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SUMMARY: We, NMFS, issue this final rule implementing our determination that the narrow sawfish (Anoxypristis cuspidata), dwarf sawfish (Pristis clavata), largetooth sawfish (collectively Pristis pristis; formerly Pristis pristis, Pristis microdon, and Pristis perotteti), green sawfish (Pristis zijsron), and the non-U.S. distinct population segment (DPS) of smalltooth sawfish (Pristis pectinata) are endangered species under the Endangered Species Act (ESA) of 1973, as amended. We also include a change in the scientific name for largetooth sawfish in this final rule to codify the taxonomic reclassification of P. perotteti to P. pristis. We are not designating critical habitat because the geographical areas occupied by the species are entirely outside U.S. jurisdiction and we have not identified any unoccupied areas within U.S. jurisdiction that are essential to the conservation of any of the five species.

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We have reviewed the status of the five species of sawfish, considered public and peer review comments, and conservation efforts being made to protect all five species, and we have made our determination based on the best available scientific and **commercial** data that all five species of sawfish--the narrow sawfish (Anoxypristis cuspidata), dwarf sawfish (Pristis clavata), largetooth sawfish (collectively Pristis pristis; formerly Pristis pristis, Pristis microdon, and Pristis perotteti), green sawfish (Pristis zijsron), and the non-U.S. DPS of smalltooth sawfish (Pristis pectinata) --are at risk of extinction throughout all of their ranges and should be listed as endangered species.

DATES: This final rule is effective January 12, 2015.

ADDRESSES: Information regarding this final rule may be obtained by contacting NMFS, Protected Resources Division, 263 13th Avenue South, St. Petersburg, Florida, 33701. The final rule and citation list are located on our Web **site** at http://sero.nmfs.noaa.gov/protected_resources/sawfish/index.html.

FOR FURTHER INFORMATION CONTACT: Shelley Norton, NMFS, Southeast Regional Office (727) 824-5312 or Dr. Dwayne Meadows, NMFS, Office of Protected Resources (301) 427-8403.

SUPPLEMENTARY INFORMATION: On September 10, 2010, we received a petition from the WildEarth Guardians (WEG) requesting we list six sawfish species-- knifetooth, narrow, or pointed sawfish (A. cuspidata), hereinafter the narrow sawfish; dwarf or Queensland sawfish (P. clavata), hereinafter the dwarf sawfish; largetooth sawfish (P. pristis and P. microdon); green sawfish (P. zijsron); and the non-listed population(s) of smalltooth sawfish (P. pectinata)--as endangered or threatened under the ESA; or alternatively, list any distinct population segments (DPS) that exist under the ESA. On March 7, 2011, we published a 90-day finding (76 FR 12308) stating the petitioned action may be warranted for five of the six species. The five species were A. cuspidata, P. clavata, P. microdon, P. zijsron, and the non-listed population(s) of P. pectinata. Information in our records at the time indicated that P. pristis, as described in the petition, was not a valid species. Our 90-day finding requested information to inform our decision, and announced the initiation of status reviews for the five species. On June 4, 2013, we published a proposed rule (78 FR 33300) to list A. cuspidata, P. clavata, P. pristis (formerly P. pristis, P. microdon, and P. perotteti), P. zijsron, and the non-U.S. DPS of P. pectinata as endangered. We also included a change in the scientific name for largetooth sawfish in the proposed rule to codify the taxonomic reclassification of P. perotteti to P. pristis. The largetooth sawfish (P. perotteti) was already listed as endangered on July 12, 2011 (76 FR 40822), but this listing decision concerns the entire largetooth sawfish (P. pristis) species as it is currently classified, which also includes the species formerly classified as P. perotteti and P. microdon. We did not propose to designate critical habitat because the geographical areas occupied by the species are entirely outside U.S. jurisdiction and we did not identify any unoccupied areas that are currently essential to the conservation of any of these species. We solicited public and peer reviewer comments on the proposed rule and also coordinated outreach on the proposed rule with the Department of State to give notice to foreign nations where the species are believed to occur.

We are responsible for determining whether species are threatened or endangered under the ESA (16 U.S.C. 1531 et seq.). To make this determination, we first consider whether a **group** of organisms constitutes a "species" under the ESA, then whether the status of the species qualifies it for listing as either threatened or endangered. Section 3 of the ESA defines a "species" as "any subspecies of fish or wildlife or plants, and any distinct population segment of any species of vertebrate fish or wildlife which interbreeds when mature." On February 7, 1996 (61 FR 4722), NMFS and the U.S. Fish and Wildlife Service (USFWS; collectively, the Services) adopted a policy identifying two elements that must be considered when identifying a DPS: (1) The discreetness of the population segment in relation to the remainder of the species (or subspecies) to which it belongs; and (2) the significance of the population segment to the remainder of the species (or subspecies) to which it belongs. As stated in the DPS policy, Congress expressed its expectation that the Services would exercise their authority with regard to the use of DPSs sparingly and only when the biological evidence indicates such action is warranted.

Section 3 of the ESA defines an endangered species as "any species which is in danger of extinction throughout all or a significant portion of its range" and a threatened species as one "which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range." Thus we interpret an "endangered species" to be one that is presently in danger of extinction. A "threatened species," is not presently in danger of extinction, but is likely to become so in the foreseeable future (that is, at a later time). In other words, the primary statutory difference between a threatened and endangered species is the timing of when a species may be in danger of extinction-- either presently (endangered) or in the foreseeable future (threatened).

Section 4(a)(1) of the ESA requires us to determine whether any species is endangered or threatened due to any one or a combination of the following five factors: (A) The present or threatened destruction, modification, or curtailment of its habitat or range; (**B**) overutilization for **commercial**, recreational, scientific, or educational purposes; (C) disease or predation; (D)

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the inadequacy of existing regulatory mechanisms; or (E) other natural or manmade factors affecting its continued existence. We are required to make listing determinations based solely on the best scientific and **commercial** data available after conducting a review of the status of the species and after taking into account efforts being made by any state or foreign nation to protect the species.

Accordingly, we have followed a stepwise approach in making our listing determinations for A. cuspidata, P. clavata, P. pristis (formerly P. pristis, P. microdon, and P. perotteti), P. zijsron, and the non-U.S.DPS of P. pectinata. For the non-U.S. DPS of P. pectinata that may qualify as a DPS, we considered biological evidence, such as genetic information to determine if the population met the DPS policy criteria. Using the best available information gathered during the status reviews, we completed an extinction risk assessment using the general procedure of Wainwright and Kope (1999). We then assessed the threats affecting the status of each species using the five factors identified in section 4(a)(1) of the ESA, and then assessed public and peer reviewer comments.

Once we determined the threats, we assessed the efforts being made to protect each species to determine if these conservation efforts were adequate to mitigate the existing threats and alter extinction risk. We evaluated conservation efforts using the criteria outlined in the joint NMFS and U.S. Fish and Wildlife Service (USFWS) Policy for Evaluating Conservation Efforts (PECE; 68 FR 15100; March 28, 2003) to determine the certainty of implementation and effectiveness for future conservation efforts not yet fully implemented or effective. Finally, we re-assessed the extinction risk of each species after considering the existing conservation efforts.

In order to conduct a comprehensive review, NMFS Southeast Region Protected Resources Division and NMFS Southeast Fisheries Science Center staff members collaborated to identify the best available information. Unlike some of our previous 12-month findings, we did not develop a separate status review report. Instead, we presented all information available for these species in the proposed rule, and we present that information again, as modified by public comment on the proposed rule, in this final rule. We first discuss background information relative to all five species, and then we include descriptions of the natural history specific to each species.

Sawfish General Species Description

 

Sawfishes are a group of shark-like rays. Taxonomically, they are classified in the Family Pristidae (sawfishes), Order Rajiformes (skates, rays, and sawfishes), subclass (Elasmobrancii), and Class Chondrichthyes (cartilaginous fish). The overall body form of sawfishes is similar to sharks, but they are flattened dorso-ventrally. Sawfishes are covered with dermal denticles (teeth-like scales) and possess enlarged pectoral fins.

The most distinct characteristic of sawfishes is their large, flat, toothed rostrum or `saw' with large teeth on each side. The rostral teeth are made from calcified tissue that is neither dentin nor enamel, though it is more similar to the latter (Bradford, 1957). Rostral teeth develop inside sockets on the rostrum and are held in place by strong fibers. Unlike sharks, sawfish rostral teeth are not replaced, although partially broken teeth may continue to grow (Miller, 1974). For some species of sawfish, the number of rostral teeth can vary by geographic region.

Sawfishes use their rostrum to locate, stun, and kill prey, generally small schooling fishes such as mullet, herring, shad, and sardines (Bigelow and Schroeder, 1953). Breder (1952), in summarizing the literature on observations of sawfish feeding behavior, noted that they attack fish by slashing sideways through schools of fish, and then impale the fish on their rostral teeth. Prey are subsequently scraped off their rostral teeth by rubbing the rostrum on the bottom and then ingesting the whole fish. Bigelow and Schroeder (1953) also report that sawfish feed on crustaceans and other benthic species. Recent studies indicate that sawfishes may use their toothed rostrum to sense their prey's electric fields (Wueringer et al., 2011; 2012).

Sawfish species are distributed primarily in circumtropical shallow coastal waters that generally vary in salinity. While sawfishes are commonly found in shallow water, adults are known to also inhabit deeper waters (greater than 130 ft, 39.6 m). Some sawfishes are found in freshwater, with established populations in major rivers and lakes of South America, Africa, Australia, and Southeast Asia. The physical characteristics of habitat, such as salinity and temperature, likely influence a sawfish's movement patterns. Tides limit the physical habitat area available, which may explain movement into shallow water areas during specific tidal cycles (Blaber et al., 1989).

Life history data on sawfishes are limited. Fertilization is internal by means of male claspers and reproduction is ovoviviparous; females carry eggs with a yolk sac that nourishes developing young until they hatch within the body. Sawfishes are born with a gelatinous substance around their rostral teeth to protect the mother during birth (Last and Stevens, 1994; Rainboth, 1996; Compagno and Last, 1999; Raje and Joshi, 2003; Field et al., 2009). It is thought that most sawfishes breed every two years and have a gestation period of about four to five months (Bigelow and Schroeder, 1953; Thorson, 1976a). The number of young in a litter varies by species, as does the age at sexual maturity.

Like most chondrichthyes, sawfishes occupy the mid- to upper-level of their food web. Smaller sawfishes, including juveniles, may be preyed upon by larger sharks like the bull shark (Carcharhinus leucas), estuarine crocodiles (Crocodylus porosus), or alligators (Alligator mississippiensis). Sawfishes may use their saw as a weapon for defense against these predators (Brewer et al., 1997; Wueringer et al., 2009).

Previously, seven valid species of sawfish were recognized worldwide (Compagno, 1999). Compagno and Cook (1995) and Compagno (1999) identified these seven species of sawfish as A. cuspidata Latham 1794, P. microdon Latham 1794, P. perotteti Muller and Henle 1841, P. pristis Linnaeus 1758, P. clavata Garman 1906, P. pectinata Latham 1794, and P. zijsron Bleeker 1851. Since then, the taxonomy, delineation, and identification of these species have proven problematic (Oijen et al., 2007; Wiley et al., 2008; Wueringer et al., 2009). Most recently, Faria et al. (2013) hypothesized that the taxonomic uncertainty occurred due to several factors: many original species descriptions were abbreviated, few holotypes are available for examination, reference material is not available for comparison in museum collections, and it is difficult to obtain fresh specimens because of the infrequent captures of all sawfishes. The majority of the confusion regarding taxonomic classification of Pristidae was related to the species P. pristis. To resolve questions regarding the taxonomy of pristids, Faria et al. (2013) used historical taxonomy, external morphology, and mitochondrial DNA (mtDNA) sequences (NADH-2 loci) to conclude that sawfishes have five species in two genera: P. pristis, P. clavata, P. pectinata, P. zijsron, and A. cuspidata. We accept this proposed taxonomy as the best available science.

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Natural History of the Narrow Sawfish (Anoxypristis cuspidata)

Taxonomy and Morphology

The narrow sawfish was first described by Latham in 1794 as P. cuspidatus. It was later reclassified as Anoxypristis due to morphological differences from Pristis that include its narrow rostral saw, which lacks teeth on the first quarter of the saw closest to the head in adults, as well as the distinct shape of the lower lobe of the caudal fin (Compagno et al., 2006a). In juveniles, the portion of the rostrum without teeth is only about one-sixth of the saw length (Wueringer et al., 2009).

In addition, the narrow sawfish is characterized by dagger-shaped rostral teeth (Fowler, 1941; Blegvad and Loppenthin, 1944; Compagno and Last, 1999; Faria et al., 2013). The narrow sawfish also has a second pair of hollow cartilaginous tubes in its rostrum that are not present in other sawfishes. These canals contain an additional connection to the ampullae of Lorenzini (special sensory receptors) located on the underside of the rostrum (Wueringer et al., 2009).

Rostral tooth count varies for this species between 18 and 22 (Last and Stevens, 1994), 24 and 28 (Hussakof, 1912), and 27-32 (Miller, 1974). The total number of teeth has been found to vary by individual, region, and sex. Some studies report males having fewer rostral teeth than females, while others report the opposite (Last and Stevens, 1994; Compagno and Last, 1999). While total rostral tooth count is often inconsistent among individuals or studies, the number of teeth an individual has is fixed during development (Wueringer et al., 2009).

The pectoral fins of the narrow sawfish are narrow, short, and shark-like in shape. The first dorsal fin is located posterior to the insertion of the pelvic fins (Compagno and Last, 1999). Within the jaw, there are 94 teeth on the upper jaw and 102 on the lower jaw (Taniuchi et al., 1991a). The eyes are large and very close to the spiracles. Coloration is dark grey dorsally and whitish ventrally (Fowler, 1941; Compagno and Last, 1999).

Narrow sawfish are the only sawfish having tricuspid (three-pointed) denticles (White and Moy-Thomas, 1941). These denticles first appear on sawfish at 25.6 to 28 in (65 to 71 cm) total length (TL), after they are born. In general, the narrow sawfish is considered "naked" because denticle coverage in adults is often sporadic and widely spaced, usually only covering the rostrum and anterior fin margins, making the skin appear smooth (Fowler, 1941; Gloerfelt-Tarp and Kailola, 1984; Last and Stevens, 1994; Wueringer et al., 2009). Narrow sawfish also have buccopharyngeal denticles (tooth-like structures) present in their mouth. This species does not have tubercles or thorns on their skin (Deynat, 2005).

Habitat Use and Migration

The narrow sawfish is largely euryhaline and moves between estuarine and marine environments (Gloerfelt-Tarp and Kailola, 1984; Last, 2002; Compagno, 2002b; Compagno et al., 2006a; Peverell, 2008). It is generally found in inshore waters in depths of less than 130 ft (39.6 m) with salinities between 25 and 35 parts per thousand (ppt), spending most of its time near the substrate or in the water column over coastal flats (Compagno and Last, 1999; Last, 2002; Peverell, 2005; Peverell, 2008; Wueringer et al., 2009). While Smith (1936) described it as a possible freshwater species, there are only a few reports from freshwater (Taniuchi and Shimizu, 1991; Last and Compagno, 2002; Bonfil and Abdallah, 2004; Wueringer et al., 2009). We are not aware of any fresh or salt water tolerance studies on the species (Compagno, 2002a; Compagno, 2002b) and conclude its habitat is euryhaline.

In studies conducted by Peverell (2008), the narrow sawfish in the Gulf of Carpentaria, Australia, undergo an ontogenetic shift in habitat. Larger individuals were commonly encountered offshore, while smaller individuals were mostly found in inshore waters. Peverell (2008) also found females were more likely to be offshore compared to males, at least during the months of the study (February to May). This suggests that smaller narrow sawfish use the protection and prey abundance found in shallow, coastal waters (Dan et al., 1994; Peverell, 2005; Peverell, 2008).

