not likely the primary reason for the decline of smalltooth sawfish abundance and their contracted distribution, it has likely been a contributing factor and almost certainly hampers the species' recovery.

The principal habitats for juvenile smalltooth sawfish in the southeast U.S. are the shallow coastal areas and estuaries, with some specimens moving up river into freshwater (Bigelow and Schroeder 1953). The continued urbanization of the southeastern coastal States has resulted in substantial loss or modification of these coastal habitats. Activities such as agricultural and urban development, commercial activities, dredge and fill operations, boating, erosion, and diversions of freshwater runoff contribute to these losses (South Atlantic Fisheries Management Council [SAFMC] 1998). Loss and degradation of habitat have contributed to the decline of many marine species and are believed but not confirmed to have affected the distribution and abundance of smalltooth sawfish. Today, smalltooth sawfish remain in the United States typically in protected or sparsely populated areas off the southern and southwestern coasts of Florida; the only known exception is the nursery area in the Caloosahatchee River in an area of waterfront residences and seawalls (Simpfendorfer and Wiley 2005a). Smalltooth sawfish may be especially vulnerable to coastal habitat degradation due to their affinity for shallow estuarine systems. Smalltooth sawfish have utilized additional nursery habitats throughout their historic range, and the recovery plan (NMFS 2009) indicates that nursery areas outside of southwest Florida must be established for the species to recover. However, the spatial or temporal distribution of future nursery areas cannot be determined because habitat features historically utilized by juveniles are unknown. Additionally many of the areas known to have been used historically by juveniles have been drastically modified. Identification of and long-term commitments to protect important habitats are necessary for the eventual recovery of the species.

The following subsections review the impacts of agricultural and urban development, commercial activities, dredge and fill operations, boating, erosion, and diversions of freshwater runoff on shallow coastal areas and habitats inhabited (or previously inhabited) by smalltooth sawfish.

Agriculture
Agricultural activities convert wetlands, and shed nutrient, pesticide, and sediment-laden runoff. These in turn lead to excessive eutrophication, hypoxia, increased sedimentation and turbidity, stimulation of hazardous algal blooms, and delivery of chemical pollutants (SAFMC 1998). Freshwater wetlands associated with southeastern rivers have been extensively converted to agriculture or degraded by flood control and diversion projects in support of agriculture. Likewise, coastal wetlands have been converted to agricultural fields and degraded by flow alterations linked to agriculture. Agriculture is the single largest contributor of nutrients in southeastern watersheds (SAFMC 1998). Animal wastes and fertilizers are the largest sources of non-point source nutrient loading (USGS 1997). Agricultural non-point discharges are responsible for the introduction of a wide range of toxic chemicals into habitats important to smalltooth sawfish (Scott 1997). Even areas not immediately adjacent to agricultural areas can be affected by these activities. For example, all of Florida Bay has undergone biological, chemical, and physical change due to large scale agricultural practices and hydrologic modifications in the Everglades (Fourqurean and Robblee 1999).

Urban development
The Pew Commission (2003) reports that over 20,000 acres of coastal habitat disappear each year. Threats from development include loss of wetlands, point and non-point sources of toxins, eutrophication, and hydrologic modification. A major concern is the destruction of wetlands by filling for urban and suburban development (SAFMC 1998). In addition, seawalls and canals for waterfront homes have replaced marsh and mangrove intertidal shorelines and shallow estuarine waters. Of particular concern are sawfish habitats in places such as the IRL (Gilmore 1995) where the species was once abundant but now appears to have been extirpated (Snelson and Williams 1981). Many of the wetland habitats in the IRL were impounded for mosquito control (Brockmeyer *et al*. 1997), and the effects of these alterations on the smalltooth sawfish there are unknown.

Commercial activities

Commercial development affects sawfish habitat in many ways. Loss of wetlands, non-point and point sources of pollution and atmospheric deposition of industrial emissions are major impacts of commercial activities (SAFMC 1998). Evidence from other elasmobranchs suggests that pollution disrupts endocrine systems and potentially leads to reproductive failure (Gelsleichter *et al*. 2006). Sawfish may also alter seasonal migration patterns in response to warm water discharges from power stations (Simpfendorfer and Wiley 2005a). The total amount of marine and estuarine fish habitat eliminated and degraded by commercial activities in the southeast is unknown but substantial (SAFMC 1998). In Florida, between 1943 and 1970, approximately 10,000 hectares (ha) of this habitat were lost due to dredge fill and other activities related to accommodating the increasing human population. While loss of mangrove ecosystems throughout Florida is not overwhelming, losses at specific locations have been substantial (Odum *et al*. 1982). Direct destruction of mangrove habitat is no longer allowed without a permit, but indirect damage to mangrove habitat from increased urbanization and the resulting overall habitat degradation still occurs. Given the documented losses that occurred during early developmental phases in Florida (1940–1970), over the last 30 years, those losses can be assumed to have continued, and the amount of available mangrove habitat is likely less than documented by these older studies. Between 1956 and 1978, about 875 square miles of marsh were lost along Louisiana's coast, mostly through subsidence, rising sea level, and construction of oil and gas infrastructure, which cumulatively resulted in conversion of wetlands to open water. During those years, another 1,234 square miles of Louisiana coastal lands were converted to agricultural, urban, or industrial uses (Boesch *et al*. 1994). The smalltooth sawfish's decline may be in part attributable to these habitat losses.

