

Status of the Species – Smalltooth Sawfish

The U.S. DPS of smalltooth sawfish was listed as endangered under the ESA effective May 1, 2003 (68 FR 15674; April 1, 2003).

Species Description

The smalltooth sawfish is a tropical marine and estuarine elasmobranch. It is a batoid (ray) with a long, narrow, flattened, rostral blade (rostrum) lined with a series of transverse teeth along both edges. In general, smalltooth sawfish inhabit shallow coastal waters of the Atlantic Ocean (Dulvy et al. 2016) and feed on a variety of fish (e.g., mullet, jacks, and ladyfish) (Poulakis et al. 2017; Simpfendorfer 2001). Although this species was historically reported throughout the tropical Atlantic, NMFS identified smalltooth sawfish from the Southeast United States as a distinct population segment (DPS), due to the physical isolation of this population from others, the differences in international management of the species, and the significance of the U.S. population in relation to the global range of the species (see 68 FR 15674).

Life History Information

Smalltooth sawfish mate in the spring and early summer (D. Grubbs, Florida State University [FSU], unpubl. data; G. Poulakis, Florida Fish and Wildlife Conservation Commission [FWC] unpubl. data). Fertilization is internal and females give birth to live young. Evidence suggests a gestation period of approximately 12 months and females produce litters of 7-14 young (Feldheim et al. 2017; Smith et al. 2021). Females have a biennial reproductive cycle (Feldheim et al. 2017) and parturition (act of giving birth) occurs nearly year round though peaking in spring and early summer (March – July; J. Carlson, NMFS, unpubl. data; (Poulakis et al. 2011). Female smalltooth sawfish exhibit parturition site fidelity, returning to the same general nursery sites to give birth each reproductive cycle (Feldheim et al. 2017; Smith et al. 2021).

Smalltooth sawfish are approximately 26–31 in (64–80 cm) at birth and contain a skin-like sheath over the rostral teeth that breaks down over a period of a few days (Poulakis et al. 2024). Simpfendorfer et al. (2008) report rapid juvenile growth for smalltooth sawfish for the first 2 years after birth, with stretched total length increasing by an average of 25–33 in (65–85 cm) in the first year and an average of 19–27 in (48–68 cm) in the second year. Uncertainty remains in estimating post-juvenile growth rates and age at maturity; yet, recent advances indicate maturity at 7–11 years (Carlson 2023; Carlson and Simpfendorfer 2015) at lengths of approximately 11 ft (340 cm) for males and 11.5–12 ft (350–370) cm for females (J. Gelsleichter, University of North Florida [UNF], unpubl. data). Sawfish may grow to a maximum length of approximately 16 ft (500 cm) (Brame et al. 2019); G. Poulakis, FWC, unpubl. data).

There are distinct differences in habitat use based on life history stage as the species shifts use through ontogeny. Juvenile smalltooth sawfish less than 7.2 ft (220 cm) inhabit shallow euryhaline waters (i.e., variable salinity) of estuaries, and can be found in sheltered bays, dredged canals, along banks and sandbars, and in rivers (NMFS 2000). These juveniles are often closely associated with muddy or sandy substrates, near shorelines containing red mangroves, *Rhizophora mangle* (Simpfendorfer 2001; Simpfendorfer 2003). Simpfendorfer et al. (2010) indicated the smallest juveniles (young-of-the-year juveniles measuring <100 cm in length)

generally used the shallowest water (depths less than 0.5 m [1.64 ft]), had small home ranges (4,264–4,557 m²), and exhibited high levels of site fidelity. Although small juveniles exhibit fidelity for specific nursery habitats for periods of time lasting up to 3 months (Wiley and Simpfendorfer 2007), they do undergo small movements coinciding with changing tidal stages. These movements often involve moving from shallow sandbars at low tide to within red mangrove prop roots at higher tides (Simpfendorfer, Wiley and Yeiser 2010)—behavior expected to reduce the risk of predation (Simpfendorfer 2006). As juveniles increase in size, they begin to expand their home ranges (Simpfendorfer, Wiley and Yeiser 2010; Simpfendorfer et al. 2011), eventually moving to more offshore habitats where they likely feed on larger prey as they continue to mature.