Age and Growth

Two studies have been conducted on age and growth of narrow sawfish. Field et al. (2009) compared previously-aged vertebrae with aged rostral teeth and found a direct correlation up to age 6. After age 6, an individual's age was often underestimated using tooth growth bands as the teeth become worn over time (Field et al., 2009). Peverell (2008) then used aged vertebrae to develop more accurate growth curves for both sexes. While the maximum observed age of narrow sawfish from vertebrae was 9 years, the theoretical longevity was calculated at 27 years (Peverell, 2008). A 1-year-old animal has a saw length of approximately 4.5 in (11.5 cm). Female narrow sawfish begin to mature at 8 ft 1 in (246 cm) TL and all are mature at 15 ft 5 in (470 cm) TL; males are mature at 8 ft (245 cm) TL (Pogonoski et al., 2002; Bonfil and Abdallah 2004; Peverell, 2005; 2008). The maximum recorded length of a narrow sawfish is 15 ft 5 in (4.7 m) TL, with unconfirmed records of 20 ft (6.1 m) TL (Last and Stevens, 1994; Compagno and Last, 1999; Pogonoski et al., 2002; Bonfil and Abdallah, 2004; Faria et al., 2013).

Reproduction

The narrow sawfish gives birth to a maximum of 23 pups in the spring. The total length (TL) of pups at birth is between 17-24 in (43-61 cm) (Compagno and Last, 1999; Peverell, 2005; 2008). The reproductive cycle is assumed to be annual, with an average of 12 pups per litter (Peverell, 2005; D'Anastasi, 2010).

The number of pups is related to female body size, as smaller females produce fewer offspring than larger females (Compagno and Last, 1999). Preliminary genetic research suggests that the narrow sawfish may not have multiple fathers per litter (D'Anastasi, 2010).

Mating season may vary by geographic region. Female narrow sawfish captured in August (dry season) in the Gulf of Carpentaria, Australia, all contained large eggs indicating they were mature (Peverell, 2005). Mature males were also captured in similar locations during the same time of year (McDavitt, 2006). Although animals are sexually mature in the dry season, mating may not occur until the rainy season in March-May in the Indo-West Pacific (Raje and Joshi, 2003).

Age at maturity for narrow sawfish is 2 years for males and 3 years for females (Peverell, 2008). The intrinsic rate of population increase (rate of growth of the population) based on life history data from the exploited population in the Gulf of Carpentaria, Australia, has been estimated at 0.27 per year (Moreno Iturria, 2012), with a potential population doubling time of 2.6 years.

Diet and Feeding

Narrow sawfish feed on small fish and cuttlefish (Compagno and Last, 1999; Field et al., 2009) and likely on crustaceans, polychaetes, and amphipods (Raje and Joshi, 2003).

Population Structure

Genetic and morphological data support the division of the global species of narrow sawfish into populations. Based on gene sequence data, there is a very low level of gene flow between the northern Indian Ocean (n = 2) and west Pacific (n = 11)

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populations. Four haplotypes (combinations of deoxyribonucleic acid sequences or DNA) were identified: northern Indian Ocean; Indonesian; New Guinean- Australian; and one specimen that lacked locality information, but had a northern Indian Ocean haplotype. Specimens collected from the Indian Ocean had a higher number of rostral teeth per side than those collected from the western Pacific (Faria et al., 2013).

Field et al. (2009) examined the primary chemical elements of rostral teeth (i.e., oxygen, calcium, and phosphorous) from narrow sawfish captured throughout Australia in an attempt to separate subpopulations based on the isotopes of these chemicals. They found distinctions between regions indicating two separate subpopulations within the Gulf of Carpentaria Australia: one in the west (Northern Territory) and one in the east (Queensland). Using isotopes to separate elasmobranch subpopulations is in its infancy, however, and, coupled with the limited number of samples, it is not clear whether these results agree with the above genetic studies of population structure. Isotopic signatures indicate the location where an animal spends most of its time and identifies its major prey resources and do not necessarily provide information on reproductive connectivity between regions. Therefore, we conclude that the best available information on isotopic signatures does not support separating narrow sawfish into subpopulations.

Distribution and Abundance

The narrow sawfish is found throughout the eastern and western portions of the Indian Ocean as well as much of the western Pacific Ocean. The range once extended from as far west as the Red Sea in Egypt and Somalia (**M**. McDavitt, National Legal Research **Group**, Inc. pers. comm. to IUCN, London, 2012) to as far north as Honshu, Japan, including India, Sri Lanka, and **China** (Blaber et al., 1994; Last and Stevens, 1994; Compagno and Last, 1999; Compagno et al., 2006a; Van Oijen et al., 2007). The species has also been recorded in rivers in India, Burma, Malaysia, and Thailand (Compagno, 2002b).

While uncertain, the current status of narrow sawfish populations across its range has declined substantially from historic levels. The species was previously commonly reported throughout its range, but it is now becoming rare in catches by both **commercial** and recreational fishers (Brewer et al., 2006; Compagno et al., 2006a). To evaluate the current and historic distribution and abundance of the narrow sawfish, we conducted an extensive search of peer- reviewed publications and technical reports, newspaper, and magazine articles. We also reviewed records from the Global Biodiversity Information Facility (GBIF) database (www.gbif.org). The results of that search are summarized by major geographic region.

Indian Ocean

The earliest reports of narrow sawfish in the Indian Ocean were from 1937 and 1938. Two sawfish were captured from the northern Indian Ocean (no specific location was reported). A third specimen was later caught in the same area (Blegvad and Loppenthin, 1944).

 

From areas in the western Indian Ocean around the Arabian Sea, three rostra were collected in 1938: Two near Bushire, Iran, presumably from the Gulf of Oman, and a third in Jask, Iran, also adjacent to the Gulf of Oman (Blegvad and Loppenthin, 1944). The most extensive report was 13 rostra from the Persian Gulf (one of those was from Iran) but it did not include date information. Four juveniles were recorded in Pakistan waters in 1975: Two females and two males (Faria et al., 2013). The last published record of narrow sawfish from the western edge of the range, in the Straits of Hormuz, was in 1997 (A. Moore, RSK Environment Ltd., pers. comm. to IUCN, 2012).

Most records of narrow sawfish in the Indian Ocean are from the Bay of Bengal. In 1960 and 1961, 118 sawfish, mostly narrow sawfish, were captured during fishery surveys using gillnets and long lines (James, 1973). There are several additional records of rostra from Bangladesh in the 1960s (Faria et al., 2013). One record from the California Academy of Sciences is from a fish market in Bangkok, Thailand in 1961. A narrow sawfish was used for a 1969 parasitological study in Bangladesh, but no further information was recorded (Moravec et al., 2006). Faria et al. (2013) also reported one specimen from 1976, as well as 11 more records off India, but no dates were recorded. Narrow sawfish were recorded from the Kirachi West Wharf Fish Market in Pakistan in 1978 (GBIF Database). From 1982 to 1994, one juvenile female, one juvenile male, and three rostra were recorded in Pondicherry, India (Deynat, 2005). Two female neonate specimens were recorded in Sri Lanka, and three juveniles (two males and one female) from Malabar in Southwest India were also reported from 1982-1994 (Deynat, 2005). Between 1981 and 2000, in the Bay of Bengal, total elasmobranch landings records are dominated by rays and include narrow sawfish (Raje and Joshi, 2003). Landings of narrow sawfish are currently reported from the Indian Ocean off India although they are infrequent (K.K. Bineesh, Marine Fisheries Research Institute, Department of Pelagic Fisheries, India, pers. comm. to IUCN, 2012).

Indo-Pacific Ocean (excluding Australia)

There are several accounts of narrow sawfish over time from various unspecified locations throughout the Indo-Pacific. One narrow sawfish specimen was recorded from Mabe, India in 1835, making it the oldest museum record from the region (GBIF Database). The first records of narrow sawfish were for juvenile males in 1852 and 1854 (Faria et al., 2013). A female and male were recorded in 1867, but no exact location was specified (Faria et al., 2013). In 1879, one male and one female were also recorded from Indonesia and four rostra were reported from **China** in 1898 (Faria et al., 2013).

The next reports of narrow sawfish from the Indo-Pacific occurred in the 1930s. A female was reported in 1931 in Indonesia (no specific location), and a male was reported in Singapore in 1937 (Blegvad and Loppenthin, 1944). A narrow sawfish was caught in the Gulf of Thailand in March 1937 (Blegvad and Loppenthin, 1944). A single report from Papua New Guinea was recorded in 1938 (Faria et al., 2013). In 1945, narrow sawfish were reported in the Chao Phraya River, Thailand and its tributaries (Smith, 1945). In 1952, two females were captured from Batavia, Semarang, Indonesia along with a third female without a rostrum (Van Oijen et al., 2007).

Records of narrow sawfish throughout the Indo-Pacific were scattered and infrequent throughout the 1950s. Faria et al. (2013) recorded rostra from Papua New Guinea; two from 1955 and one each from 1966, 1980, and 2000. A male was caught in 1989 from the Oriomo River, Papua New Guinea (Taniuchi et al., 1991b; Taniuchi and Shimizu, 1991; Taniuchi, 2002). There are other reports of narrow sawfish from Papua New Guinea around the Gulf of Papua and in Bootless Bay from the 1970s, but there are no recent records (Taniuchi et al., 1991b). In a comprehensive literature search for the period 1923 to 1996 on the biodiversity of elasmobranchs in the South **China** Sea, Compagno (2002a) found no records of sawfishes. Yet, fresh dorsal and caudal fins of narrow sawfish were found during a survey of fish markets from 1996 to 1997 in Thailand (Manjaji, 2002b).

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There are even fewer records of narrow sawfish from the Indo-Pacific over the last few decades. The only known specimen in the twenty-first century is a single report from New Guinea in 2001 (L. Harrison, IUCN, pers. comm. to John Carlson, NMFS, 2012).

Australia

Australia may have larger populations of narrow sawfish than any other area within the species' range (Peverell, 2005). According to the GBIF Database for Australia flora and fauna, the first museum record of the narrow sawfish in Australia is from the Australia Museum in Townsville, Queensland in 1963. This database also lists observations of narrow sawfish throughout the 1980s, mostly recorded by the Commonwealth Scientific and Industrial Research Organization (CSIRO) Marine and Atmospheric Research **group**. One individual was observed in Western Australia in 1982 and in 1983. In 1984, CSIRO observed one narrow sawfish just west of Darwin, Northern Territory, and five in the Gulf of Carpentaria (three in the east and two in the northwest). Five additional records in 1984 were from the northwest tip of the western Gulf of Carpentaria, one from outside the Daly River, and three outside of Kakadu National **Park**. In 1985, two narrow sawfish were observed near Marchinbar **Island**, Northern Territory. In the eastern Gulf of Carpentaria, four narrow sawfish were observed in 1986, with single observations in 1987 and 1988. In 1988, a narrow sawfish was observed in Western Australia. Two narrow sawfish were reported from the Gulf of Carpentaria in 1990 (Blaber et al., 1994). Single specimens were captured in 1991 from the west coast of Australia (Alexander, 1991), the Gulf of Carpentaria in 1995 (Brewer et al., 1997), and the Arafura Sea in 1999 (Beveridge et al., 2005). Faria et al. (2013) reported three rostra records from private collections in Australia from 1998-1999, but no other information on the collection location was reported.

Narrow sawfish have been reported in multiple studies between 2000 and 2011, mostly from northern Australia. In a bycatch reduction device study conducted in 2001 in the Gulf of Carpentaria, 25 narrow sawfish were captured in trawling gear (Brewer et al., 2006). Later in 2001, a bycatch reduction device study conducted in the Queensland shallow-water eastern king prawn (Penaeus plebejus) trawl fishery did not capture a single specimen (Courtney et al., 2006). The European Molecular Biology Lab recorded narrow sawfish in 2003 in the Northern Territory (GBIF database). A review of fisheries data and records from 2000 to 2002, identified 74 offshore and 37 inshore records of narrow sawfish in the Gulf of Carpentaria (Peverell, 2005). Between April 2004 and April 2005, 16 narrow sawfish were caught in the Gulf of Carpentaria during a trawl bycatch study; the mean catch rate was 0.16 sawfish per hour (Dell et al., 2009). Observers on **commercial** fishing boats recorded nine captures of narrow sawfish in 2007 within the Great Barrier Reef World Heritage Area, Queensland, which accounted for 0.86 percent of the shark and ray catch in the **commercial** fisheries (Williams, 2007). Observers in the Northern Territory's Offshore Net and Line Fishery encountered several narrow sawfish from 2007 to 2010 (Davies, 2010). Data from the Kimberley (R. McAuley, Department of Fisheries, Western Australia, pers. comm. to Colin Simpfendorfer, 2012), the Northern Territory (Field et al., 2009), the Gulf of Carpentaria (Peverell, 2005), and parts of the Queensland east coast (Harry et al., 2011) suggest viable subpopulations may remain locally, but at significantly lower levels compared to historic levels.

In summary, it appears the current range of narrow sawfish is restricted largely to Australia. Narrow sawfish are considered very rare in many places where evidence is available, including parts of India (Roy, 2010), Bangladesh (Roy, 2010), Burma (FIRMS, 2007-2012), Malaysia (including Borneo; Almada-Villela, 2002; Manjaji, 2002), Indonesia (White and Kyne, 2010), Thailand (CITES, 2007; Compagno, 2002a; Vidthayanon, 2002), and Singapore (CITES, 2007). In Australia, narrow sawfish are primarily located in the north. The most recent museum record for narrow sawfish in southern Australia was from New South Wales in the 1970s (Pogonoski et al., 2002). Data from the Queensland Shark Control Program, conducted along the east coast of Queensland, from 1969 to 2003 show a clear decline in sawfish catch (although not species-specific) with the complete disappearance of sawfish in southern regions of Queensland by 1993 (Stevens et al., 2005). Although we cannot rule out underreporting of narrow sawfish, especially in remote areas of its historic range, we conclude from the consistent lack of records that narrow sawfish have been severely depleted in numbers and their range has contracted.

Natural History of Dwarf Sawfish (Pristis clavata)

Taxonomy and Morphology

Due to its size and the geographic location where it was described, P. clavata is referred to as the dwarf or the Queensland sawfish. The species was first described by Garman in 1906; however, it has often been confused with largetooth sawfish (Last and Stevens, 1994; Cook et al., 2006; Morgan et al., 2010a). This species can be distinguished from largetooth sawfish based on rostral tooth morphology (Thorburn et al., 2007).

The dwarf sawfish is olive brown in color dorsally with a white underside. The rostrum of this species is quite short, with 19 to 23 rostral teeth that are moderately flattened, elongated, and peg-like. Studies indicate that this species does not display significant differences in the number of rostral teeth between males (19 to 23 teeth) and females (20 to 23 teeth) (Ishihara et al., 1991a; Thorburn et al., 2008; Morgan et al., 2010a; Morgan et al., 2011). The rostrum makes up 21 to 26 percent of the total length of the dwarf sawfish (Blaber et al., 1989; Grant, 1991; Last and Stevens, 1994; Compagno and Last, 1999; Larson et al., 2006; Wueringer et al., 2009; Morgan et al., 2011).

Morphologically, the origin of the first dorsal fin is slightly posterior to the insertion of the pelvic fins, and the second dorsal fin is smaller than the first. The pectoral fins are small compared to other sawfish species, and are "poorly developed" (Ishihara et al., 1991a). There is no lower lobe on the caudal fin. Lateral and low keels are present along the base of the tail (Compagno and Last, 1999; Wueringer et al., 2009; Morgan et al., 2010a; Morgan et al., 2011). Within the mouth are 82-84 tooth rows on the upper jaw. The total vertebrae number is 225-231. The dwarf sawfish has regularly overlapping monocuspidate denticles on its skin. As a result, there are no keels or furrows formed on the skin (Fowler, 1941; Last and Stevens, 1994; Deynat, 2005).