Channel dredging

Riverine, nearshore, and offshore areas are dredged for navigation, construction of infrastructure, and marine mining. The total environmental impact of dredging in the southeast is unknown, "but undoubtedly great" (SAFMC 1998). An analysis of 18 major southeastern estuaries (Orlando *et al*. 1994) recorded over 703 miles of navigation channels and 9,844 miles of shoreline modifications. Habitat effects of dredging include the loss of submerged habitats by disposal of excavated materials, turbidity and siltation effects, contaminant release, alteration of hydrodynamic regimes, and fragmentation of physical habitats (SAFMC 1998). Cumulatively, these effects have degraded habitat areas used by juvenile and adult smalltooth sawfish.

Boating activities
Several environmental impacts have been associated with boating activities. These include pollutants associated with boat use and maintenance, pollutants carried by stormwater runoff from marinas, boating support facilities, and physical alteration and destruction of estuarine and marine habitats by boat propellers and dredging for canals and navigation channels. Boat registrations have increased dramatically in Florida, and new boat designs allow ever faster boats to use ever shallower waters.

Modification of freshwater flows
Modifications of natural freshwater flows into estuarine and marine waters through construction of canals and other controlled devices have changed temperature, salinity, and nutrient regimes; reduced both wetlands and submerged aquatic vegetation; and degraded vast areas of coastal habitat (Gilmore 1995; Reddering 1988; Whitfield and Bruton 1989). Profound impacts to hydrological regimes have been produced in South Florida through the construction of a 1,400-mile network of canals, levees, locks, and other water control structures that modulate freshwater flow from Lake Okeechobee, the Everglades, and other coastal areas (Serafy *et al*. 1997). The Comprehensive Everglades Restoration Project (CERP) is a major reconstruction project jointly led by the U.S. Army Corps of Engineers (USACE) and the South Florida Water Management District (SFWMD), which has the potential to restore habitats and hydrological regimes in South Florida. Of particular concern are Biscayne Bay (Serafy *et al*. 1997), Florida Bay, the Ten Thousand Islands (Fourqurean and Robblee 1999), and Charlotte Harbor—areas most affected by discharge through the Everglades.

2.3.2.2 Overutilization for commercial, recreational, scientific, or educational purposes:

The primary reason for the decline in smalltooth sawfish abundance has been bycatch in various commercial fisheries, including gillnets, otter trawls, trammel nets, and seines. Smalltooth sawfish have also been caught as bycatch and occasionally landed in recreational fisheries.

Commercial fisheries
Historically, smalltooth sawfish were often taken as bycatch in various fishing gears, including otter trawl, trammel net, seine, and, to a lesser degree, hand line. Reports of smalltooth sawfish becoming entangled in fishing nets are common in early literature from areas where smalltooth sawfish were once common, but are now rare, if not extirpated. Henshall (1895) described smalltooth sawfish as being common along both coasts of Florida and noted that the smalltooth sawfish "does considerable damage to turtle nets and other set nets by becoming entangled in the

meshes and is capable of inflicting severe wounds with its saw, if interfered with." Henshall further reported that smalltooth sawfish were always killed by fishermen when captured because of this problem. Evermann and Bean (1898) noted that smalltooth sawfish were an abundant, permanent resident in the IRL on the east coast of Florida and also noted that they did considerable damage to fishing gear by becoming entangled in nets: "The larger smalltooth sawfish tore or cut the nets, while the smaller individuals became entangled and were difficult to remove." Large catches of smalltooth sawfish occurred sporadically; one fisherman interviewed by Evermann and Bean (1898) reported taking an estimated 300 smalltooth sawfish in just one netting season on the IRL. Smalltooth sawfish are now nearly extirpated from the IRL (Snelson and Williams 1981; Schmid *et al*. 1988) with only a few recent records (Simpfendorfer and Wiley 2005a). Snelson and Williams (1981) attributed the loss of smalltooth sawfish in the IRL to heavy mortality associated with incidental captures by commercial fishermen. Baughman (1943) discussed, documented, and reported accounts of smalltooth sawfish being taken in shrimp trawls along the Texas coast. Bigelow and Schroeder (1953), who described smalltooth sawfish as "plentiful in Florida waters," noted they were of "considerable concern to fishermen as nuisances because of the damage they do to drift- and turtle-nets, to seines, and to shrimp trawls in which they often become entangled and because of the difficulty of disentangling them without being injured by their saws."