Researchers have identified several areas within the Charlotte Harbor Estuary that are disproportionately more important to juvenile smalltooth sawfish, based on intra- or inter-annual (within or between year) capture rates during random sampling events within the estuary (Poulakis et al. 2011). These high-use areas (HUAs) correspond with areas where public encounters are most frequently reported. Use of these HUAs can vary within and among years based on the amount and timing of freshwater inflow. Juvenile smalltooth sawfish use HUAs further upriver during high salinity conditions (drought) and areas closer to the mouth of the Caloosahatchee River during times of high freshwater inflow (Poulakis et al. 2011). Researchers are unsure what specific biotic or abiotic factors influence this habitat use, but they believe a variety of conditions in addition to salinity, such as temperature, dissolved oxygen, water depth, shoreline vegetation, and food availability, may influence habitat selection (Poulakis et al. 2011).

The juvenile HUAs may be of further significance as NMFS expects parturition sites align closely with them given the high fidelity shown by the smallest size/age classes of sawfish to specific nursery areas. Therefore, disturbance within HUAs could have wide-ranging effects on the sawfish population if it were to disrupt future parturition or juvenile survival within the nurseries.

While adult smalltooth sawfish may also use the estuarine habitats used by juveniles, particularly during periods of parturition, they are more commonly observed in deeper waters along the coasts. Simpfendorfer and Wiley (2005) and Waters et al. (2014) reported encounters in deeper waters off the Florida Keys, to depths up to 130 ft (~40 m). However, adult smalltooth sawfish also use shallow estuarine habitats within Florida Bay and the Everglades (D. Grubbs, FSU, unpubl. data). An acoustic tagging study identified three important locations (Boca Grande, the Florida Keys, and Cape Canaveral) for large juvenile (those >7.2 ft) and adult sawfish based on high detections at these locations over extended periods (Graham et al. 2021). This same study also detailed seasonal migrations whereby a portion of males and females moved north as the water warmed and back south later in the fall.

Population Dynamics

Few long-term abundance data exist for the smalltooth sawfish, making it very difficult to estimate historical or current population size. However, based on the contraction of the species' geographic range, we expect the population to be a fraction of its historical size. Despite the lack of scientific data, recent encounters with young-of-the-year, older juveniles, and sexually mature smalltooth sawfish indicate that the U.S. population is currently reproducing (Seitz and Poulakis

2002; Simpfendorfer 2003). The abundance of juveniles publically encountered by anglers and boaters, including very small individuals, suggests that the population remains viable (Waters et al. 2014), and data analyzed from Everglades National Park as part of an established fisheries-dependent monitoring program (angler interviews) indicated a slightly increasing trend in juvenile abundance within the park over the past decade (Carlson and Osborne 2012; Carlson, Osborne and Schmidt 2007). Similarly, preliminary results of juvenile smalltooth sawfish sampling programs in Everglades National Park suggest the juvenile population is at least stable (J. Carlson, NMFS, unpubl. data).

Genetic studies over the last 20 years have been useful in estimating population size and trends. An analysis of 137 juvenile smalltooth sawfish samples collected in southwest Florida from 2005–2008 estimated an effective population size¹ (N_e) of 250–350 individuals (95% Confidence Interval [CI] = 142–955; (Chapman et al. 2011)). Using similar molecular techniques on 116 samples collected from 2012–2015, Smith (2021) estimated N_e of 650 individuals (95% CI = 368–2,358) with 284 (95% CI = 1–1,425) breeding adults (N_b). Given the similarity of methods between the studies, it appears the population is small but increasing, though variability is high. Alternate analyses used genetic samples of juveniles from the known primary nursery sites to complete parental reconstructions. Results support previous findings of a diminished population, as only 55 and 71 females contributed to sampled juveniles in Charlotte Harbor and the Ten Thousand Islands/Everglades over 12- and 16-year periods, respectively (126 total females, Feldheim et al. 2017, Smith et al. 2021). The number of reconstructed parental males was higher in each region with 192 genotypes in Charlotte Harbor (Feldheim et al. 2017) and 117 in Ten Thousand Islands/Everglades (Smith et al. 2021). At this time, these genetic results represent our best estimates of current population size.

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 for the species at 0.08–0.13 yr⁻¹ and population doubling times from 5.4–8.5 years. Carlson (2023) modeled a slightly higher intrinsic rate of population increase of 0.153 yr⁻¹ with updated data. Species with rates below 0.15 yr⁻¹ are considered vulnerable to population declines, after which recovery may take decades (Musick 1999a; Musick et al. 2000) so vigilance is necessary to ensure threats to sawfish are minimized to prevent mortality.