 

Habitat Use and Migration

The dwarf sawfish has been found along tropical coasts in marine and estuarine waters, mostly from northern Australia; it may inhabit similar habitats in other areas. Dwarf sawfish are reported on mudflats in water 6 ft 7 in to 9 ft 10 in (2 to 3 m) deep that is often turbid and influenced heavily by tides. Thorburn et al. (2008) reported dwarf sawfish occur in waters 2 to 22 ft (0.7 to 7 m) deep, while Stevens et al. (2008) recorded a maximum depth of 65 ft (20 m). This species has also been reported in rivers (Last and Stevens, 1994; Wueringer et al., 2009; Morgan et al., 2010a) and as commonly occurring in both brackish and freshwater, and in both marine and estuarine habitats (Rainboth, 1996; Thorburn et al., 2008).

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For example, two dwarf sawfish were found 31 miles (50 km) upstream from the mouth of the south Alligator River, Kakadu National Park, Northern Territory, Australia in 2013 at salinities of 0.12 and 7.64 ppt (P. Kyne, Charles Darwin University, pers. comm. to S. Norton, NMFS, June 2013).

Juvenile dwarf sawfish may use the estuaries associated with the Fitzroy River, Australia as nursery habitat for up to three years (Thorburn et al., 2008). Dwarf sawfish are also known to use the Gulf of Carpentaria, Australia as nursery area in a variety of habitats (Gorham, 2006). However, physical characteristics such as salinity, temperature, and turbidity may limit seasonal movements (Blaber et al., 1989).

Age and Growth

Dwarf sawfish are considered to be small compared to other sawfishes. Their maximum size has been reported as 4 ft 11 in (1.5 m) total length (TL) (Grant, 1991) and 4 ft 7 in (140 cm) TL (Last and Stevens, 1994; Rainboth, 1996; Compagno and Last, 1999). But more recently, much larger sizes have been reported, as high as 19.7 ft (6000 cm) TL (Peverell, 2005). Specimens from Western Australia in 2008 indicate that females reach at least 10 ft 2 in (310 cm) TL (Morgan et al., 2010a; Morgan et al., 2011).

Thorburn et al. (2008) and Peverell (2008) estimated age and growth for this species based on the number of vertebral rings and total length. The average growth estimates for dwarf sawfish are 16.1 in (41cm) TL in the first year, slowing to 9.4 in (24 cm) in the second year (Peverell 2008). Thorburn et al. (2008) determined that animals close to 3 ft (90 cm) TL were age 1, those between 3.5 and 4 ft (110 cm and 120 cm) TL were age 2, and those around 5 ft (160 cm) TL were age 6. Peverell (2008) reported dwarf sawfish between 2 ft 11 in and 3 ft 3 in (90 and 98 cm) TL were age 0, those between 3 ft 7 in and 5 ft 9 in (110 to 175 cm) TL were considered 1 to 3 years old, and those between 6 ft 7 in and 8 ft (201 to 244 cm) TL were considered 4 to 6 years old (Peverell, 2008). Any dwarf sawfish over 9 ft 10 in (300 cm) TL is considered to be at least 9 years old (Morgan et al., 2010a). The theoretical maximum age calculated from von Bertalanffy parameters for dwarf sawfish is 94 years (Peverell, 2008).

Reproduction

There is little information available regarding the time or location of dwarf sawfish mating. It is hypothesized that dwarf sawfish move into estuarine or fresh waters to breed during the wet season (Larson et al., 2006), although no information on pupping habitat, gestation period, or litter size has been recorded (Morgan et al., 2010a).

Dwarf sawfish are born between 2 ft 2 in and 2 ft 8 in (65 cm and 81 cm) TL (Morgan et al., 2010a; Morgan et al., 2011). Males become sexually mature between 9 ft 8 in and 10 ft (295 and 306 cm) TL with fully calcified claspers, though they may mature at smaller sizes, around 8 ft 5 in (255-260 cm) TL (Peverell, 2005; Thorburn et al., 2008; Last and Stevens, 2009; Morgan et al., 2011). All males captured by Thorburn et al. (2008) less than 7 ft 5 in (226 cm) TL were immature; two females, both smaller than 3 ft 11 in (120 cm) TL, were also immature. There is little specific information about sexual maturation of females; females are considered immature at 6 ft 11 in (210 cm) TL (Peverell, 2005; Peverell, 2008; Morgan et al., 2010a). Wueringer et al. (2009) indicates that neither males nor females are mature before 7 ft 8 in (233 cm) TL.

Intrinsic rates of population increase, based on life history data from Peverell (2008), has been estimated to be about 0.10 per year (Moreno Iturria, 2012), with a potential population doubling time of 7.2 years.

Diet and Feeding

Dwarf sawfish, like other sawfishes, use their saw to stun small schooling fishes. They may also use the saw for rooting in the mud and sand for crustaceans and mollusks (Breder Jr., 1952; Raje and Joshi, 2003; Larson et al., 2006; Last and Stevens, 2009). In Western Australia, the dwarf sawfish eats shrimp (Natantia spp.), mullet (Mugilidae), herring (Clupeidae), and croaker (Sciaenidae) (Thorburn et al., 2008; Morgan et al., 2010a).

 

Population Structure

Phillips et al. (2011) conducted a genetic study looking at mtDNA of dwarf sawfish and found no distinct difference in dwarf sawfish from Western Australia and those from the Gulf of Carpentaria in northern Australia. The genetic diversity of this species was moderate overall; however, dwarf sawfish from the Gulf of Carpentaria may have a lower genetic diversity than those of the west coast, possibly due to either a small sample size or a reduction in abundance (Phillips et al., 2008). Further declines in abundance as well as genetic drift may result in reduced genetic diversity (Morgan et al., 2010a; 2011).

Phillips et al. (2011) determined the populations of the dwarf sawfish are organized matrilineally (from mother to daughter), indicating the possibility that females are philopatric (return to their birth place). While the genetic diversity of this species is considered low to moderate across Australia, haplotype diversity in the Gulf of Carpentaria was very low, but was greater in the west compared to the east. Low diversity among and within groups of dwarf sawfish may be detrimental (Phillips et al., 2011).

Distribution and Abundance

Dwarf sawfish are thought to historically occur in the Indo-Pacific, western Pacific, and eastern Indian Oceans, with the population largely occurring in northern Australia (Last and Stevens, 1994; Last and Compagno, 2002; Compagno, 2002a; Compagno, 2002b; Thorburn et al., 2008; Wueringer et al., 2009; Morgan et a l., 2010a; Kyne et al., 2013). While dwarf sawfish may have been historically more widespread throughout the Indo-West Pacific (Compagno and Last, 1999; Last and Stevens, 2009), there are questions regarding records outside of Australian waters (DSEWPaC 2011; Kyne et al., 2013; GBIF database).

In an effort to gather more information on the species' historic and current range and abundance, we conducted an extensive search of peer-reviewed publications and technical reports, newspaper, and magazine articles. We also reviewed records from the Global Biodiversity Information Facility (GBIF) Database (www.gbif.com). A summary of those findings is presented by major geographic region.

Indian Ocean

Dwarf sawfish are considered extremely rare in the Indian Ocean and there are few records indicating its current presence (Last, 2002). Faria et al. (2013) report a female from the Reunion Islands, a female from an unidentified location in the Indian Ocean, and a museum record of a male from Bay of Bengal, India. A sawfish was landed at a port in Arabian Peninsula (presumably caught in the Gulf of Oman or the Arabian Gulf) in January of 2006. It may have been a dwarf sawfish, but identification could not be confirmed (Kyne et al., 2013). There are no reports of dwarf sawfish from Sri Lanka in more than a decade, although they have been assumed to occur there (Last, 2002).

Indo-Pacific (excluding Australia)

Dwarf sawfish are considered very rare in Indonesia, with only a few records (Last, 2002). Faria et al. (2013) compiled most reports of dwarf sawfish in Indonesia; since the first record in 1894 from Borneo, there have been two

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rostral saws in 1910 and five other rostra without date or length information. There is also one museum record of a dwarf sawfish from Papua New Guinea in 1828 (Kyne et al., 2013).

Although reported historically, dwarf sawfish have not been found in any other areas in the Indo-Pacific in over a decade. Rainboth's (1996) guide to fishes of the Mekong reported a dwarf sawfish from the Mekong River Basin, Laos, in the early 1900s but no specimen exists to confirm this report. No sawfish of any species, including the dwarf sawfish, were reported from the South **China** Sea from 1923-1996 (Compagno, 2002a). Faria et al. (2013) reported on two specimens from the Pacific Ocean, but no specifics were provided.

Australia

The northern coast of Australia represents the geographic center of dwarf sawfish range that extends from Cape York, Queensland west to the Pilbara area in Western Australia (Compagno and Last, 1999; Last and Stevens, 2009; Kyne et al., 2013). Dwarf sawfish may have occurred as far south as Cairns, but reports are lacking. Most records for dwarf sawfish are from the north and northwest areas of Australia.

The earliest record of dwarf sawfish in Australia is from 1877, but no specific location was recorded (Faria et al., 2013). A single rostrum from a dwarf sawfish was found in 1916, but no other information was recorded. In 1945, a single specimen was reported from the Northern Territory, Australia (Stevens et al., 2005). There is a single record of a dwarf sawfish from the Victoria River in 1964 that is currently housed at the Museum Victoria (GBIF Database).

Five female and five male dwarf sawfish (32 to 55 in; 82 to 140 cm TL) were captured in 1990 in the Pentecost River using gillnets (Taniuchi and Shimizu, 1991; Taniuchi, 2002). CSIRO recorded five dwarf sawfish in Western Australia in 1990 (GBIF Database). CSIRO also found one dwarf sawfish in Walker Creek (a tributary of the Gulf of Carpentaria) in 1991 (GBIF Database). In 1992, one specimen was found near Darwin, Northern Territory, Australia (GBIF Database). Between 1994 and 2010, almost 75 tissue samples were taken from live dwarf sawfish or dried rostra from the Gulf of Carpentaria and the northwest coast of Australia (Phillips et al., 2011). In 1997, two specimens were collected near the mouth of Buffalo Creek in Darwin, Northern Territory (Chisholm and Whittington, 2000). In 2005, Naylor et al. (2005) collected one dwarf sawfish from Darwin, Australia. One dwarf sawfish was captured in 1998 in the upper reaches of the Keep River Estuary (Larson, 1999; Gunn et al., 2010). CSIRO reported one dwarf sawfish in Western Australia (GBIF Database). In 2006, the European Molecular Biology Lab reported the occurrence of three dwarf sawfish in Western Australia (GBIF Database). One interaction was reported between 2007 and 2010 by observers in the Northern Territory Offshore Net and Line Fishery (Davies, 2010). A single specimen from Queensland (northeastern Australia) is preserved at the Harvard Museum of Comparative Zoology (Fowler, 1941).

In a comprehensive survey of the Gulf of Carpentaria from 2001 to 2002 (Peverell, 2005; 2008), indicated dwarf sawfish were concentrated in the west where 12 males and 10 females were captured. Most individuals caught in the inshore fishery were immature except for two mature males: 10 ft and 9 ft 8 in (306 cm and 296 cm) TL (Peverell, 2005; 2008).

Within specific riverine basins in northwestern Australia, dwarf sawfish have been reported in various surveys. Forty-four dwarf sawfish were captured between October 2002 and July 2004, in the King Sound and the Robison, May, and Fitzroy Rivers (Thorburn et al., 2008). Between 2001 and 2002, one dwarf sawfish was caught at the mouth of the Fitzroy River in Western Australia (Morgan et al., 2004). Morgan et al. (2011) acquired 109 rostra from dwarf sawfish from the King Sound area that were part of museum or personal collections.

In summary, there is some uncertainty in the species identification of historic records of dwarf sawfish, however, it appears the dwarf sawfish has become extirpated from much of the Indo-Pacific region and from the eastern coast of Australia. An October 2001 study on the effectiveness of turtle- excluder devices in the prawn trawl fishery in Queensland, Australia, reported no dwarf sawfish (Courtney et al., 2006). Dwarf sawfish are now considered rare in the Gulf of Carpentaria. It is likely the Kimberley region and Pilbara region (Western Australia) may be the last remaining areas for dwarf sawfish (P. Kyne, Charles Darwin University, pers. comm. to IUCN, 2012).

Natural History of the Largetooth Sawfish (Pristis pristis)

Taxonomy and Morphology

Many taxonomists have suggested classification of largetooth sawfish into a single circumtropical species given common morphological features of robust rostrum, origin of first dorsal fin anterior to origin of pelvic fins, and presence of a caudal-fin lower lobe (Guenther, 1870; Garman, 1913; Fowler, 1936; Poll, 1951; Dingerkus, 1983; Daget, 1984; Seret and McEachran, 1986; McEachran and Fechhelm, 1998; Carvalho et al., 2007). The recent analysis by Faria et al. (2013) used mtDNA (mitochondrial deoxyribonucleic acid) and contemporary genetic analysis to argue that the previously classified P. pristis, P. microdon, and P. perotteti should now be considered one species named P. pristis. After reviewing Faria et al. (2013) and consulting other sawfish experts, we conclude, based on the best available information, that P. pristis applies to all the largetooth sawfishes previously identified as P. pristis, P. microdon, and P. perotteti.

The largetooth sawfish has a robust rostrum, noticeably widening posteriorly (width between the two posterior-most rostral teeth is 1.7 to 2 times the width between the second anterior-most rostral teeth). Rostral tooth counts are between 14 and 23 per side with grooves on the posterior margin. The body is robust with the origin of the first dorsal-fin anterior to the origin of the pelvic fin; dorsal fins are high and pointed with the height of the second dorsal fin greater than the first. The lower lobe of the caudal-fin is small, but well-defined, with the lower anterior margin about half as long as the upper anterior margin (Wallace, 1967; Taniuchi et al., 1991a; Last and Stevens, 1994; Compagno and Last, 1999; Deynat, 2005; Wueringer et al., 2009; Morgan et al., 2010a; Morgan et al., 2010b; Morgan et al., 2011). The largetooth sawfish has buccopharyngeal denticles and regularly overlapping monocuspidate dermal denticles on its skin. The denticles are present on both dorsal and ventral portions of the body (Wallace, 1967; Deynat, 2005). Within the mouth, there are between 70 and 72 tooth rows on the upper jaw, and 64 to 68 tooth rows on the lower jaw. The number of vertebrae is between 226 and 228 (Morgan et al., 2010a). Coloration of the largetooth sawfish is a reddish brown dorsally and dull white ventrally (Fowler, 1941; Wallace, 1967; Compagno et al., 1989; Taniuchi et al., 1991a; Compagno and Last, 1999; Chidlow, 2007).

 

Male and female largetooth sawfish differ in the number of rostral teeth. Using largetooth sawfish teeth collected from Papua New Guinea and Australia, Ishihara et al. (1991b) found males to have an average of 21 rostral teeth on the left and 22 on the right; females averaged 19 rostral teeth on both the left and the right side of the rostrum.

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Rostrum length can vary between males and females (Wueringer et al., 2009).

Habitat Use and Migration

Largetooth sawfish are found in coastal and inshore waters and are considered euryhaline (Compagno et al., 1989; Last and Stevens, 1994; Compagno and Last, 1999; Chisholm and Whittington, 2000; Last, 2002; Compagno, 2002b; Peverell, 2005; Peverell, 2008; Wueringer et al., 2009), being found in salinities ranging from 0 to 40 ppt (Thorburn et al., 2007). The species has been found far upriver, often occupying freshwater lakes and pools; they are associated with freshwater more than any other sawfish species (Last and Stevens, 1994; Rainboth, 1996; Peter and Tan, 1997; Compagno and Last, 1999; Larson, 1999). Largetooth sawfish have even been observed in isolated fresh water billabongs or pools until floodwaters allow them to escape; juveniles often use these areas for multiple years as deepwater refuges (Gorham, 2006; Thorburn et al., 2007; Wueringer et al., 2009; Morgan et al., 2010b). Similarly, largetooth sawfish have been found in Lake Nicaragua in depths up to 400 ft (122 m) and are found in deeper holes, occupying muddy or sandy bottoms (Thorson, 1982). Adults more often use marine habitats than juveniles, and are typically found in waters with salinity at 31 ppt (Wueringer et al., 2009).