Large-scale directed fisheries for smalltooth sawfish have not existed; however, sawfish bycatch has been documented in commercial landings in various regions, with the greatest amount of data available from Louisiana (this does not imply that the greatest catches were made in Louisiana, rather this is a reflection of enhanced data gathering). The majority of the documented landings of smalltooth sawfish were from otter trawl fisheries (categorized as other, shrimp, or fish). There were also landings from trammel nets, beach haul seines, pelagic longlines, cast nets, trap float lines, and hand lines. Total Gulf of Mexico landings dropped continually from 1950 to 1978 from around 5 metric tons to less than 0.2 metric tons during this time period. NMFS does not have any records of landings since 1978. Simpfendorfer (2002) extracted a data set from "Fisheries Statistics of the United States," taken from 1945–1978 of smalltooth sawfish landings in Louisiana by shrimp trawlers (Figure 4). The data set contains both landings data and crude information on effort (number of vessels, vessel tonnage, number of gear units). Smalltooth sawfish landings in Louisiana reported over time declined from a high of 34,900 lbs in 1949 to less than 1,500 lbs in most years after 1967. Drastic reductions in the species' abundance in Louisiana waters are demonstrated by the lack of landings since 1978. Anecdotal information collected by NMFS port agents indicates that smalltooth sawfish are now taken very rarely in the shrimp trawl fishery. The most recent records from Texas are from the 1980s. Smalltooth sawfish are still occasionally documented in shrimp trawls in Florida.

Smalltooth sawfish are also taken in various Federal shark fisheries. Two fisheries identified as incidentally capturing sawfish are the shark drift gillnet fishery and shark bottom longline fishery (NMFS 2003). Interactions with smalltooth sawfish have been recorded by fishery observers onboard fishing vessels in the South Atlantic region targeting shark with bottom longline gear. Interactions are low, no more than four in any 1 year for bottom longline gear and one interaction observed in the shark drift net fishery in 2003.

The long, toothed rostrum of the smalltooth sawfish causes this species to be particularly vulnerable to both gear types. The large gillnet mesh size used to catch sharks allows the saw to easily penetrate through nets, causing the animal to become entangled when it attempts to escape. The toothed saw makes it difficult to easily remove the fishing gear without causing mortal damage to the animal, or damaging gear. Entangled specimens frequently have to be cut free, causing extensive damage to nets and presenting a substantial hazard if brought on board. When captured on longlines, the gangion frequently becomes wrapped around the animal's saw (NSED). This may be due to slashing during the fight, from spinning on the line, or any other action that brings the rostrum in contact with the line. Information on the post-release effects (long- and short-term) of these interactions is not available.

Recreational fisheries
Smalltooth sawfish have historically occurred as occasional bycatch in the hook-and-line recreational fishery (Caldwell 1990). Bigelow and Schroeder (1953) described sawfish as being "too sluggish to be held in any regard as game fish by anglers" and that "once hooked they swim so powerfully, though slowly and are so enduring, that the capture of a large one entails a long and often wearisome struggle." Based on the observations of Caldwell (1990), however, Bigelow and Schroeder may have been too quick to disregard recreational fishing. In Texas, Caldwell (1990) stated that sport fishermen in the bays and surf prior to the 1960s took many sawfish incidentally. A few were retained and displayed as trophy fish, but most were released. Caldwell (1990) noted that the saws of smalltooth sawfish were consistently removed prior to their live release and marks this as one of the reasons for their decline. Hoover (2008) provides a history of sawfish legend as well as recounting centuries of sawfish fishing tales. Since completion of the status review, a substantial amount of data has been collected from recreational fisheries (Seitz and Poulakis 2002; Poulakis and Seitz 2004; Simpfendorfer and Wiley 2005a). These data indicate that smalltooth sawfish are still taken as bycatch, mostly by shark, red drum, snook, and tarpon fishers. There are no studies

on post-release mortality, but mortality is probably low. Expanding and continuing education of anglers regarding the status of the smalltooth sawfish may help to minimize any negative effects of the recreational fishery on the sawfish population. Historically, recreational catches of sawfish were rare and poorly documented for the most part, except within the ENP. Surveys in the ENP indicate that a sustaining population still exists there, with consistent annual catches by private recreational anglers and guide boats. Possession of smalltooth sawfish has been prohibited in Florida since April 1992. The records in the angler survey database indicate that only one sawfish was kept; this record was from 1990. Fourteen smalltooth sawfish were recorded as kept in the guide survey database; one in 1991, one in 1992, and twelve in 1997. Through the cooperation of fishing guides and anglers, and aggressive education and outreach efforts, reports of individual catches to the NSED has grown markedly in recent years.

Commercial trade

Information regarding the direct commercial utilization of smalltooth sawfish has been limited. Recently, McDavitt (2005) reviewed the information related to the commercial trade in sawfish, including the smalltooth sawfish. He identified two forms of trade—whole live sawfish for the aquarium trade and sawfish parts derived mostly from sawfish captured as bycatch in fisheries. Issues related to the aquarium trade are covered in the next section. The parts of sawfish that McDavitt (2005) identified in trade were:

- Fins. The fins of sawfish are used to produce shark fin soup. Sawfish fins are highly favored in Asian markets and are some of the most valuable shark fins. Demand for sawfish fins is high.

- Whole rostra (saws). Sawfish rostra are often traded as curios, ceremonial weapons, or for use in traditional medicines. Their trade as ceremonial weapons is focused in Asia; McDavitt (2005) reported that demand is currently outstripping supply, resulting in replica rostra becoming available. The prices of large rostra can reach several thousand dollars, given their current rarity. Some smalltooth rostra have been traded online in recent years, but most appear to be antiques captured many years previously. However, there has been some trade in recently caught sawfish rostra, mostly out of Australia. In January 2006, eBay responded to conservationists' requests and agreed to officially ban the sale of smalltooth sawfish parts and products on their online auction site in accordance with eBay's wildlife policies. Because of the similarity of appearance among sawfish species, this prohibition will require careful monitoring in order to be effective. The use of rostra in traditional medicine includes some use in China, Ethiopia, Mexico, and Brazil. There is no specific information on the trade of smalltooth sawfish rostra from the U.S. DPS.