Carlson (2023) constructed an age-structured Leslie matrix model for the U.S. population of smalltooth sawfish, using updated life history information, to determine the species' ability to recover under scenarios of variable life history inputs and mortality levels. As expected, population growth was highest ($\lambda=1.165$ yr⁻¹) when age-at-maturity was 8 yr and decreased to 1.150 yr⁻¹ when age-at-maturity was 11 yr. Population viability analysis outcomes ranged from population increases to extinction; outcomes were heavily dependent on assumptions regarding initial population size (1,255–8,075 females) and the rate of bycatch mortality (25%–100%). Population projections resulted in extinction or quasi-extinction under 6 of the 16 scenarios assessed, generally when mortality was high (75–100%) and initial population size was small. Carlson (2023) concluded that smalltooth sawfish in U.S. waters appear to have the ability to recover within the foreseeable future but noted that better estimates of both the current

¹ Effective population size (N_e) – the number of individuals that are actively contributing to the next generation within a population.

population and bycatch mortality rates are needed to refine the model. Considering recent genetic studies indicating limited numbers of breeding females (Chapman et al. 2011; Feldheim et al. 2017; Smith 2021; Smith et al. 2021), the lower initial population estimate (1,255 females) from Carlson (2023) seems best supported when considering population viability.

Status and Distribution

Within the United States, smalltooth sawfish were historically documented in estuarine and coastal waters from North Carolina southward through Texas, although peninsular Florida was always the region of the United States with the largest number of recorded captures (NMFS 2018). Generally, specimens captured along the Atlantic coast north of Florida were large juveniles or adults (over 10 ft) that likely represented seasonal migrants, wanderers, or colonizers from a historical Florida core population to the south, rather than being members of a continuous, even-density population (Bigelow and Schroeder 1953). The range of sawfish contracted during the latter half of the 20th century to the point that sawfish accounts outside of south Florida are now rare. A resident reproducing population of smalltooth sawfish persists in south and southwest Florida from Charlotte Harbor through the Florida Keys (Poulakis and Seitz 2004; Seitz and Poulakis 2002; Simpfendorfer and Wiley 2005).

Historical records indicate young juveniles were once distributed throughout coastal waters of the Gulf of Mexico (Smith et al. 2024) and the lagoons of eastern Florida (Commission 1897). However, juveniles are now only found with regularity from Charlotte Harbor south to the Florida Keys. Recently there has been a modest increase in the number of reported juveniles in historical nursery areas including Tampa Bay (T. Wiley, Havenworth Coastal Conservation, unpubl. data) and the lower Indian River Lagoon (G. Poulakis, FWC, unpubl. data). Water temperatures (no lower than 8–12°C) and the availability of appropriate coastal habitat (shallow, euryhaline waters and red mangroves) are environmental constraints limiting the northern movements of juvenile smalltooth sawfish in the western North Atlantic.

Large juvenile and adult sawfish are distributed in coastal waters of south Florida but make northern migrations as waters warm in the spring. Acoustic telemetry suggests areas just offshore of Cape Canaveral, Boca Grande, and the lower Florida Keys are important for larger sawfish (Graham et al. 2021).

Threats

Past literature indicates smalltooth sawfish were once abundant along both coasts of Florida and quite common along the shores of Texas and the northern Gulf coast ((NMFS 2010) and citations therein). Based on recent comparisons with these historical reports, the U.S. DPS of smalltooth sawfish has declined over the past century (Simpfendorfer 2001; Simpfendorfer 2002). The decline in smalltooth sawfish abundance has been attributed to several factors, most notably bycatch mortality in fisheries, habitat loss, and life history limitations of the species (NMFS 2010). Yet the species is also threatened by entanglement, climate change, and stochastic events to varying degrees.

Bycatch Mortality

Bycatch mortality is cited as the primary cause for the decline in smalltooth sawfish in the United States (NMFS 2010). While there has never been a large-scale directed fishery,