Despite the variety of habitats occupied, females have been found to be highly philopatric as indicated by mtDNA studies, while males often undergo long movements (Lack et al., 2009; Phillips et al., 2009; Morgan et al., 2010a; Morgan et al., 2010b; Morgan et al., 2011). Largetooth sawfish occurred from the Caribbean and Gulf of Mexico south through Brazil, and in the United States, largetooth sawfish were reported in the Gulf of Mexico, mainly along the Texas coast (NMFS, 2010a). Largetooth sawfish were rarely reported in U.S. waters and may have been long-distance migrants from the Caribbean or Brazil (Feldheim et al., 2011).

The physical characteristics of habitat strongly influence the movements of, and areas used by, largetooth sawfish. Recruitment of neonate largetooth sawfish was correlated with the rise in water levels during the wet season in Australia (Whitty et al., 2009). A study of juvenile largetooth sawfish movements in the Fitzroy River in Australia found young-of-the-year using extremely shallow areas (0 to 1 ft 7 in or 0 to 0.49 m) up to 80 percent of the time, mostly to avoid predators (Thorburn et al., 2007). Juvenile and adult largetooth sawfish also use rivers (Compagno, 2002b; Gorham, 2006) and can be found in areas up to 248.5 miles (400 km) upstream (Morgan et al., 2004; Chidlow, 2007). The space used on a day to day basis by largetooth sawfish increases with body length (Whitty et al., 2009).

Age and Growth

There are several age and growth studies for the largetooth sawfish; results vary due to differences in aging techniques, data collection, or location. In Australia, largetooth sawfish are between 2 ft 6 in and 3 ft (76 and 91 cm) TL at birth, with females being slightly smaller than males on average (Chidlow, 2007; Morgan et al., 2011). Thorson (1982) found pups at birth average 2 ft 4.7 in to 2 ft 7.5 in (73-80 cm) TL, with a growth rate of 1 ft 2 in to 1 ft 3 in (35-40) cm per year in Lake Nicaragua (NMFS, 2010a; Kyne and Feutry, 2013). Peverell (2008) found that largetooth sawfish in the Indo-West Pacific are born at 2 ft 4 in to 2 ft 11 in (72-90 cm) TL. Juveniles (age 1 to age at maturity) range in size from 2 ft 6 in to 9 ft (76 to 277 cm) TL (Morgan et al., 2011).

Size at maturity in the Western Atlantic is estimated to be around 9 ft 10 in (300 cm) TL for both sexes at around age 8 (Lack et al., 2009; Morgan et al., 2010a; Morgan et al., 2010b; NMFS, 2010; Morgan et al., 2011; Kyne and Feutry, 2013). Thorson (1982) estimated age of maturity to be 10 years at 9 ft 10 in (300 cm) TL in Lake Nicaragua. Peverell (2008) estimated age at maturity in the Gulf of Carpentaria to be between 8 and 10 years. In the Indo-Pacific, males tend to mature earlier than other regions (9 ft 2 in (280 cm)) TL (Kyne and Feutry, 2013). Generally, males under 7 ft 7 in (230 cm) TL and females under 8 ft 10 in (270 cm) TL are considered immature (Whitty et al., 2009; Wueringer et al., 2009).

The largest recorded length of a largetooth sawfish is 22 ft 11 in (700 cm) TL (Compagno et al., 1989. The largest largetooth sawfish recorded in the Kimberley, Queensland measured 21 ft 6 in (656 cm) TL (Compagno and Last, 1999). In other areas of Australia, largetooth sawfish can reach up to 15 ft (457 cm) and at least 11 ft 10 in (361 cm) TL (Fowler, 1941; Chidlow, 2007; Gunn et al., 2010). Thorson (1982) estimated that largetooth sawfish in Lake Nicaragua only reach a maximum size of about 14 ft 1 in (430 cm) TL.

 

Age and growth for largetooth sawfish has been estimated by Tanaka (1991) who generated a von Bertalanffy growth model for specimens collected from Papua New Guinea and Australia. For both sexes combined, the theoretical maximum size (L [infin.] ) from the von Bertalanffy growth equation was calculated at 11 ft 11 in (363 cm) TL with a growth rate (K) of 0.066 per year. Largetooth sawfish grow around 7 in (18 cm) in the first year and 4 in (10 cm) by the tenth year (Tanaka, 1991). Thorson (1982a) estimated an early juvenile growth rate of 13-15 in (35 to 40 cm) per year and annual adult growth rate of 1 in (4.4 cm) per year based on largetooth from Lake Nicaragua. Simpfendorfer (2000) estimated the theoretical maximum size of largetooth sawfish to be 14 ft 11 in (456 cm) TL with a growth rate (Brody growth coefficient K) of 0.089 per year based on Thorson's (1982) data from Lake Nicaragua. Peverell (2008) calculated that largetooth sawfish from the Gulf of Carpentaria, Australia grow 1 ft 8.5 in (52 cm) in the first year and 7 in (17 cm) during the fifth year. Maximum size was estimated at 20 ft 11 in (638 cm) TL with a growth rate (Brody growth coefficient K) of 0.08 per year from the von Bertalanffy equation (Peverell, 2008). Kyne and Feutry (2013) summarize maximum age estimates of 30 years in Lake Nicaragua and 35 years in the Gulf of Carpentaria. Based on the von Bertalanffy equation, growth slows at about 35 years or 19 ft 10 in (606 cm) TL (Kyne and Feutry, 2013).

Reproduction

Largetooth sawfish are thought to reproduce in freshwater environments (Compagno and Last, 1999; Last, 2002; Compagno, 2002b; Martin, 2005; Thorburn and Morgan, 2005; Compagno et al., 2006b). Pupping seems to vary across the range, occurring during the wet season from May to July in the Indo-Pacific (Raje and Joshi, 2003), and from October to December in the western Atlantic and Lake Nicaragua (Thorson, 1976a; Kyne and Feutry, 2013).

The number of pups in a largetooth sawfish litter varies by location, possibly due to a number of factors. One of the earliest reproductive studies on largetooth sawfish by Thorson (1976a) reported the litter sizes of 67 females ranged between 1 to 13 pups and an embryonic sex ratio for this species is 0.86 males for every 1 female. Average number of pups is 7 (NMFS, 2010a; Kyne and Feutry, 2013). Thorson (1976a) also found that both ovaries appeared to be functional, with the left ovary producing more eggs. Estimates of litter size from other studies in the Indo-West Pacific (e.g., Wilson, 1999; Moreno Iturria, 2012; Peverell, 2005) cannot be confirmed (Kyne and Feutry, 2013). Length of gestation for largetooth sawfish is approximately five months in Lake Nicaragua, with a biennial

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reproduction cycle (Thorson 1976a; NMFS 2010a; Kyne and Feutry, 2013). In the Indo-West Pacific, largetooth sawfish may reproduce every year (Peverell, 2008).

Intrinsic rates of population growth vary tremendously throughout the species' range. Simpfendorfer (2000) estimated that the largetooth sawfish in Lake Nicaragua had an intrinsic rate of population growth of 0.05 to 0.07 per year, with a potential population doubling time of 10.3 to 13.6 years. Using data from Australia, rates of population increase for the Indo-Pacific were estimated to be around 0.12 per year (Moreno Iturria, 2012), with a population doubling time of approximately 5.8 years and a generation time of 14.6 years. Data from the western Atlantic Ocean indicate an intrinsic rate of increase of 0.03 per year, with a population doubling time of 23.3 years and a generation time of 17.2 years (Moreno Iturria, 2012). Annual natural mortality for the western Atlantic has been estimated at 0.07 to 0.16 (Simpfendorfer, 2000) and 0.14 to 0.15 per year (Moreno Iturria, 2012).

Diet and Feeding

Largetooth sawfish diet is predominantly fish, but varies depending on geographic area. Small fishes including seer fish, mackerels, ribbon fish, sciaenids, and pomfrets are likely main diet items of largetooth sawfish in the Indian Ocean (Devadoss, 1978; Rainboth, 1996; Raje and Joshi, 2003). Small sharks, mollusks, and crustaceans are also potential prey items (Devadoss, 1978; Rainboth, 1996; Raje and Joshi, 2003). Taniuchi et al. (1991a) found small fishes and shrimp in the stomachs of juveniles in Lake Murray, Papua New Guinea, while juveniles in Western Australia had catfish, cherabin, mollusks, and insect parts in their stomachs (Thorburn et al., 2007; Whitty et al., 2009; Morgan et al,. 2010a). Largetooth sawfish have also been found to feed on catfish, shrimp, croaker, small crustaceans, croaker, and mollusks (Chidlow, 2007; Thorburn et al., 2007; Morgan et al., 2010a; Morgan et al., 2010b). Largetooth sawfish captured off South Africa had bony fish and shellfish as common diet items (Compagno et al., 1989; Compagno and Last, 1999). In general, largetooth sawfish subsist on the most abundant small schooling fishes in the area (NMFS, 2010a).

Population Structure

Genetic analyses based on specific sequences of mitochondrial DNA indicated largetooth sawfish can be found in populations based on ocean basin: Atlantic, Indo-West Pacific, and Eastern Pacific. There is also restricted flow of genes in largetooth sawfish between these geographic areas: Atlantic and Indo-West Pacific; Atlantic and eastern Pacific; and Indo-West Pacific and eastern Pacific (Faria et al. 2013).

Genetic analyses based on a 480-base pair sequencing of the mtDNA gene NADH-2 sequence also revealed information indicating largetooth sawfish subpopulations. West and East Atlantic subpopulations differed as did samples from Australia and the wider Indian Ocean. Collectively, a total of 19 haplotypes were identified across largetooth sawfish: One east Pacific haplotype, 12 western Atlantic haplotypes, two eastern Atlantic haplotypes, one Indian Ocean haplotype, one Vietnamese-New Guinean haplotype, and two Australian haplotypes (Faria et al., 2013). This fine-scale structuring by haplotypes was only partially corroborated by the regional variation in the number of rostral teeth. While the rostral tooth count differed significantly in largetooth sawfish collected from the western and eastern Atlantic Ocean, it did not vary significantly between specimens collected from the Indian Ocean and western Pacific (Faria et al., 2013). Largetooth sawfish collected from the western Atlantic specimens had a higher rostral teeth count than those collected from the eastern Atlantic. Data from separate protein and genetics studies indicates some evidence of distinction among populations of largetooth sawfish in the Indo-Pacific. At a broad scale, Watabe (1991) found that there was limited genetic variability between samples taken from Australia and Papua New Guinea based on lactate dehydrogenase (LDH) isozyme patterns. Largetooth sawfish might be genetically subdivided within the Gulf of Carpentaria, Australia, with both eastern and western Gulf populations (Lack et al., 2009).

Phillips et al. (2011) found that the population of largetooth sawfish in the Gulf of Carpentaria is different from animals on the west coast of Australia (Fitzroy River) based on mtDNA. Recent data (Phillips, 2012) suggests that matrilineal structuring is found at relatively small spatial scales within the Gulf of Carpentaria region (i.e., this region contains more than one maternal `population'), although the precise location and nature of population boundaries are unknown. The difference in the genetic structuring using markers with different modes of inheritance (maternal versus bi- parental) suggests that largetooth sawfish may have male-biased dispersal and females remaining at, or returning to, their birth place to mate (Phillips et al., 2009; Phillips, 2012). Phillips (2012) noted that the presence of male gene flow between populations in Australian waters suggests that a decline of males in one location could affect the abundance and genetic diversity of assemblages in other locations.

The genetic diversity for largetooth sawfish throughout Australia seems to be low to moderate. Genetic diversity was greater in the Gulf of Carpentaria than in Australian rivers, also suggesting potential philopatry: Animals return to or stay in their home range (Lack et al., 2009). Yet, given limited sampling, additional research is needed to better understand potential population structure of largetooth sawfish in Australia (Lack et al., 2009; Phillips et al., 2009; Morgan et al., 2010a; Morgan et al., 2010b).

Distribution and Abundance

Largetooth sawfish have the largest historical range of all sawfishes. The species historically occurred throughout the Indo-Pacific near Southeast Asia and Australia and throughout the Indian Ocean to east Africa. Older literature notes the presence of this species in Zanzibar, Madagascar, India, and the southwest Pacific (Fowler, 1941; Wallace, 1967; Taniuchi et al., 2003). Largetooth sawfish have also been noted in the Eastern Pacific Ocean from Mexico to Ecuador (Cook et al., 2005) or possibly Peru (Chirichigno and Cornejo, 2001). In the Atlantic Ocean, largetooth sawfish inhabit warm temperate to tropical marine waters from Brazil to the Gulf of Mexico in the western Atlantic, and Namibia to Mauritania in the eastern Atlantic (Burgess et al., 2009).

Given the recent taxonomic changes for largetooth sawfish, we examined all current and historic records of P. microdon, P. perotteti, and P. pristis for a comprehensive overview on distribution and abundance. We conducted an extensive search of peer-reviewed publications and technical reports, newspaper, records from the GBIF Database, and magazine articles. The results of that search are summarized below by major geographic region.

Indian Ocean

Largetooth sawfish historically occurred throughout the Indian Ocean; however, current records are rare for many areas. The earliest record of largetooth sawfish was in 1936 from Grand Lac near the Gulf of Aden, Indian Ocean (Kottelat, 1985). A second record in 1936 is from the Mangoky River, Madagascar (Taniuchi et al., 2003).

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Records from the 1960s and 1970s are largely from India and South Africa. One largetooth sawfish was reported from the confluence of the Lundi and Sabi Rivers, South Africa in 1960, over 200 miles (mi) inland (Jubb, 1967). Between 1964 and 1966, several largetooth sawfish were caught in the Zambesi River, South Africa during a general survey of rays and skates; largetooth sawfish have also been recorded in the shark nets off Durban, South Africa (Wallace, 1967). In 1966, a male (10 ft; 305 cm TL) was captured in a trawl net in the Gulf of Mannar, Sri Lanka (Gunn et al., 2010). Largetooth sawfish were commonly caught between 1973 and 1974 in the Bay of Bengal during the wet season (July and September) but rarely during other times of the year. Largetooth sawfish were also reported in three major rivers that empty into the Bay of Bengal: The Pennaiyar, Paravanar, and Gadilam (Devadoss, 1978).

Current reports of largetooth sawfish throughout the Indian Ocean are isolated and rare. Largetooth sawfish were recorded in South Africa 1992 and 1993 between Nelson Mandela Bay and Cape Town. Eight additional observations are reported in South Africa but associated date information was not included (GBIF database). While the species could not be confirmed, a survey of fishing landing sites and interviews with 99 fishers in Kenya by Nyingi found 71 reports of sawfishes over the last 40 years (unpublished report from Dorothy Wanja Nyingi to J. Carlson, NMFS, 2007). The longest time series of largetooth sawfish catches is from the swimmer protection beach nets off Natal, South Africa with a yearly average capture rate of 0.2 sawfish per 0.6 mi (1 km) net per year from 1981 to 1990; since then only two specimens have been caught (CITES, 2007). Largetooth sawfish were reported in Cochin, India by the Central Marine Fisheries Research Institute in 1994, but no information about location, size, or number of animals is available (Dan et al., 1994). **Commercial** landings of elasmobranchs from 1981 to 2000 in the Bay of Bengal were mostly rays with some largetooth sawfish (Raje and Joshi, 2003). In the Betsiboka River, Madagascar, four largetooth sawfish were caught in 2001. The most recent capture of a largetooth sawfish (18 ft; 550 cm TL) in India occurred on January 18, 2011, between Karnataka and Goa (www.mangalorean.com).