- Rostral teeth. Rostral teeth are used and traded for use in cockfighting in Peru. The teeth are used as spurs that are strapped to the cock's legs. The teeth are obtained from South American and Caribbean countries and are likely to include smalltooth sawfish teeth. Whether any were historically sourced from the U.S. DPS is unknown. McDavitt (2005) estimated that if all the teeth from a rostrum were utilized they would be valued from $2,000 to $7,000. Whether the use of rostral teeth in cockfighting extends beyond Peru, and how much demand there is for these products is unclear.

- Meat. Sawfish are regularly used for their meat; however, most of the consumption is local and so they appear to be only occasionally traded beyond local markets. Sawfish meat has been utilized historically in the U.S.; Romer (1936) reported that sawfish were the second most common elasmobranch species taken in the shark fishery in the Florida Keys during the 1930s.

- Organs. Chinese traditional medicine also uses other sawfish parts, including liver, ova, and gall bladder. Sawfish liver has also been used as a source of liver oil. The fishery in the Florida Keys described by Romer (1936) used livers as a source of vitamin A. The use of livers as a source of vitamin A stopped during the late 1940s when cheap synthetic forms became available. There are no data available on the trade in these parts for any species of sawfish.

- Skin. Sawfish skin has been used to produce leather, which, like shark leather, is considered of very high quality. The leather is used to make belts, boots, purses, and even to cover books. Although historically shark leather (including sawfish) was produced in the United States, there is currently limited demand and little production. Tanneries in other countries, however, continue to produce shark leather, but the use of sawfish is unknown.

On the basis of these trade data, the current commercial trade in smalltooth sawfish parts from the U.S. DPS appears to be minimal due to their rarity. Nevertheless, the demand for fins and saws provides a motivation to kill sawfish, a threat that will become increasingly significant as the population recovers. In 2007, the Convention on International Trades in Endangered Species (CITES) granted Appendix I protection to almost all species of sawfish (including *Pristis pectinata*), banning the international trade of sawfish and sawfish parts and adding an additional layer of protection for these species.

Public display/aquarium trade
Sawfish have been exhibited in large public aquaria for over 80 years (Hoover 2008). Their large size, bizarre shape, and shark-like features have made them popular additions to shark aquaria exhibits worldwide. Currently, there are approximately 10 smalltooth sawfish in 4 public aquaria (Choromanski 2008). Since the ESA listing, NMFS has not granted any permits to take live smalltooth sawfish for public display. There has been some trade between institutions that house these sawfish, but no new specimens have been added. To meet the demand for sawfish for public display, U.S. aquaria turned to suppliers in Australia who have supplied *Pristis microdon* and *Pristis. zijsron*. *Pristis microdon* was granted Appendix II protection allowing Australia to get a limited sawfish trade exemption for live exports for aquaria.

Scientific research
Scientific study of smalltooth sawfish has been sparse and has yet to pose a significant threat to the U.S. DPS. Current scientific studies are limited to a small number of researchers who carry out non-lethal research in the wild. All research carried out on smalltooth sawfish requires a permit from NMFS due to the protections afforded under the ESA. Other permits are also required for research on smalltooth sawfish (e.g., State agencies for work in State waters and protected area management agencies). Requests for sawfish research permits are carefully reviewed, and the effects of the research on the population are considered before issuance.

2.3.2.3 Disease or predation:

The final listing rule for the species did not determine that disease or predation was a causal listing factor. However, current data from acoustic monitoring, public encounter database data, and satellite archival tagging data suggests that small juveniles use red mangrove prop root habitat to avoid predators (see Habitat section), and therefore indicate that predation, via habitat loss, is likely a threat to the species. Further investigations are necessary to confirm this theory. Photographs of bite marks on larger juveniles, taken by researchers C. Simpfendorfer and T. Wiley suggest this size class of animals is also prey for lemon and bull sharks that co-occur in the same habitats. Crocodiles (Thorburn *et al* 2004), large sharks (Compagno 1984; Thorburn et al 2004), and marine mammals such as dolphins (Bigelow and Schroeder 1953) are known predators of juvenile sawfishes. Data are not available on predation of adult smalltooth sawfish.

2.3.2.4 Inadequacy of existing regulatory mechanisms:

Prior to listing, existing Federal and State laws, regulations, and policies were inadequate to protect smalltooth sawfish throughout their range.

There were no Federal regulations or State conservation plans specifically for the protection of sawfish. With the exception of Florida and Louisiana, smalltooth sawfish could be harvested in State waters. Smalltooth sawfish bycatch in gillnets has likely been reduced due to recent regulations prohibiting or limiting the use of gillnets in State waters, but bycatch in other gear, such as trawls, still poses a threat to this species. NMFS consults on federal fishing activities that may take the smalltooth sawfish under section 7 of the ESA. Terms and Conditions resulting from these consultations require fishers to use dehookers to safely remove fishing hooks from the species and also requires compliance with the Smalltooth Sawfish Safe Handling Guidelines to insure the safe release of sawfish caught in fishing gears. However, these measures are only applicable to federally-managed fisheries; large portions of the public are not well-informed about the species and how to release them unharmed after they are captured during fishing. Additionally, information on post-release mortality in various fisheries is still unknown. Action items related to this criterion focus on education and outreach efforts.