smalltooth sawfish easily become entangled in fishing gears (gill nets, otter trawls, trammel nets, and seines) directed at other commercial species, often resulting in serious injury or death (NMFS 2009). This has historically been reported in Florida, Louisiana (Simpfendorfer 2002; Snelson and Williams 1981), and Texas (Baughman 1943). For instance, one fisherman interviewed by Evermann and Bean (1897) reported taking an estimated 300 smalltooth sawfish in just one netting season in the Indian River Lagoon, Florida. In another example, smalltooth sawfish landings data gathered by Louisiana shrimp trawlers from 1945–1978, which contained both landings data and crude information on effort (number of vessels, vessel tonnage, number of gear units), indicated declines in smalltooth sawfish landings from a high of 34,900 lbs in 1949 to less than 1,500 lbs in most years after 1967. The Florida net ban implemented in 1995 led to a reduction in the number of smalltooth sawfish incidentally captured, “...by prohibiting the use of gill and other entangling nets in all Florida waters, and prohibiting the use of other nets larger than 500 square feet in mesh area in nearshore and inshore Florida waters”² (FLA. CONST. art. X, § 16). However, the threat of bycatch currently remains in commercial fisheries (e.g., Southeast U.S. shrimp fishery, federal shark fisheries of the South Atlantic, and the Gulf of Mexico reef fish fishery). (Graham et al. 2022) assessed three federal fisheries and determined the Southeast U.S. shrimp fishery posed the greatest threat to sawfish given spatio-temporal overlap. This study also indicated that adult female sawfish were at greater risk given they are more commonly found in the deeper waters where shrimp effort is greater.

In addition to incidental bycatch in commercial fisheries, smalltooth sawfish have historically been and continue to be captured by recreational anglers. Encounter data (U.S. Sawfish Recovery Database) and past research (Caldwell 1990) document that rostra are sometimes removed from smalltooth sawfish caught by recreational anglers. Sawfish without rostra are expected to die due to starvation (Morgan et al. 2016). While the current threat of mortality associated with recreational fisheries is expected to be low given that possession of the species in Florida has been prohibited since 1992, bycatch in recreational fisheries remains an ongoing threat to the species.

Habitat Loss

Modification and loss of smalltooth sawfish habitat, especially nursery habitat, is another contributing factor in the decline of the species. Activities such as agricultural and urban development, commercial activities, dredge-and-fill operations, boating, erosion, and diversions of freshwater runoff contribute to these losses (SAFMC 1998). Large areas of coastal habitat were modified or lost between the mid-1970s and mid-1980s within the United States (Dahl and Johnson 1991). Since then, rates of loss have decreased, but habitat loss continues. From 1998–2004, approximately 64,560 acres of coastal wetlands were lost along the Atlantic and Gulf coasts of the United States, of which approximately 2,450 acres were intertidal wetlands consisting of mangroves or other estuarine shrubs (Steadman and Dahl 2008). Further, Orlando et al. (1994) analyzed 18 major southeastern estuaries and recorded over 703 mi of navigation channels and 9,844 mi of shoreline with modifications. In Florida, coastal development often involves the removal of mangroves and the armoring of shorelines through seawall construction. Changes to the natural freshwater flows into estuarine and marine waters through construction of

² “nearshore and inshore Florida waters” means all Florida waters inside a line 3 mi seaward of the coastline along the Gulf of Mexico and inside a line 1 mi seaward of the coastline along the Atlantic Ocean.

canals and other water control devices have had other impacts: altered the temperature, salinity, and nutrient regimes; reduced both wetlands and submerged aquatic vegetation; and degraded vast areas of coastal habitat utilized by smalltooth sawfish (Gilmore 1995; Reddering 1988; Whitfield and Bruton 1989). While these modifications of habitat are not the primary reason for the decline of smalltooth sawfish abundance, they are likely a contributing factor and almost certainly hamper the recovery of the species. Juvenile sawfish and their nursery habitats are particularly likely to be affected by these kinds of habitat losses or alternations, due to their affinity for shallow, estuarine systems. Prohaska et al. (2018) showed that juvenile smalltooth sawfish within the anthropogenically altered Charlotte Harbor estuary have higher metabolic stress compared to those collected from more pristine nurseries in the Everglades. Although many forms of habitat modification are currently regulated, some permitted direct and/or indirect damage to habitat from increased urbanization still occurs and is expected to continue to threaten survival and recovery of the species in the future.

Life History Limitations

The smalltooth sawfish is also limited by its life history characteristics as a relatively slow-growing, late-maturing, and long-lived species. Animals using this life history strategy are usually successful in maintaining small, persistent population sizes in constant environments, but are particularly vulnerable to increases in mortality or rapid environmental change (NMFS 2000). The combined characteristics of this life history strategy result in a very low intrinsic rate of population increase (Musick 1999b) that make it slow to recover from any significant population decline (Simpfendorfer 2000).