Indo-Pacific Ocean (Excluding Australia)

Many islands within the Indo-Pacific region contain suitable habitat for largetooth sawfish, but few reports are available, perhaps due to the lack of surveys or data reporting. The earliest records of largetooth sawfish from the Indo-Pacific are from a compilation study of elasmobranchs in the waters off Thailand that reports a largetooth sawfish in the Chao Phraya River and its tributaries in 1945 (Vidthayanon, 2002). In 1955, two largetooth sawfish were captured from Lake Sentani (present day Intan Jaya, Indonesia). Juvenile largetooth sawfish have also been reported around the same time in a freshwater river close to Genjem, Indonesia (Boeseman, 1956). In 1956, largetooth sawfish were recorded in Lake Sentani (present day Intan Jaya, Indonesia), (Boeseman, 1956; Thorson et al., 1966). In a study by Munro (1967) in the Laloki River in the southeastern portion of New Guinea, no sawfish were captured. From 1967 to 1977, five largetooth sawfish were captured from the Indragiri River, Sumatra (Taniuchi, 2002). The presence of largetooth sawfish in the Mahakam River, Borneo was recorded in 1987 (Christensen, 1992). Three largetooth sawfish rostra were acquired from local fish markets in Sabah in 1996 (Manjaji, 2002a). Additional surveys of local fish markets indicate largetooth sawfish are still present in these areas, although locals have noticed a decline in their abundance (Manjaji, 2002a). In 1996, two specimens were found in Malaysia: One in Palau Nangka and one in Palau Besar (GBIF Database).

Multiple records of largetooth sawfish have occurred in areas throughout Papua New Guinea. From 1970 to 1971, Berra et al. (1975) collected five largetooth sawfish from the Laloki River, Papua New Guinea. Four largetooth sawfish were recorded in 1975 from the Fly River system, Papua New Guinea and one in 1979 in the northern part of Papua New Guinea near new Tangu (GBIF Database). In a survey of the Fly River system, Papua New Guinea, 23 individuals were captured in 1978 (Roberts, 1978; Taniuchi and Shimizu, 1991; Taniuchi et al., 1991b; Taniuchi, 2002). There are two reports of largetooth sawfish in the 1980s in Papua New Guinea: One in 1987 and one in 1988 (GBIF Database). More recently, 36 largetooth sawfish were captured in September 1989 in Papua New Guinea (Taniuchi and Shimizu, 1991; Taniuchi, 2002).

The scarcity of records from Indo-Pacific led to an increased effort to document species presence. Anecdotal evidence suggests that largetooth sawfishes have not been recorded in Indo-Pacific for more than 25 years (White and Last, 2010). Largetooth sawfish have not been recorded in the Mekong River, Laos for decades (Rainboth, 1996). In a comprehensive study compiled by Compagno (2002a), no sawfishes were found in the South **China** Sea between the years of 1923 and 1996. Data from 200 survey days at fish landing sites in eastern Indonesia between 2001 and 2005 recorded over 40,000 elasmobranchs, but only 2 largetooth sawfish (White and Dharmadi, 2007; Kyne and Feutry, 2013).

Australia

Australia may have a higher abundance of largetooth sawfish than other areas within the species' current range (Thorburn and Morgan, 2005; Field et al., 2009). Despite their current abundance levels, we only identified a few historic records from Australia. The first record of a largetooth sawfish was in 1945 in the Northern Territory (Stevens et al., 2005). There was a subsequent record in 1947, and two largetooth sawfish from the Gulf of Carpentaria, Queensland were reported in 1959 (GBIF Database). Faria et al. (2013) obtained a rostrum that was collected in Australia in 1960.

 

Since the 1980s, we found significantly more records of largetooth sawfish in Australia than other regions. A largetooth sawfish was captured from the Keep River, Australia in 1981 (Compagno and Last, 1999). Three largetooth sawfish were recorded in 1984 near Marchinbar **Island**, Northern Territory (GBIF Database). Blaber et al. (1990) found that largetooth sawfish were among the top twenty-five most abundant species in the trawl fisheries of Albatross Bay from 1986 to 1988. Three largetooth sawfish were reported from the Gulf of Carpentaria, Queensland: One in 1987 in Walker Creek, one in 1988 in the Gilbert River, and one in 1991 in Marrakai Creek, a tributary of the Adelaide River, Northern Territory (GBIF Database). Eight individuals were captured in the Leichhardt River in 2008 (Morgan et al., 2010b). In a preliminary survey of the McArthur River, Northern Territory, Gorham (2006) reported two largetooth sawfish captured between 2002 and 2006. Surveys (Peverell, 2005; Gill et al., 2006; Peverell, 2008) in the Gulf of Carpentaria found largetooth sawfish widely distributed throughout the eastern portion of the Gulf with most catches occurring near the mouth of

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many rivers (Mitchell, et al., 2005; 2008).

Juvenile largetooth sawfish in Australia use the Fitzroy River and other tributaries of King Sound (Morgan et al., 2004) as nursery areas while adults are found more often offshore (Morgan et al., 2010a). In Western Australia, besides the Fitzroy River and King Sound, the only other areas where juvenile sawfish have been recently recorded are in Willie Creek and Roebuck Bay (Gill et al., 2006; Morgan et al., 2011). Nursery areas for largetooth sawfish are also reported in northern Australia in the Gulf of Carpentaria (Gorham, 2006). Juvenile largetooth sawfish have been captured within the Adelaide River, Australia in 2013 (P. Kyne, Charles Darwin University, pers. comm., 2013). Abundance estimates for the largetooth sawfish from areas that support higher human populations may be declining (Taniuchi and Shimizu, 1991; Taniuchi et al., 1991a; Morgan et al., 2010a). Whitty et al. (2009) found that the population of juvenile largetooth sawfish in the Fitzroy River had declined; catch per unit effort was 56.7 sawfish per 100 hours in 2003 compared to 12.4 in 2009. There were no reported captures of largetooth sawfish in 2008 from the Roper River system, which drains into the western Gulf of Carpentaria, Northern Territory (Dally and Larson, 2008). No adult sawfish were captured in any of the prawn trawl fisheries in Queensland, Australia during the month of October 2001 (Courtney et al., 2006).

Outside the northern and western areas of Australia, largetooth sawfish do occur but reports are less frequent. In southwestern Australian waters, one female sawfish was captured by a **commercial** shark fisherman in February 2003 east of Cape Naturaliste (Chidlow, 2007). Data from the Queensland, Australia Shark Control Program shows a clear decline in sawfish catch over a 30 year period from the 1960s, and the complete disappearance of sawfish in southern regions by 1993 (Stevens et al., 2005).

Eastern Pacific

In the eastern Pacific, the historic range of largetooth sawfish was from Mazatlan, Mexico to Guayaquil, Ecuador (Cook et al., 2005) or possibly Peru (Chirichigno and Cornejo, 2001). There is very little information on the population status in this region and few reports of capture records. The species has been reported in freshwater in the Tuyra, Culebra, Tilapa, Chucunaque, Bayeno, and Rio Sambu Rivers, and at the Balboa and Miraflores locks in the Panama Canal, Panama; in Rio San Juan, Colombia; and in the Rio Goascoran, along the border of El Salvador and Honduras (Fowler, 1936, 1941; Beebe and Tee-Van, 1941; Bigelow and Schroeder, 1953; Thorson et al., 1966a; Dahl, 1971; Thorson, 1974, 1976, 1982a, 1982b, 1987; Compagno and Cook, 1995; all as cited in Cook et al., 2005). There are 4 records of largetooth sawfish south of Purto Vallarta, Mexico in 1975, and several reports from Panama with no associated dates (GBIF Database). The only recent reports of largetooth sawfish in this area are anecdotal reports from Colombia, Nicaragua, and Panama (R. Graham, Wildlife Conservation Society, pers. comm. to IUCN, 2012).

Western Atlantic Ocean

In the western Atlantic Ocean, largetooth sawfish were widely distributed throughout the marine and estuarine waters in tropical and subtropical climates and historically found from Brazil through the Caribbean, Central America, the Gulf of Mexico, and seasonally into waters of the United States (Burgess et al., 2009). Largetooth sawfish also occurred in freshwater habitats in Central and South America. Throughout the Caribbean Sea, the historical presence of the largetooth sawfish is uncertain and early records might have been misidentified smalltooth sawfish (G. Burgess, Florida Museum of Natural History, pers. comm. to IUCN, 2012).

Historic records of largetooth sawfish in the western north Atlantic have been previously reported in NMFS (2010a). Sawfish were documented in Central America in Nicaragua as early as 1529 by a Spanish chronicler (Gill and Bransford, 1877). This species was also historically reported in Nicaragua by Meek (1907), Regan (1908), Marden (1944), Bigelow and Schroeder (1953) and Hagberg (1968). Five largetooth sawfish were reported from a survey of Lake Izabal, Guatemala from 1946 to 1947, and sawfishes were reported to be important to inland fisheries (Saunders et al., 1950). There is a single largetooth sawfish report from Honduras, but the true origin of the rostrum and the date of capture could not be confirmed (NMFS, 2010a).

In Atlantic drainages, largetooth sawfish has been found in freshwater at least 833 miles (1,340 km) from the ocean in the Amazon River system (Manacapuru, Brazil), as well as in Lake Nicaragua and the San Juan River; the Rio Coco, on the border of Nicaragua and Honduras; Rio Patuca, Honduras; Lago de Izabal, Rio Motagua, and Rio Dulce, Guatemala; and the Belize River, Belize. Largetooth sawfish are found in Mexican streams that flow into the Gulf of Mexico; Las Lagunas Del Tortuguero, Rio Parismina, Rio Pacuare, and Rio Matina, Costa Rica; and the Rio San Juan and the Magdalena River, Colombia (Thorson, 1974, 1982b; Castro-Augiree, 1978 as cited in Thorson, 1982b; Compagno and Cook, 1995; C. Scharpf and **M**. McDavitt, National Legal Research **Group**, Inc., as cited in Cook et al., 2005).

In the United States, largetooth sawfish were reported in the Gulf of Mexico mainly along the Texas coast east into Florida waters, though nearly all records of largetooth sawfish encountered in U.S. waters were limited to the Texas coast (NMFS, 2010a). Though reported in the United States, it appears that largetooth sawfish were never abundant, with approximately 39 confirmed records (33 in Texas) from 1910 through 1961.

The Amazon River basin and adjacent waters are traditionally the most abundant known range of largetooth sawfish in Brazil (Bates, 1964; Marlier, 1967; Furneau, 1969). Most of the records for which location is known originated in the state of Amazonas, which encompasses the middle section of the Amazon River basin along with the confluence of the Rio Negro and Rio Solimoes Rivers. The other known locations are from the states of Rio Grande do Norte, Sergipe, Bahia, Espirito Santo, Rio de Janeiro, Sao Paulo, Para, and Maranhao (NMFS, 2010a). Most records of largetooth sawfish in the Amazon River (Amazonia) predate 1974. The Magdalena River estuary was the primary source for largetooth sawfish encounters in Colombia from the 1940's (Miles, 1945), while other records originated from the Bahia de Cartagena and Isla de Salamanca (both marine), and Rio Sinu (freshwater) from the 1960's through the 1980's (Dahl, 1964; 1971; Frank and Rodriguez, 1976; Alvarez and Blanco, 1985). In other areas of South America, there are only single records from Guyana, French Guiana, and Trinidad from the late 1800's and early 1900's. Of the 5 records from Suriname, the most recent was 1962. Though thought to have once been abundant in some areas of Venezuela (Cervignon, 1966a, 1966b), the most recent confirmed records of largetooth sawfish from that country was in 1962.

Many records in the 1970's and 1980's are largely due to Thorson's (1982a, 1982b) research on the Lake Nicaragua-Rio San Juan system in Nicaragua and Costa Rica. Bussing (2002) indicated that this species was known to inhabit the Rio Tempisque and tributaries of the San Juan basin in Costa Rica. Following Thorson's (1982a, 1982b) studies,

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records of largetooth sawfish in the western North Atlantic decline considerably. By 1981, Thorson (1982a) was unable to locate a single live specimen in the original areas he surveyed. There are no known Nicaraguan records of the largetooth sawfish outside of the Lake Nicaragua-Rio San Juan- Rio Colorado system (Burgess et al., 2009), although largetooth sawfish are still captured incidentally by fishers netting for other species (McDavitt, 2002). Of the known largetooth sawfish reported from Mexico, most records are prior to 1978 (NMFS, 2010a). Caribbean records are very sparse (NMFS, 2010a). The last record of a largetooth sawfish in U.S. waters was in 1961 (Burgess et al., 2009).

Most recent records for largetooth sawfish are in isolated areas. While many reports of largetooth sawfish from Brazil were from the 1980's and 1990's (Lessa, 1986; Martins-Juras et al., 1987; Stride and Batista, 1992; Menni and Lessa, 1998; and Lessa et al., 1999), recent records indicate largetooth sawfish are primarily found in fish markets near the Amazon-Orinoco estuaries (Charvet-Almeida, 2002; Burgess et al., 2009). A Lake Nicaragua fisherman reports he encounters a few sawfish annually (McDavitt, 2002). Other records are rare for the area. Three recent occurrences were found in Internet searches, one being a 200 lb. (90.7 kg) specimen caught recreationally in Costa Rica (Burgess et al., 2009). Though reported by Thorson et al. (1966a, 1966b) to be common throughout the area, there are no recent reports of encounters with sawfishes in Guatemala. Scientists in Colombia have not reported any sawfish sightings between 1999 and 2009 (Burgess et al., 2009).

Eastern Atlantic Ocean

Historic records indicate that largetooth sawfish were once relatively common in the coastal estuaries along the west coast of Africa. Verified records exist from Senegal (1841-1902), Gambia (1885-1909), Guinea-Bissau (1912), Republic of Guinea (1965), Sierra Leone (date unknown), Liberia (1927), Cote d'Ivoire (1881-1923), Congo (1951-1958), Democratic Republic of the Congo (1951-1959), and Angola

 

(1951). Most records, however, lacked species identification and locality data and may have been confused taxonomically with other species. Unpublished notes from a 1950's survey detail 12 largetooth sawfish from Mauritania, Senegal, Guinea, Cote d'Ivoire, and Nigeria, ranging in size from 35-275 in (89-700 cm) TL (Burgess et al., 2009).

A more recent status review by Ballouard et al. (2006) reported that sawfishes, including the largetooth sawfish, were once common from Mauritania to the Republic of Guinea, but are now rarely captured or encountered. According to this report, the range of sawfishes has decreased to the Bissagos Archipelago (Guinea Bissau). The most recent sawfish encounters outside Guinea Bissau were in the 1990's in Mauritania, Senegal, Gambia, and the Republic of Guinea. The most recent documented largetooth sawfish capture was from 2005 in Nord de Caravela (Guinea Bissau), along with anecdotal accounts from fishers of captures off of two islands in the same area in 2008 (Burgess et al., 2009).

In summary, on a global scale, largetooth sawfish appear to have been severely fragmented throughout their historic range into isolated populations of low abundance. Largetooth sawfish are now considered very rare in many places where evidence is available, including parts of East Africa, India, parts of the Indo-Pacific region, Central and South America and West Africa. Even within areas like Australia and Brazil, the species is primarily located in remote areas. Information from genetic studies indicates that largetooth sawfish display strong sex-biased dispersal patterns; with females exhibiting patterns of natal philopatry while males move more broadly between populations (Phillips et al., 2011). Thus, the opportunity for re-establishment of these isolated populations is limited because any reduction in female abundance in one region is not likely to be replenished by movement from another region (Phillips, 2012).