Numerous international, Federal, State, and inter-jurisdictional laws, regulations, and policies have the potential to affect the abundance and survival of smalltooth sawfish in U.S. waters. While many State measures may lead to overall environmental enhancements indirectly aiding smalltooth sawfish recovery, only a few State prohibitions have been applied specifically for the protection of smalltooth sawfish. Following the ESA listing Alabama prohibited the catch of smalltooth sawfish in 2004 and Texas in 2006. In 2007, the Convention on International Trades in Endangered Species (CITES) granted Appendix I protection to almost all species of sawfish (including *Pristis pectinata*), banning the international trade of sawfish and sawfish parts and adding an additional layer of protection for these species. It is necessary to promote the conservation and recovery of smalltooth sawfish under Appendix I of CITES and the enforcement of existing regulations.

2.3.2.5 Other natural or human-made factors affecting its continued existence:

Inferences about the life history of the species indicate that it has a slow growth rate, is late to mature, and has a long life span and low fecundity. The recovery of smalltooth sawfish is limited by these life history characteristics and the current small population size.

Life history limitations

Smalltooth sawfish have slow growth, late maturity, a long life span, and a small brood size. These characteristics, combined, result in a very low intrinsic rate of population increase and are associated with the life history strategy known as "k-selection." K-selected animals are usually successful at maintaining relatively small, persistent population sizes in relatively constant environments. However, they are not able to sustain additional and new sources of mortality resulting from changes in their environment, such as overexploitation and habitat degradation (Musick 1999). Smalltooth sawfish have been subjected to both overexploitation (primarily bycatch but some limited directed fishing) and habitat degradation.

The intrinsic rate of population growth can be a useful parameter to estimate the capacity of species to withstand exploitation. Animals with low intrinsic rates of increase are particularly vulnerable to excessive mortality and rapid stock collapse, after which recovery may take decades. For example, rapid stock collapses have been documented for many elasmobranchs shown to have low intrinsic rates of increase, particularly larger species (Musick *et al*. 2000). Musick (1999) noted that intrinsic rates of increase less than 0.1 were low, and placed species at risk. Simpfendorfer (2000) used a demographic approach to estimate intrinsic rate of natural increase and population doubling time. Since there are very limited life history data for smalltooth sawfish, much of the data (e.g., reproductive periodicity, longevity, and age-at-maturity) were inferred from the more well-known largetooth sawfish. The results indicated that the intrinsic rate of population increase ranged from 0.08–0.13 per year, and population doubling times ranged from 5.4 –8.5 years. Simpfendorfer (2000) concluded that "recovery to levels where there is little risk of extinction will take at least several decades."

There are no firm estimates of the size of the remaining population, but all available evidence indicates that smalltooth sawfish survive today in small fragmented areas where the impact of humans, particularly from net fishing, has been less severe. The existence or development of separate subpopulations would increase the time that it takes for recovery because the demographic models used in the study above assume a single inter-breeding population. Another barrier to recovery from very small population size may be deleterious effects of potential inbreeding. Genetic studies currently underway will answer some of these questions (e.g., Chapman *et al*. 2008). Recovery to a level where the risk of extinction is low will likely take decades, while recovery to pre-European settlement levels would probably take several centuries.

Marine pollution and debris

Because of their toothed rostra, smalltooth sawfish are susceptible to entanglement in a variety of marine debris. Examples include discarded fishing gear (e.g., monofilament line, braided line) and various cylindrical objects, such as polyvinyl chloride pipe and elastic bands (Seitz and Poulakis 2006). The impact of these types of interactions on the recovery of this species is unknown, but has the potential to be significant given the importance of coastal habitats to the species.

Stochastic events
Stochastic events, such as hurricanes and red tides, are common throughout the range of the smalltooth sawfish, especially in the current core of its range (i.e., south and southwest Florida). These events are by nature unpredictable and their effect on the recovery of the species is unknown; however, they have the potential to impede recovery directly if animals die as a result of them or indirectly if important habitats are damaged as a result of these disturbances. Simpfendorfer *et al*. (2005) reported on the effects of Hurricane Charley on smalltooth sawfish habitat in Charlotte Harbor. It was unclear if the damage to the mangrove shoreline habitats in Charlotte Harbor had, or would have in the future, negative impacts on its ability to act as a sawfish nursery area. Survey and telemetry studies completed and currently underway are assessing the habitat use patterns of juvenile sawfish in this region. The impact of the damage to the shoreline mangrove habitats on smalltooth sawfish is likely to depend on which components of the habitat are most important. For example, if it is the shallow depth of the habitats that sawfish prefer, then the mangrove damage may have limited impact unless the degradation of the old trees leads to erosion. Alternatively if the sawfish prefer the mangroves because of the high prey density that occurs because of the high primary productivity, then impacts would likely be greater until the mangroves recover. Simpfendorfer (2003) has also hypothesized that juvenile sawfish use the prop roots of red mangroves to help in predator avoidance. In this case, immediate impact may be limited as most of the prop root habitat appeared to remain after the storm, but with high mangrove mortality the decay over time may reduce its availability.