Stochastic Events

Stochastic events such as aperiodic extreme weather and harmful algal blooms have and are expected to periodically continue to affect smalltooth. A strong and prolonged cold weather event in January 2010 resulted in the mortality of at least 15 juvenile and 1 adult sawfish (Poulakis et al. 2011; Scharer et al. 2012), and led to far fewer catches in directed research throughout the remainder of the year (Bethea et al. 2011). Another less severe cold front in 2011 did not result in any known mortality but did alter the typical habitat use patterns of juvenile sawfish within the Caloosahatchee River. Since surveys began, 3 hurricanes have made direct landfall within the core range of US sawfish. While these storms denuded mangroves along the shoreline and created hypoxic water conditions, we are unaware of any direct effects to sawfish. Just prior to the passage of Hurricane Irma in 2017, acoustically tagged sawfish moved away from their normal shallow nurseries and then returned within a few days (G. Poulakis, FWC, unpubl. data; J. Carlson, NMFS, unpubl. data).

Harmful algal blooms (HABs) have occurred within the core range of smalltooth sawfish and affected a variety of fauna including sea turtles, fish, and marine mammals. While red tide (*Karenia brevis*) is among the most common HABs leading to negative effects on a variety of species, we have no evidence this particular species of bloom has adversely affected sawfish (Brame et al. 2019). However, a yet to be identified HAB event occurred in the lower Florida Keys in early 2024 that resulted in the mortality of 56 large juvenile and adult smalltooth sawfish—mortality was likely greater as more than 170 additional sawfish were reported as showing symptomatic behavior (spinning, thrashing, beaching) but were not recovered. When even just a portion of this loss is considered in relation to the estimated number of breeding

adults from genetic studies—which suggest just a few hundred adults currently sustain the population (Feldheim et al. 2017, Smith 2021, Smith et al. 2021)—this mortality represents a large proportion of the total breeding population and may limit reproduction over the next few years. The cumulative effects of this mortality event are still being studied and juvenile recruitment will be closely monitored for any reductions resulting from the loss of breeding adults. Though we are unsure how the scale of this mortality event will affect the population’s ability to persist and recover, we are concerned that additional mortality, at similar levels from this event, in the future will be unsustainable.

Threats Summary

The 3 major factors that led to the current status of the U.S. DPS of smalltooth sawfish—bycatch mortality, habitat loss, and life history limitations—continue to be the greatest threats to their population today. Stochastic events such as extreme cold events and HABs are also an emerging threat that have resulted in sawfish mortality over the last decade and will require additional monitoring. Other threats such as the illegal commercial trade of smalltooth sawfish or their body parts, predation, and marine pollution and debris may also affect the population and recovery of smalltooth sawfish on smaller scales (NMFS 2010). Another rising threat involves entanglement in small bungee cords used to secure boat house canopies, which can lead to disfigurement and may affect both feeding and respiration. We anticipate that all of these threats will continue to affect the rate of recovery for the U.S. DPS of smalltooth sawfish.

Climate Change

In addition to the anthropogenic effects mentioned previously, changes to the global climate are expected to be an ongoing threat to smalltooth sawfish and the habitats they use. The Intergovernmental Panel on Climate Change stated that “it is unequivocal that human influence has warmed the atmosphere, ocean, and land” (IPCC 2007; IPCC 2021). Some of the likely effects commonly mentioned are sea level rise, increased frequency of severe weather events, changes in the amount and timing of precipitation, and changes in air and water temperatures (EPA 2012; NOAA 2012). The direct impacts to smalltooth sawfish cannot, for the most part, be predicted with any degree of certainty, but we can project some possible effects, particularly as climate alters habitat. Warming air and water temperatures may alter the current distribution of smalltooth sawfish as juvenile sawfish show affinities for specific temperature and salinity ranges (Poulakis et al. 2011; Simpfendorfer et al. 2011). Similarly, changes in precipitation could affect salinity patterns and thus habitat use by the species.

Both essential features of smalltooth sawfish critical habitat—red mangroves and shallow, euryhaline waters—will be directly impacted by sea level rise, which is expected to increase 0.45 to 0.75 m by 2100 (IPCC 2013). An updated IPCC report indicates the rate of sea level rise is accelerating, largely due to glacier and ice sheet melting, thus exasperating the threat (Oppenheimer et al. 2019). Sea level rise will impact mangrove resources, as sediment surface elevations for mangroves will not keep pace with conservative projected rates of elevation in sea level (Gilman et al. 2008). Sea level increases will also affect the amount of shallow water available for juvenile smalltooth sawfish nursery habitat, especially in areas where there is shoreline armoring (e.g., seawalls).

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