Natural History of Green Sawfish (Pristis zijsron)

Taxonomy and Morphology

Pristis zijsron (Bleeker, 1851) is frequently known as the narrowsnout sawfish or the green sawfish. Synonymous names include P. dubius (Gloerfelt- Tarp and Kailola, 1984; Van Oijen et al., 2007; Wueringer et al., 2009). An alternative spelling for this species' scientific name (P. zysron) is found in older literature, due to either inconsistent writing or errors in translation or transcription (Van Oijen et al., 2007).

The green sawfish has a narrow saw with 25-32 small, slender rostral teeth; tooth count may vary geographically (Marichamy, 1969; Last and Stevens, 1994; Morgan et al., 2010a). Specimens collected along the west coast of Australia have 24-30 left rostral teeth and 23-30 right rostral teeth (Morgan et al., 2010a), although other reports are 23-34 (Morgan et al., 2011). There have been no studies to determine sexual dimorphism from rostral tooth counts for green sawfish. The rostral teeth are generally denser near the base of the saw than at the apical part of the saw (Blegvad and Loppenthin, 1944). The total rostrum length is between 20.6-29.3 percent of the total length of the animal and may vary based on the number and size of individuals. In general, green sawfish have a greater rostrum length to total length ratio than other sawfish species (Morgan et al., 2010a, 2011).

In terms of body morphology, the origin of the first dorsal fin on green sawfish is slightly posterior to the origin of pelvic fins. The lower caudal lobe is not well defined and there is no subterminal notch (Gloerfelt-Tarp and Kailola, 1984; Compagno et al., 1989; Last and Stevens, 1994; Compagno and Last, 1999; Bonfil and Abdallah, 2004; Wueringer et al., 2009; Morgan et al., 2010a; Morgan et al., 2011). The green sawfish has limited buccopharyngeal denticles and regularly overlapping monocuspidate dermal denticles on its skin. As a result, there are no keels or furrows formed on the skin (Deynat, 2005). The green sawfish is greenish brown dorsally and white ventrally. This species might be confused with the dwarf or smalltooth sawfish due to its similar size and range (Compagno et al., 2006c).

Habitat Use and Migration

The green sawfish mostly uses inshore, marine habitats, but it has been found in freshwater environments (Gloerfelt-Tarp and Kailola, 1984; Compagno et al., 1989; Compagno, 2002b; Stevens et al., 2008; Wueringer et al., 2009). In the Gilbert and Walsh Rivers of Queensland, Australia, specimens have been captured as far as 149 miles (240 km) upriver (Grant, 1991). However, Morgan et al. (2010a, 2011) report green sawfish do not move into freshwater for any portion of their lifecycle. Like most sawfishes, the green sawfish prefers muddy bottoms in estuarine environments (Last, 2002). The maximum depth recorded for this species is 131 ft (40 **m**) but it is often found in much shallower waters, around 16 ft (5 **m**; Compagno and Last, 1999; Wueringer et al., 2009). Adults tend to spend more time in offshore waters in Australia, as indicated by interactions with the offshore Pilbara Fish Trawl Fishery, while juveniles prefer protected, inshore waters (Morgan et al., 2010a; Morgan et al., 2011).

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Age and Growth

 

At birth pups are between 2 ft and 2 ft 7 in (61 and 80 cm) TL. At age 1 green sawfish are generally around 4 ft 3 in (130 cm) TL (Morgan et al., 2010a). Peverell (2008) found between ages 1 and 5, green sawfish measure between 4 ft 2 in and 8 ft 5 in (128 and 257 cm) TL, based on the vertebral analysis of 6 individuals (Peverell, 2008; Morgan et al., 2010a; Morgan et al., 2011). A 12 ft 6 in (380 cm) TL green sawfish was found to be age 8, a 14 ft 4 in (438 cm) TL individual was found to be age 10, a 14 ft 9 in (449 cm) TL specimen was found to be age 16, and a 15 ft (482 cm) TL specimen was found to be age 18 (Peverell, 2008; Morgan et al., 2011).

Adult green sawfish often reach 16 ft 5 in (5 **m**) TL, but may grow as large as 23 ft (7 **m**) TL (Compagno et al., 1989; Grant, 1991; Last and Stevens, 1994; Compagno and Last, 1999; Bonfil and Abdallah, 2004; Compagno et al., 2006c; Morgan et al., 2010a). The largest green sawfish collected in Australia was estimated to be 19 ft 8 in (600 cm) TL based on a rostrum length of 5 ft 5 in (165.5 cm; Morgan et al., 2010a; Morgan et al., 2011).

Peverell (2008) completed an age and growth study for green sawfish using vertebral growth bands. Von Bertalanffy growth model parameters from both sexes combined resulted in estimated maximum theoretical size of 16 ft (482 cm) TL, relative growth rate of 0.12 per year and theoretical time at zero length of 1.12 yrs. The theoretical maximum age for this species is calculated to be 53 years (Peverell, 2008; Morgan et al., 2010a).

Reproduction

Last and Stevens (2009) reported size at maturity for green sawfish at 9 ft 10 in (300 cm) TL, corresponding to age 9. In contrast, Peverell (2008) reported one mature individual of 12 ft 4 in (380 cm) TL and estimated its age as 9 yrs. Using the growth function from Peverell (2008) and assuming length of maturity at 118 in (300 cm), Moreno Iturria (2012) determined maturation is likely to occur at age 5. Demographic models based on life history data from the Gulf of Carpentaria indicate the generation time is 14.6 years, the intrinsic rate of population increase is 0.02 per year, and population doubling time is approximately 28 years (Moreno Iturria, 2012).

Green sawfish give birth to as many as 12 pups during the wet season (January through July); Last and Stevens, 1994; Peverell, 2008; Morgan et al., 2010a, 2011). In Western Australia, females are known to pup in areas between One Arm Point and Whim Creek, with limited data for all other areas (Morgan et al., 2010a; Morgan et al., 2011). The Gulf of Carpentaria, Australia is also a known nursery area for green sawfish (Gorham, 2006). It is not known where the green sawfish breed or their length of gestation.

Diet and Feeding

Like other sawfish, green sawfish use their rostra to stun small, schooling fishes, such as mullet, or use it to dig up benthic prey, including mollusks and crustaceans (Breder Jr., 1952; Rainboth, 1996; Raje and Joshi, 2003; Compagno et al., 2006c; Last and Stevens, 2009). One specimen captured in 1967 in the Indian Ocean had jacks and razor fish (Caranx and Centriscus) species in its stomach (Marichamy, 1969). In Australia, the diet of this species often includes shrimp, croaker, salmon, glassfish, grunter, and ponyfish (Morgan et al., 2010a).

Population Structure

Faria et al. (2013) found no global population structure for green sawfish in their genetic studies. However, geographical variation was found in the number of rostral teeth per side, suggesting some population structure may occur. Green sawfish from the Indian Ocean have a higher number of rostral teeth per side than those from western Pacific specimens (Faria et al., 2013).

In Australia, genetic analysis found differences in green sawfish between the west coast, the east coast, and the Gulf of Carpentaria (Phillips et al., 2011). Genetic data suggests these populations are structured matrilineally (from the mother to daughter) but there is no information on male gene flow at this time. These results may be indicative of philopatry where adult females return to or remain in the same area they were born (Morgan et al., 2010a; Morgan et al., 2011; Phillips et al., 2011). Phillips et al. (2011) also found low levels of genetic diversity for green sawfish in the Gulf of Carpentaria, suggesting the population may have undergone a genetic bottleneck.

Distribution and Abundance

The green sawfish historically ranged throughout the Indo-West Pacific from South Africa northward along the east coast of Africa, through the Red Sea, Persian Gulf, Southern Asia, Indo-Australian archipelago, and east to Asia as far north as Taiwan and Southern **China** (Fowler, 1941; Blegvad and Loppenthin, 1944; Smith, 1945; Misra, 1969; Compagno et al., 2002a, 2002b; Last and Stevens, 2009). Historic records indicating species presence are available from India, Southeast Asia, Thailand, Malaysia, Indonesia, New South Wales, and Australia (Cavanagh et al., 2003; Wueringer et al., 2009; Morgan et al., 2010a; Morgan et al., 2011). Green sawfish have also been found in South Africa, the South China Sea, and the Persian Gulf (Fowler, 1941; Compagno et al., 1989; Grant, 1991; Compagno and Last, 1999; Last, 2002; Compagno, 2002b; Morgan et al., 2010a). To evaluate the current distribution and abundance of the green sawfish, we conducted an extensive search of peer-reviewed publications and technical reports, newspaper, magazine articles, and the GBIF Database. The results are summarized by geographic area.

Indian Ocean

Green sawfish are widely distributed throughout the Indian Ocean with the first record coming from Saudi Arabia in 1830 (GBIF Database). An additional record was reported from the Indian Ocean in the 1850s (GBIF Database). Several green sawfish were described near the Indian archipelago in the late 1800s (Van Oijen et al., 2007). Additional historical records include one female specimen captured in the Red Sea near Dollfus in 1929. In Egypt, two green sawfish rostra were found in 1938, and an additional rostrum was found on Henjam Island, Gulf of Oman (Blegvad and Loppenthin, 1994).

Unconfirmed reports of green sawfish are available from the Andaman and Nicobar Islands, India. In 1963, a male was captured at Port Blair, Gulf of Andaman (James, 1973). A female was captured in 1967, in the same area (Marichamy, 1969). One green sawfish was captured in the St. Lucia estuary, South Africa during a survey between 1975 and 1976 (Whitfield, 1999). In 1984, a green sawfish was observed in Trafalgar, South Africa (GBIF Database).

Despite historic records, there are few current records of green sawfish in the Indian Ocean. There are some reports of green sawfish from Iraq, Iran, South Africa, and Pakistan, but no dates are available (GBIF Database). We presume green sawfish are extremely rare or extirpated in the Indian Ocean based on the lack of current records.

Indo-Pacific Ocean (Excluding Australia)

The first description of the green sawfish was based on a rostral saw (Bleeker, 1851) from Bandjarmasin, Borneo (Van Oijen et al., 2007). A juvenile male was captured in Amboine, Indonesia in 1856 (Deynat, 2005). An isolated saw from the Gulf of Thailand

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was obtained in 1895 and estimated to be from a green sawfish 4 ft 8 in (143 cm) TL (Deynat, 2005). Eight specimens were sent to the Wistar Institute of Anatomy in 1898 from Baram, British North Borneo (Fowler, 1941). One green sawfish was reported from East Sepik, Papua New Guinea in 1929 (GBIF Database). In 1940, a green sawfish specimen was collected from Zamboanga, Philippines (GBIF Database).

Many islands within the Indo-Pacific region contain suitable habitat for sawfish, but few records are available, possibly due to the lack of surveys or data reporting. Before 1995, there were few local scientific studies on elasmobranchs, and only two species of freshwater rays had been recorded in Borneo. As a result, a great effort to document any unknown species was undertaken by Fowler (2002). Rostra and records were documented in the study, including several dried rostra of green sawfish from the Kinabatangan River area in the local markets of Sabah, Borneo; no collection specifics were provided. Locals also indicated that this species could often be found in the Labuk Bay area (Manjaji, 2002a) and in the country's freshwater systems (Manjaji, 2002b); they also reported a decline of sawfish populations overall.

Elsewhere in the Indo-Pacific region, few records of green sawfish have been reported. This species is currently considered endangered in Thailand by Vidthayanon (2002) and Compagno (2002a); they also reported no sawfish species from the South China Sea from 1923 to 1996. Anecdotal evidence suggests that sawfishes have not been recorded in Indonesia for more than 25 years (White and Last, 2010). Several reports of green sawfish exist from Malaysia, Indonesia, and New Zealand without any associated dates (GBIF Database).

Australia

In Australian waters, the earliest museum collection of the green sawfish was in 1913 in Llyod Bay, Queensland, Australia (GBIF Database). The Queensland Museum houses a green sawfish specimen collected in 1929 that was found in Moreton Bay, Queensland (Fowler, 1941). Two records exist of green sawfish collected in 1936 from Adeliade, South Australia (GBIF Database). We found very few records for green sawfish during the middle part of the last century. In the late 1970s and 1980s, reports of green sawfish began to occur again. In 1978, green sawfish were recorded in the Western Territory by CSIRO (GBIF Database). There are multiple observations in 1980 of green sawfish in Australia: two from the Northern Territory, and one from the Gulf of Carpentaria (GBIF Database). A green sawfish was observed in the Gulf of Carpentaria in 1981 by CSIRO. Two were observed in Western Australia, one in 1982 and one in 1983 (GBIF Database). Two green sawfish were captured from Balgal, Queensland, Australia in

 

1985 (Beveridge and Campbell, 2005). In the Gulf of Carpentaria, two green sawfish were recorded in 1986, and one was recorded in 1987 (GBIF Database).

One green sawfish was caught in the southern portion of the Gulf of Carpentaria in late 1990 during a fish fauna survey (Blaber et al., 1994). Alexander (1991) captured a female green sawfish from the west coast of Australia that was used for a morphological study. Between 1994 and 2010, almost 50 tissue samples were taken from live green sawfish or dried rostra from multiple areas around Australia, primarily the Gulf of Carpentaria and northwest and northeast coasts (Phillips et al., 2011). In 1997, one green sawfish was found at the mouth of Buffalo Creek near Darwin, Northern Territory (Chisholm and Whittington, 2000). In a survey from 1999 through 2001 by White and Potter, (2004), one green sawfish was captured in Shark Bay, Queensland. In 1999, one green sawfish was captured by CSIRO from the Gulf of Carpentaria (GBIF Database). Peverell (2005, 2008) noted the green sawfish was one of the least encountered species in a survey from the Gulf of Carpentaria. In 2004, one green sawfish was reported near Darwin, Northern Territory by the European Molecular Biology Lab (GBIF Database). No green sawfish were captured from the Roper River system in 2008, which drains into the western Gulf of Carpentaria, Northern Territory (Dally and Larson, 2008). Some records have been reported for the east coast of Australia; one female green sawfish was acoustically tracked for 27 hours in May 2004 (Peverell and Pillans, 2004; Porteous, 2004). Peverell (2005, 2008) noted the green sawfish was one of the least encountered species in a survey from the Gulf of Carpentaria.

In summary, limited data makes it difficult to determine the current range and abundance of green sawfish. Nonetheless, given the uniqueness (size and physical characteristics) of the sawfish, we believe the lack of records in the areas where the species was historically found indicates the species is no longer present or has declined to extremely low levels. Extensive surveys at fish landing sites throughout Indonesia since 2001 have failed to record the green sawfish (White pers. comm. to IUCN, 2012). There is some evidence from the Persian Gulf and Red Sea (e.g., Sudan) of small but extant populations (A. Moore, RSK Environment Ltd., pers. comm. to IUCN, 2012). Green sawfish are currently found primarily along the northern coast of Australia, but all sawfish species have undergone significant declines in Australian waters. The southern extent of the range of green sawfishes in Australia has contracted (Harry et al., 2011). Green sawfish have been reported as far south as Sydney, New South Wales, but are rarely found as far south as Townsville, Queensland (Porteous, 2004).

Natural History of the Non-Listed Population(s) of Smalltooth Sawfish (Pristis pectinata)

This section includes information from the listed U.S. DPS of smalltooth sawfish. The U.S. DPS of smalltooth sawfish was listed as endangered on April 1, 2003 (68 FR 15674). The basis of the U.S. DPS smalltooth sawfish listing was the significant differences in management across international borders. We discuss information from the U.S. DPS of smalltooth sawfish here because there is very little basic biological information on smalltooth sawfish found outside the U.S. We believe the information from the U.S. DPS is likely representative of the non-U.S. population of smalltooth sawfish and is useful for understanding its biology and extinction risk.