2.4 Synthesis

There has been no significant change in the range limits of *Pristis pectinata* since its listing in 2003. The population continues to be found predominately in southwest Florida, centered in the protected areas of the ENP and the Ten Thousand Islands. Continued long-term collection of public sawfish encounter reports for the NSED will be an excellent source of information regarding the distribution of the species.

Presently, the population appears stable. Long-term monitoring and relative abundance field studies are necessary to continue to gather biological data on the species and to ensure the goals of the recovery plan are being met. These actions need to continue into the future to determine abundance information on the species.

The protection of *Pristis pectinata* under CITES Appendix I in 2007 has afforded the species an additional layer of protection. However, laws protecting sawfish need to be enforced. Public outreach and education are essential to protecting the species from mortality associated with recreational and commercial fisheries. These projects should be supported and funded in the future. Sawfish Handling and Release Guidelines (SHRG) have been developed by the Smalltooth Sawfish Recovery Team and are located in the recovery plan for the species in Appendix B. Implementation of the SHRG will promote the conservation and recovery of the species.

This review has complied with the statutory requirement of section 4(c)(2) of the ESA. Based on this review, NMFS concludes that the U.S. DPS of smalltooth sawfish remains vulnerable to extinction and the species still meets the definition of endangered under the ESA, in that the species is in danger of extinction throughout its range. Though some studies suggest the population may be stable, the sawfish is still at risk due to its depressed population size, restricted range, and continuing impact from all of the threats identified in the original listing rule. In 2009, NMFS published a detailed recovery plan that identifies numerous achievable criteria for delisting or downlisting the species to threatened. Those criteria have not been met and there is no new information to dispute the plan's estimation that recovery is expected to take approximately 100 years (4 generations.

3. RESULTS

3.1 Recommended classification

_____Downlist to threatened
_____Uplist to endangered
_____Delist (indicate reasons for delisting per 50 CFR 424.11):
  _____extinction
  _____recovery
  _____original data for classification in error
__X__No change is needed

3.2 New Recovery Priority Number _____

No change is recommended.

3.3 Listing and Reclassification Priority Number

Reclassification is not recommended.

4. RECOMMENDATIONS FOR FUTURE ACTIONS

Many of the "actions needed" identified in the recovery plan need to be completed or initiated. Future actions of priority should include: continued public outreach and education, and implementation of a relative abundance monitoring program. Research projects addressing these priority actions should be supported and funded in the future.

The Smalltooth Sawfish Recovery Implementation Team should continue to monitor the population status, the continuing threats to the population, and the priority research actions. The team should ensure that progress is being made at meeting the recovery criteria and advancing the priority action items listed in the recovery plan.

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6. FIGURES

Figure 1. Historical World Distribution Map for the Smalltooth Sawfish. *From Burgess and Curtis (2003).*

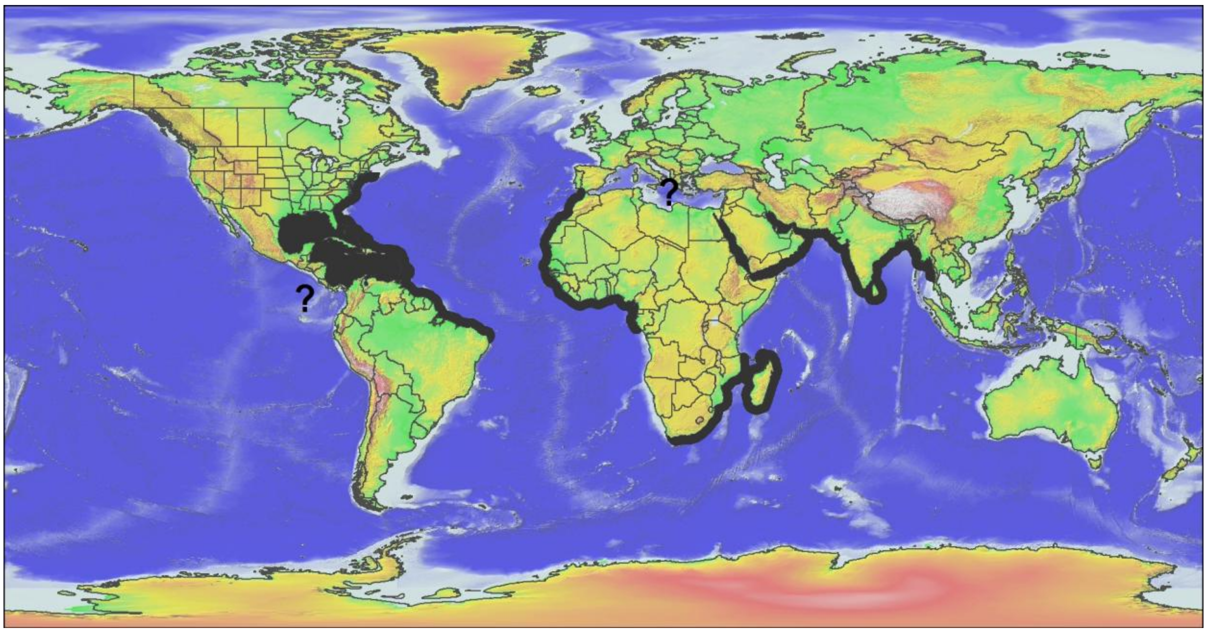

Figure 2. Historic and Current Distribution of Smalltooth Sawfish in the United States. Darker areas indicate greater concentration of records. *From Burgess and Curtis (2003).*