Taxonomy and Morphology

The smalltooth sawfish was first described as Pristis pectinatus, Latham 1794. The name was changed to the currently valid P. pectinata to match gender of the genus and species as required by the International Code of Zoological Nomenclature.

The smalltooth sawfish has a thick body with a moderately sized rostrum. As with many other sawfishes, tooth count varies by individual or region. While there is no reported difference in rostral tooth count between sexes, there have been reports of sexual dimorphism in tooth shape, with males having broader teeth than females (Wueringer et al., 2009). Rostral teeth are denser near the apex of the saw than the base. Most studies report a rostral tooth count of 25 to 29 for smalltooth sawfish (Wueringer et al., 2009). The saw may constitute up to one-fourth of the total body length (McEachran and De Carvalho, 2002).

The pectoral fins are broad and long with the origin of the first dorsal fin over or anterior to the origin of the

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pelvic fins (Faria et al., 2013). The lower caudal lobe is not well defined and lacks a ventral lobe (Wallace, 1967; Gloerfelt-Tarp and Kailola, 1984; Last and Stevens, 1994; Compagno and Last, 1999; Bonfil and Abdallah, 2004; Wueringer et al., 2009). This species has between 228 and 232 vertebrae (Wallace, 1967).

The smalltooth sawfish has buccopharyngeal denticles and regularly overlapping monocuspidate (single-pointed) dermal denticles on their skin. As a result, there are no keels or furrows formed on the skin (Last and Stevens, 1994; Deynat, 2005). The body is an olive grey color dorsally, with a white ventral surface (Compagno et al., 1989; Last and Stevens, 1994; Compagno and Last, 1999). This species may be confused with the narrow or green sawfish (Compagno, 2002b).

Habitat Use and Migration

All research on habitat use and migration has been conducted on the U.S. DPS of smalltooth sawfish. A summary of recent information (NMFS, 2010b) indicates smalltooth sawfish are generally found in shallow waters with varying salinity level that are associated with red mangroves (Rhizophora mangle). Juvenile sawfish appear to have small home ranges and limited movements. Simpfendorfer et al. (2011) reported smalltooth sawfish have an affinity for salinities between 18 and at least 24 ppt, suggesting movements are likely made, in part, to remain within this salinity range. Therefore, freshwater flow may affect the location of individuals within an estuary. Poulakis et al. (2011) found juvenile smalltooth sawfish had an affinity for water less than 3 ft (1.0 **m**) deep, water temperatures greater than 86 degrees Fahrenheit (30 degrees Celsius), dissolved oxygen greater than 6 mg per liter, and salinity between 18 and 30 ppt. Greater catch rates for smalltooth sawfish less than 1 year old were associated with shoreline habitats with overhanging vegetation such as mangroves. Poulakis et al. (2012) further determined daily activity space of smalltooth sawfish is less than 1 mi (0.7 km) of river distance. Hollensead (2012) reported smalltooth sawfish activity areas ranged in size from 837 square yards to 240,000 square yards to approximately 3 **million** square yards (0.0007 to 2.59 km^2^) with average range of movements of 2.3 yards to 6.67 yards (2.4 to 6.1 **m**) per minute. Hollensead (2012) also found no difference in activity area or range of movement between ebb and flood, or high and low tide. Smalltooth sawfish movements at night suggest possible nocturnal foraging. Using a combination of data from pop-off archival transmitting tags across multiple institutional programs, movements and habitat use of adult smalltooth sawfish were determined in southern Florida and the Bahamas (Carlson et al., 2013). Smalltooth sawfish generally remained in coastal waters at shallow depths less than 32 ft; (10 **m**) for more than 96 percent of the time that they were monitored. Smalltooth sawfish also remained in warm water temperatures of 71.6 to 82.4 degrees Fahrenheit (22 to 28 degrees Celsius) within the region where they were initially tagged. Tagged smalltooth sawfish traveled an average of 49 mi (80.2 km) from deployment to pop-off location during an average of 95 days. No smalltooth sawfish tagged in U.S. or Bahamian waters have been tracked to countries outside where they were tagged.

Age and Growth

There is no age and growth data for smalltooth sawfish outside of the U.S. DPS. A summary of age and growth data on the U.S. DPS of smalltooth sawfish (NMFS, 2010b) indicates rapid juvenile growth for smalltooth sawfish for the first two years after birth. Recently, Scharer et al. (2012) counted bands on sectioned vertebrae from naturally deceased smalltooth sawfish and estimated von Bertalanffy growth parameters. Theoretical maximum size was estimated at 14.7 ft (4.48 **m**), relative growth was 0.219 per year, with theoretical maximum size at 15.8 years.

Reproduction

In the eastern Atlantic Ocean, smalltooth sawfish have been recorded breeding in Richard's Bay and St. Lucia, South Africa (Wallace, 1967; Compagno et al., 1989; Compagno and Last, 1999). Pupping grounds are usually inshore, in marine or fresh water. Pupping occurs year-around in the tropics, but in only spring and summer at higher latitudes (Compagno and Last, 1999). Records of captive breeding have been reported from the Atlantis Paradise **Island** Resort Aquarium in Nassau, Bahamas; copulatory behavior was observed in 2003 and six months later the female aborted the pups for unknown reasons (McDavitt, 2006). In October 2012, a female sawfish gave birth to five live pups at the Atlantis Paradise **Island** Resort Aquarium in Nassau, Bahamas (J. Choromanski, Ripley's Entertainment pers. comm to NMFS, 2013).

Several studies have examined demography of smalltooth sawfish in U.S. waters. Moreno Iturria (2012) calculated demographic parameters for smalltooth sawfish in U.S. waters and estimated intrinsic rates of increase at seven percent annually with a population doubling time of 9.7 years. However, preliminary results of a different model by Carlson et al. (2012) indicates population increase rates may be greater, up to 17.6 percent annually, for the U.S. population of smalltooth sawfish. It is not clear which of these models is more appropriate for the non-U.S. population of smalltooth sawfish.

Diet and Feeding

Smalltooth sawfish often use their rostrum saw in a side-sweeping motion to stun their prey, which may include small fishes, or to dig up invertebrates from the bottom (Breder Jr., 1952; Compagno et al., 1989; Rainboth, 1996; McEachran and De Carvalho, 2002; Raje and Joshi, 2003; Last and Stevens, 2009; Wueringer et al., 2009).

Population Structure

 

A qualitative examination of genetic sequences revealed no geographical structuring of smalltooth sawfish haplotypes; however, variation in the number of rostral teeth per side was found in specimens from the western and eastern Atlantic Ocean (Faria et al., 2013).

Distribution and Abundance

Smalltooth sawfish were thought to be historically found in South Africa, Madagascar, the Red Sea, Arabia, India, the Philippines, along the coast of West Africa, portions of South America including Brazil, Ecuador, the Caribbean Sea, the Mexican Gulf of Mexico, as well as Bermuda (Bigelow and Scheroder, 1953; Wallace, 1967; Van der Elst 1981; Compagno et al., 1989; Last and Stevens, 1994; IUCN, 1996; Compagno and Last, 1999; McEachran and De Carvalho, 2002; Monte-Luna et al., 2009; Wueringer et al., 2009). Yet, reports of smalltooth sawfish from other than the Atlantic Ocean are likely misidentifications of other sawfish (Faria et al., 2013). The lack of confirmed reports of smalltooth sawfish from areas other than the Atlantic Ocean indicates that smalltooth sawfish are only found in the Atlantic Ocean. In the eastern Atlantic Ocean, smalltooth sawfish were historically found along the west coast of Africa from Angola to Mauritania (Faria et al., 2013). Although smalltooth sawfish were included in historic faunal lists of species found in the Mediterranean Sea (Serena, 2005), it is still unclear if smalltooth sawfish occurred as part of the Mediterranean ichthyofauna or were only seasonal migrants.

To evaluate the current and historic distribution and abundance of the

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smalltooth sawfish outside the U.S. DPS, we conducted an extensive search of peer-reviewed publications and technical reports, newspaper, records from the GBIF Database, and magazine articles. The results of that search are summarized by major geographic region.

Eastern Atlantic Ocean

Smalltooth sawfish were once common in waters off the west coast of Africa, but are now rarely reported or documented in the area. The earliest record of a smalltooth sawfish is a specimen from Namibia in 1874 (GBIF Database). Other records of smalltooth sawfish in Africa occurred in 1907 from Cameroon, five males and two females. Female specimens were recorded in the Republic of the Congo in 1911 and 1948. Other reports from the Republic of Congo include a male and two females, but dates were not recorded. An undated female specimen from Mauritania was recorded (Faria et al., 2013). A rostrum from Pointe Noire, Molez, Republic of the Congo was found in 1958 (Deynat, 2005; Faria et al., 2013). There are records of smalltooth sawfish from Senegal as early as 1956 and another rostral saw was recorded in 1959. Faria et al. (2013) also reports on four other rostra from Senegal, but no other information is available.

Many records of smalltooth sawfish from the eastern Atlantic Ocean are reported in the GBIF database during the 1960s, particularly between 1963 and 1964. The majority of these records are from Nigeria (118), but others are from Gabon (77), Ghana (51), Cameroon (43), and Liberia (39). Another online database, Fishbase (www.fishbase.org), has the same records. It is unclear if these records are duplicative due to the lack of specific information.

In the 1970s, records of smalltooth sawfish became limited to more northern areas of West Africa. One rostral saw from Senegal was recorded in 1975 (Alexander, 1991). Similarly, one rostral saw was reported from Gambia in 1977, but information about exact location or sex of the animal was absent (Faria et al., 2013). Faria et al. (2013) report a record of smalltooth sawfish in Guinea-Bissau in 1983 and a record of a saw in 1987. For a morphological study, Deynat (2005) obtained a juvenile female from Cacheu, Guinea-Bissau in 1983, and another from Port-Etienne, Mauritania, in 1986. Two rostra were reported from the Republic of Guinea, one in 1980 and one in 1988 (Faria et al., 2013).

In the last 10 years, there has been only one confirmed record of a smalltooth sawfish in the eastern Atlantic Ocean in Sierra Leone, West Africa, in 2003 (**M**. Diop, pers. comm. to IUCN, 2012). Two other countries have recently reported sawfish (Guinea Bissau, Africa in 2011, and Mauritania in 2010), but these reports did not identify the species as smalltooth sawfish.

Western Atlantic Ocean (Outside U.S Waters)

Overall, records of smalltooth sawfish in the western Atlantic Ocean are scarce and show a non-continuous range, potentially due to misidentification with largetooth sawfish. Faria et al. (2013) summarized most records of smalltooth sawfish in these areas. Faria et al. (2013) report the earliest records are a female smalltooth sawfish from Haiti in 1831 and a female sawfish from Trinidad and Tobago in 1876 (Faria et al., 2013). One smalltooth sawfish was recorded in Belem, Brazil in 1863 (GBIF Database). Two smalltooth sawfish saws were reported from Guyana in 1886, and an additional saw was later recorded in 1900. In Brazil, there is a 1910 report of a female smalltooth sawfish. In 1914, there is a report of a smalltooth sawfish in Laguna de Terminos, Mexico (GBIF Database).

In the middle part of the twentieth century, there are reports of two female smalltooth sawfish from Mexico in 1926. Rostral saws were found in Suriname in 1943, 1944, and 1963, but no additional location or specimen information is known. One rostrum was reported from Costa Rica in 1960 and one rostral saw from Trinidad and Tobago in 1944 (Faria et al., 2013). Several whole individuals and one rostrum were recorded from Guyana in 1958 and 1960. There are also several other undated specimens recorded from Guyana from this period (Faria et al., 2013). There are other records of smalltooth sawfish's presence in the western Atlantic Ocean but specific information is lacking. For example, Faria et al. (2013) report that 4 rostral saws came from Mexico and two from Belize. One female was reported from Venezuela and two rostra from Trinidad and Tobago. Despite lacking date information, the GBIF Database and Fishbase have reports of smalltooth sawfish throughout South and Central America: French Guiana (48), Mexico (9), Guyana (6), Venezuela (3), Haiti (2), and individual records from Colombia, Nicaragua, and Belize.

In summary, while records are sparse, it is likely the distribution of smalltooth sawfish in the Atlantic Ocean is patchy and has been reduced in a pattern similar to largetooth sawfish. Data suggests only a few viable populations might exist outside the United States. The Caribbean Sea may have greater numbers of smalltooth sawfish than other areas given high quality habitats and reduced urbanization. For example, smalltooth sawfish have been repeatedly reported along the western coast of Andros **Island**, Bahamas (R.D. Grubbs, Florida State University pers. comm. to J. Carlson, NMFS, 2014) and The Nature Conservancy noted two smalltooth sawfish at the northern and southern end of the **island** in 2006. Fishing guides commonly encounter smalltooth sawfish around Andros **Island** while fishing for bonefish and tarpon (R.D. Grubbs pers. comm. to J. Carlson, NMFS, 2014), and researchers tagged two in 2010 (Carlson et al., 2013). In Bimini, Bahamas, generally one smalltooth sawfish has been caught every two years as part of shark surveys conducted by the Bimini Biological Station (D. Chapman pers. comm.to Carlson, NMFS). In West Africa, Guinea Bissau represents the last areas where sawfish can be found (**M**. Diop pers. comm. to IUCN, 2012). Anecdotal reports indicate smalltooth sawfish may also be found in localized areas off Honduras, Belize, and Cuba (R. Graham, Wildlife Conservation Society, pers. comm. to IUCN, 2012).

Peer Review and Public Comments

In December 2004, the Office of Management and Budget (OMB) issued a Final Information Quality Bulletin for Peer Review pursuant to the Information Quality Act (IQA). The Bulletin was published in the Federal Register on January 14, 2005 (70 FR 2664). The Bulletin established minimum peer review standards, a transparent process for public disclosure of peer review planning, and opportunities for public participation with regard to certain types of information disseminated by the Federal Government. The peer review requirements of the OMB Bulletin apply to influential or highly influential scientific information. The proposed rule and included status review were considered influential scientific information under this policy and subject to peer review. Similarly, a joint NMFS/FWS policy (59 FR 34270; July 1, 1994) requires us to solicit independent expert review from at least three qualified specialists, concurrent with the public comment period, on the science that is the basis for listing decisions. To ensure this final rule was based on the best scientific and **commercial** data available, we solicited peer review comments from three scientists familiar with elasmobranchs.

On June 4, 2013, we published a proposed rule to list as endangered five species of sawfish: Narrow sawfish (A.

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cuspidata ), dwarf sawfish (P. clavata), largetooth sawfish (P. pristis), green sawfish (P. zijsron), and the non-U.S. DPS of smalltooth sawfish (P. pectinata), that occurs outside U.S. waters, and opened a 90-day public comment period (78 FR 33300). In the proposed rule, we stated that we were not proposing to designate critical habitat for any of the five species because they occur outside U.S. waters. During our comment period we received a request to extend the public comment period by 45 days. On August 7, 2013, we published a notice extending the public comment period by 45 days (78 FR 48134). We received a total of four public comments.

In the following sections of the document we summarize and respond to the comments received from the public and peer reviewers on the proposed rule.

Peer Review Comments

Comment 1: One commenter noted that the section of the proposed rule addressing protective efforts did not include details on the Sawfish Conservation Strategy developed by the IUCN Shark Specialist **Group**. The commenter stated that the strategy is a protective effort and will improve the conservation status of sawfishes worldwide. The commenter predicted a medium to high certainty that the actions identified in the Conservation Plan, when implemented, will be effective.