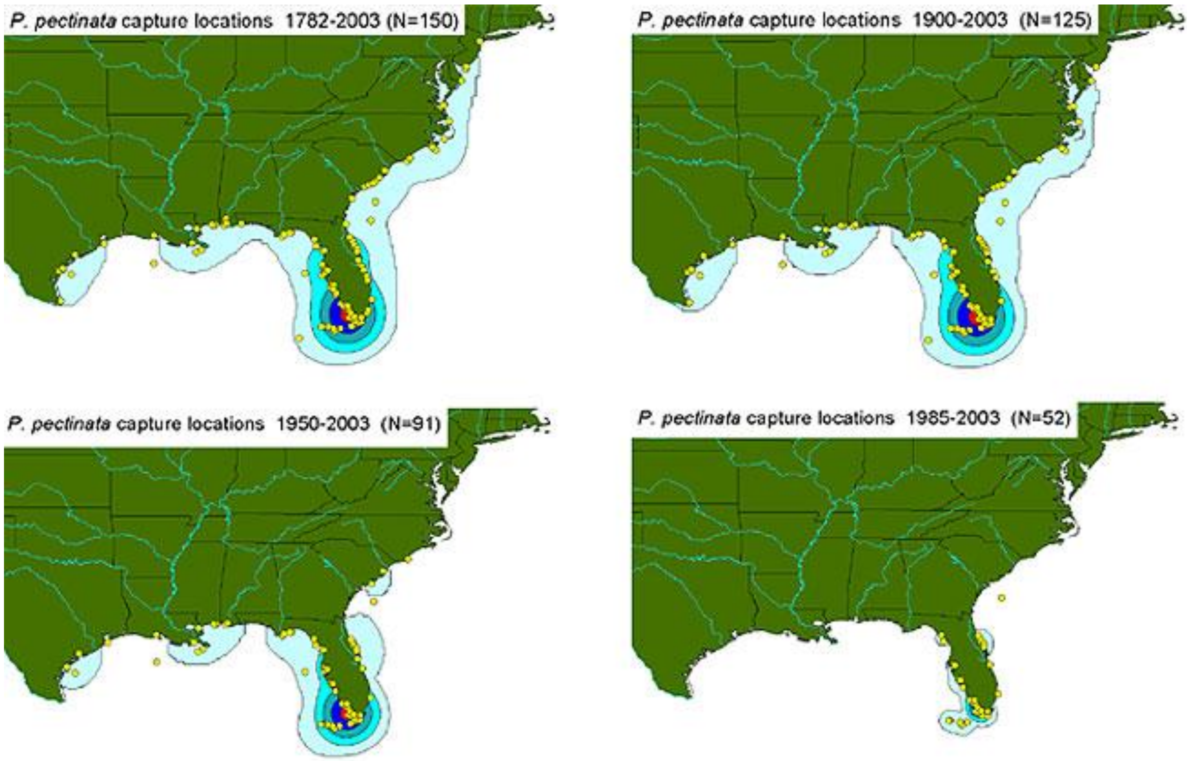

Figure 3. Latitudinal Distribution of Smalltooth Sawfish (*Pristis pectinata*) Encounters on the East and West Coasts of Florida, 1998–2004. The map of Florida is adjacent for orientation only. *From Simpfendorfer and Wiley (2005a).*

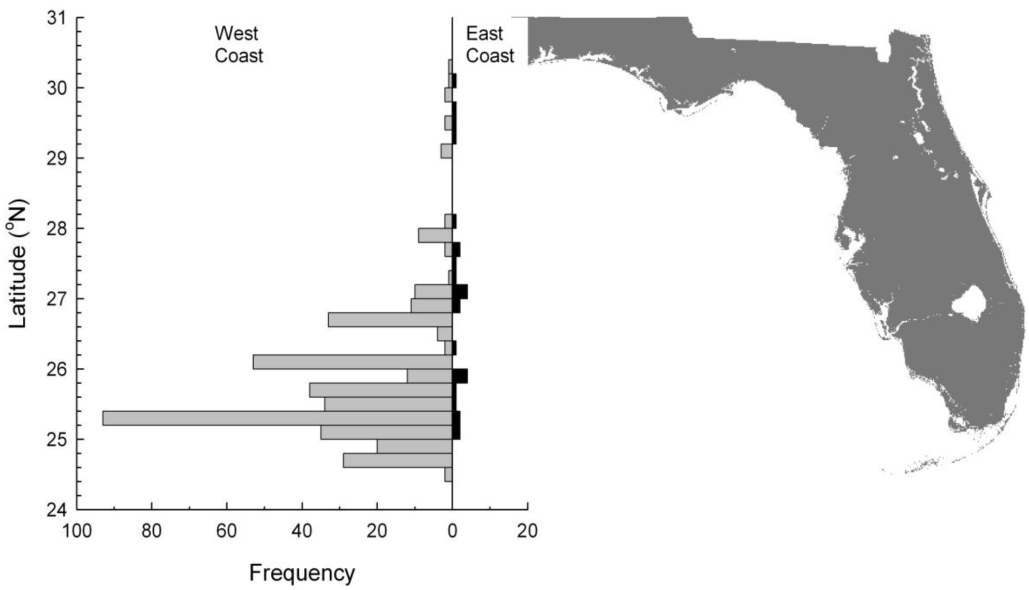

Figure 4. Mean Annual Landing of Sawfish per Trawler in Louisiana Waters. *From Simpfendorfer (2002).*

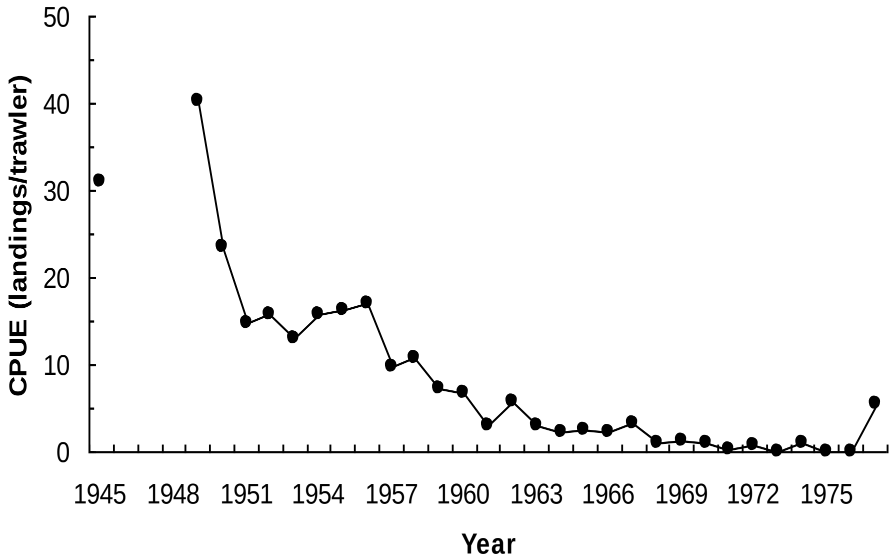

Figure 5. Standardized Relative Abundance of Smalltooth Sawfish Caught by Anglers in the Everglades National Park. Vertical bars represent the coefficient of variation. *From Carlson et al. 2007.*

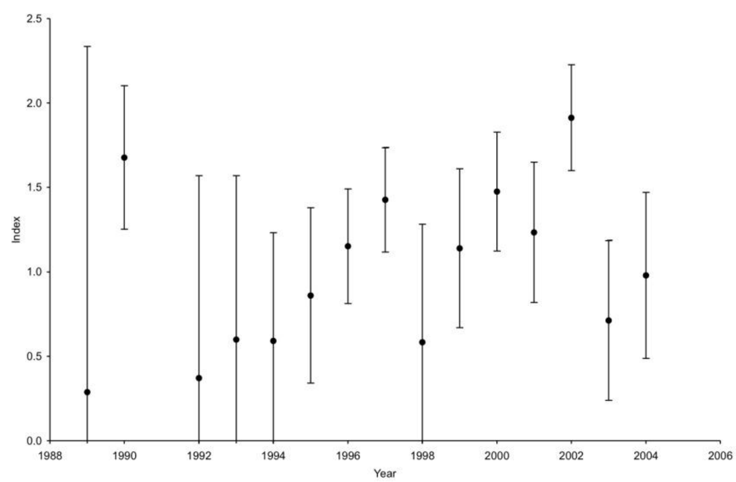

Figure 6. Relationship between Estimated Sawfish Size and Depth of Encounter. Upper and lower lines represent 95 percent confidence intervals. *From Simpfendorfer and Wiley (2005a).*

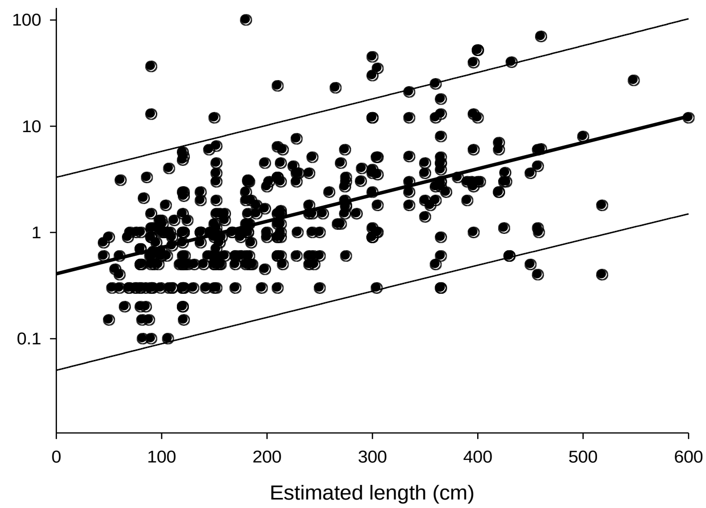

Figure 7. Depth Track of a 79 in (200 cm) Sawfish Tagged at the Marquesas Keys on February 17, 2002, with a Wildlife Computers PAT tag. *From Simpfendorfer and Wiley (2005b).*