Response: We have included the IUCN Sawfish Conservation Strategy in the Protective Efforts section of this final rule. The Services established two basic criteria in the PECE for evaluating conservation efforts: (1) The certainty that the conservation efforts will be implemented, and (2) the certainty that the efforts will be effective. We evaluated the IUCN Sawfish Conservation Strategy and determined it does not meet either criterion identified in the PECE. The strategy identifies actions for countries to develop regulations or adopt management actions to implement the strategy. However, the strategy does not legally bind any country to enact laws or regulations, fund conservation actions, or otherwise implement the strategy. We believe there is considerable uncertainty that the actions identified in the strategy will be adopted by the various countries within the range of the five species of sawfish, and that resources are limited to support these actions. Therefore, we cannot find that the strategy will decrease extinction risk for any of the species.

Comment 2: One commenter stated that the Protective Efforts section of the proposed rule did not include national protective efforts except for the Convention on International Trade of Endangered Species of Wild Fauna and Flora (CITES). The commenter stated that sawfish protections in Australia were likely effective, but protections in India were likely ineffective.

Response: We updated the Protective Efforts section of the rule and included the new information on sawfish protections and conservation efforts in Australia from the Australian Government's recently published 2014 Draft Recovery Plan for Sawfish and River Sharks (Department of Environment, 2014). We also included updated information on existing laws in Australia and India designed to protect sawfishes into the Inadequacy of Existing Regulatory Mechanisms section of this final rule.

Comment 3: It was suggested we use information in Kyne et al. (2013) to update the occurrence information for P. clavata.

Response: We appreciate the new information and updated the occurrence information in the preceding sections. The information did not impact our evaluation of the status of P. clavata.

Comment 4: We received a question about the origin of the 1996 record of dwarf sawfish from the Mekong River Basin, Laos.

Response: We cite Rainboth (1996) for this report from the early 1900s that assumed the dwarf sawfish was from the Mekong River Basin, Laos. We acknowledge no specimen exists to confirm this report.

Comment 5: The validity of narrow sawfish reports from Tasmania by Deynat (2005) was questioned in one comment given the cold, temperate waters that do not support sawfish. The commenter suggested the record of the sawfish specimen in the fish collection of CSIRO in Hobart, Tasmania was erroneous.

Response: We reviewed the literature and agree with the commenter. We removed the reference to reports of narrow sawfish in Tasmania.

Public Comments

Comment 1: One commenter requested we cite a more recent reference for the information on the supply and demand of sawfish than the 1996 reference in the proposed rule. Specifically, the commenter questioned the statement that "sawfishes are in high demand throughout the world for display" and suggested that sawfishes are no longer in high demand for display in aquaria.

Response: We updated our information on the aquaria trade of sawfishes on current supply and demand of sawfishes in the Scientific and Educational Uses section and removed the statement cited by the commenter. Although we believe that sawfish are still in high demand in the aquaria trade, we recognize that the recent inclusion of all sawfishes under CITES Appendix I limits the use of sawfish for display and requires **acquisition** of animals for aquaria from captivity or captive breeding.

Comment 2: Several commenters stated that they were concerned about the impacts of including "injuring or killing a captive sawfish through experimental or potentially injurious veterinary care or conducting research or breeding activities on captive sawfish, outside the bounds of normal animal husbandry practices" in the list of activities that could result in a violation of the ESA Section 9 prohibitions. The concerns relate to the impacts on captive propagation and rearing programs being conducted by aquaria, and on the use of the latest advanced technological techniques available for captive held animals. The commenters requested clarification that fish care and husbandry techniques could continue to be used by aquaria.

 

Response: As stated in the proposed rule, sawfish held in captivity at the time of listing are afforded all of the ESA protections and may not be killed or injured or otherwise harmed, and, therefore, must receive proper care. We realize that the care of captive animals necessarily entails handling or other manipulation and we do not consider such activities to constitute injury or harm to the animals so long as adequate care, including veterinary care, is provided. Such veterinary care includes confining, tranquilizing, and anesthetizing sawfishes when such practices, procedures, or provisions are necessary and not likely to result in injury.

On the effective date of a final listing, ESA Section 9 take prohibitions automatically apply for species listed as endangered and any `take' of the species is illegal unless that take is authorized under a permit or through an incidental take statement. Incidental take statements result from ESA Section 7 consultations on the effects of federal activities. ESA Section 10 permits can authorize directed take (e.g., for scientific research or enhancement of the species) or incidental take during an otherwise lawful activity that would not be subject to ESA section 7 consultation. ESA Section 10 permits are issued to entities or persons subject to the

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jurisdiction of the United States. We encourage institutions with captive sawfish who are considering activities outside the bounds of normal animal husbandry (e.g., breeding or research) to contact NMFS Office of Protected Resources, Permits and Conservation Division, to determine if an ESA Section 10 permit is required to authorize the proposed activity. We do not have information regarding emerging advances in fish care and animal husbandry for sawfish held in captivity so we cannot determine at this time if they are outside the bounds of normal care for captive animals.

Comment 3: Several commenters requested clarification of the meaning of the terms "non-**commercial**" and "non-commercially" as those terms are used in the section titled Identification of those Activities that Would Constitute a Violation of Section 9 of the ESA.

Response: Section 3 of the ESA defines the term "**commercial** activity" to mean "all activities of industry and trade, including but not limited to, the buying and selling of commodities and activities conducted for the purposes of facilitating such buying and selling: Provided, however, That it does not include exhibitions of commodities by museums or similar cultural or historical organizations." NMFS will use the definition of "**commercial** activity" to evaluate whether an activity is "non-**commercial**" or a sawfish is being held "non-commercially" in captivity.

Our listing determinations and summary of the data on which it is based, with the incorporated changes, are presented in the remainder of this document.

Species Determinations

We first consider whether the narrow sawfish (A. cuspidata), dwarf sawfish (P. clavata), largetooth sawfish (P. pristis), green sawfish (P. zijsron), and of the non-U.S. DPS of smalltooth sawfish (P. pectinata) meet the definition of "species" pursuant to section 3 of the ESA. Then we consider if any populations meet the DPS criteria.

Consideration as a "Species" Under the Endangered Species Act

Based on the best available scientific and **commercial** information described above in the natural history sections for each species, we have determined that the narrow sawfish (A. cuspidata), dwarf sawfish (P. clavata), largetooth sawfish (P. pristis), and green sawfish (P. zijsron) are taxonomically- distinct species and therefore eligible for listing under the ESA. The largetooth sawfish (P. pristis) now includes the formerly recognized species P. microdon and the previously listed P. perotteti. The decision to list P. pristis will replace our 2011 listing determination for P. perotteti.

Distinct Population Segments

In order to determine if the petitioned and currently non-listed population segment of smalltooth sawfish (P. pectinata) constitutes a "species" eligible for listing under the ESA, we evaluated it under our joint NMFS- USFWS Policy regarding the recognition of distinct population segments (DPS) under the ESA (61 FR 4722; February 7, 1996). We examined the three criteria that must be met for a DPS to be listed under the ESA: (1) The discreteness of the population segment in relation to the remainder of the species to which it belongs; (2) the significance of the population segment to the remainder of the species to which it belongs; and (3) the population segment's conservation status in relation to the Act's standards for listing (i.e., Is the population segment, when treated as if it were a species, endangered or threatened?).

A population may be considered discrete, if it satisfies one of the following conditions: (1) It is markedly separated from other populations of the same taxon as a consequence of physical, physiological, ecological, or behavioral factors; or (2) it is delimited by international governmental boundaries within which differences of control of exploitation, management of habitat, conservation status, or regulatory mechanisms exist that are significant in light of section 4(a)(1)(D) of the ESA.

We previously determined that smalltooth sawfish in the United States merited protection as a DPS and listed the U.S. DPS of smalltooth sawfish as endangered (68 FR 15674; April 1, 2003). At that time, there was no information available to indicate smalltooth sawfish in U.S. waters interact with those in international waters or other countries, suggesting that the U.S. population may be effectively isolated from other populations. However, there were few scientific data on the biology of smalltooth sawfish, and it was not possible to conclusively subdivide this species into discrete populations on the basis of genetics, morphology, behavior, or other biological characteristics. Because there were no identified mechanisms regulating the exploitation of this species anywhere outside of the United States, we considered that lack of protection as directly relevant to the inadequacy of existing regulatory mechanisms and a basis for considering the U.S. population as discrete across international boundaries.

We now evaluate the non-U.S. population of smalltooth sawfish to determine if it meets the discreteness criteria of the joint DPS policy. First, we determine whether the non-U.S. population of smalltooth sawfish is discrete from the U.S. population because it is delimited by international governmental boundaries within which differences of control of exploitation, management of habitat, conservation status, or regulatory mechanisms exist that are significant in light of section 4(a)(1)(D) of the ESA. Because we have designated critical habitat for the U.S. DPS population of smalltooth sawfish, there is a significant regulatory mechanism for protecting smalltooth sawfish and their habitats in the United States that does not exist for the non-U.S. population of smalltooth sawfish. Movement data from smalltooth sawfish tagged in U.S. and Bahamian waters also indicate no movement to countries outside where they were tagged. This information provides support that the non-U.S. population is discrete from the already-listed U.S. DPS on the basis of being markedly separate as a consequence of ecological factors, in addition to our previous determination that the U.S. DPS is discrete on the basis of international boundaries and significant differences in regulatory mechanisms. For smalltooth sawfish outside the U.S., we have no information regarding genetic or other biological differences that would provide a strong basis for further separating the non-U.S. smalltooth sawfish population into smaller, discrete units. We, therefore, conclude that the non-U.S. population of smalltooth sawfish meets the discreteness criterion of the joint DPS policy and we consider this population as a single potential DPS.

We next must consider whether the non-U.S. population of smalltooth sawfish meets the significance criterion. The joint DPS policy gives examples of potential considerations indicating the population's significance to the larger taxon. Among these considerations is evidence that the discrete population segment would result in a significant gap in the range of the taxon. Smalltooth sawfish are limited in their distribution outside of the United States to West Africa, the Caribbean, Mexico, and Central and South America. Loss of this **group** of smalltooth sawfish would result in a significant gap in the range of this species and restrict distribution to U.S. waters. Because the loss of smalltooth sawfish in areas outside the United States would result in a

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significant gap in the range of the species, we conclude the non-U.S. population of smalltooth sawfish is significant as defined by the DPS policy.

Based on the above analysis of discreteness and significance, we conclude that the non-U.S. population of smalltooth sawfish (P. pectinata) meets the definition of a DPS and is eligible for listing under the ESA, and hereafter refer to it as the non-U.S. DPS of smalltooth sawfish.

Extinction Risk

Our updated extinction risk analysis provides a more detailed discussion of the extinction risk analysis process that we used to determine the risk of extinction for narrow sawfish, dwarf sawfish, green sawfish, largetooth sawfish, and the non-U.S. DPS of smalltooth sawfish to determine whether the species are threatened or endangered per the ESA's definitions. We used an adaptation of the approach, including the primary concepts, developed by Wainwright and Kope (1999) to organize and summarize our findings. This approach was originally developed for salmonids and has been adapted and applied in the review of many other species (Pacific salmonid, Pacific hake, walleye pollock, Pacific cod, Puget Sound rockfishes, Pacific herring, and black abalone) to summarize the status of the species according to demographic risk criteria. The approach is useful when there is insufficient quantitative data to support development of population viability models to investigate extinction risk and it allows the incorporation of sparse and qualitative data. Wainwright and Kope (1999) identified key demographic parameters that have a strong bearing on extinction risk, with a focus on risks to small populations from genetic effects and population dynamics. Using these concepts, adapted to the biology of these sawfishes and our available data, we estimated the extinction risk, based on demographic factors, for each of the five species under both current threats and threats expected in the foreseeable future. We also performed a threats assessment by identifying the severity of threats that exist now and in the foreseeable future.

We defined the "foreseeable future" as the timeframe over which threats, or the species' response to those threats, can be reliably predicted to impact the biological status of the species. We determined that the foreseeable future is approximately three generation times, calculated for each of the species based on the demographic calculations of Moreno Iturria (2012): Narrow sawfish, 14 years; dwarf sawfish, 49 years; largetooth sawfish, 48 years; green sawfish, 38 years; and the non-U.S. DPS of smalltooth sawfish, 30 years. After considering the life history of each species, availability of data, and type of threats, we concluded that three generations was an appropriate measure to evaluate threats in the foreseeable future. As a late-maturing species, with slow growth rate and low productivity, it would take more than one generation for any conservation management action to be realized and reflected in population abundance indices. The timeframe of three generations is a widely used scientific indicator of biological status, and has been applied to decision making models by many other conservation management organizations, including the American Fisheries Society, the CITES, and the IUCN.

We considered three demographic categories in which to summarize available data and assess extinction risk of each sawfish species: (1) Abundance, (2) population growth rate/productivity, and (3) genetic integrity which include the connectivity and genetic diversity of the species. We determined the extinction risk for each category, for both now and in the foreseeable future, using a five level qualitative scale to describe our assessment of the risk of extinction. At the lowest level, a factor, either alone or in combination with other factors, is considered "unlikely" to significantly contribute to risk of extinction for a species. The next lowest level is considered to be a "low" risk to contribute to the extinction risk, but could contribute in combination with other factors. The next level is considered a "moderate" risk of extinction for the species, but in combination with other factors contributes significantly to the risk of extinction. A ranking of "high" risk means that factor by itself is likely to contribute significantly to the risk of extinction. Finally, a ranking of "very high" risk means that factor is considered "highly likely" to contribute significantly to the risk of extinction.

We ranked abundance as high or very high risk which is likely to contribute significantly to the current and foreseeable risk of extinction for all five species. While it appears the northern coast of Australia supports the largest remaining groups of dwarf, largetooth, green, and narrow sawfish in the Pacific and Indian Ocean, data from the Queensland, Australia Shark Control Program show a clear decline in sawfish catch (non-species-specific) over a 30-year period from the 1960s. In addition, it shows the complete disappearance of sawfish in southern regions (Stevens et al., 2005). The available data on abundance of sawfishes indicates there are still some isolated groups of sawfish in the western and central Indo-Pacific region, but their abundance has likely declined from historic levels. Smalltooth sawfish are still being reported outside of U.S. waters in the Caribbean Sea, but records are few and mostly insular (e.g., Andros **Island**) where habitat is available and gillnet fisheries are not a threat to the species (see below). There are only four records of largetooth sawfish in the eastern Atlantic Ocean over the last decade. In the western Atlantic, recent largetooth sawfish records are from only the Amazon River basin and the Rio Colorado-Rio San Juan area in Nicaragua.

Wainright and Kope (1999) stated short- and long-term trends in abundance are a primary indicator of extinction risk. These trends may be calculated from a variety of quantitative data such as research surveys, **commercial** logbook or observer data, and landings information when accompanied by effort, but there is an absence of long-term monitoring data for all five sawfishes. We looked at the available data closely to see if we could support inferences about extinction risk based on the trends in past observations using the presence of a particular species at specified places and times (e.g., Dulvy et al., 2003; Rivadeneira et al., 2009). The available museum records, negative scientific survey results, and anecdotal reports do indicate the abundance trend for all five sawfishes is declining and population sizes are small. Information available on the species' distribution indicates the species' ranges have also contracted. In many areas where sawfish still occur, they are subject to **commercial** and artisanal fisheries and potential habitat loss. We therefore ranked the risk of extinction posed by the sawfishes' abundances as high, now and into the foreseeable future.

We next considered the species' potential growth rates and productivity as measures of their ability to recover from depleted levels and provide inherent protection against extinction risk. Sawfish have historically been classified as having both low reproductive productivity and low recovery potential. The demography of smalltooth and largetooth sawfish from the northwest Atlantic Ocean that was originally investigated using an age-structured life table (Simpfendorfer, 2000). Using known estimates of growth, mortality, and reproduction at the time, Simpfendorfer (2000) determined that intrinsic rates of

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population increase ranged from 8 to 13 percent per year, and population doubling times were approximately 5 to 8.5 years for both species. These estimates included assumptions that there was no fishing mortality, no habitat limitations, no population fragmentation, or other effects of small population sizes. Simpfendorfer (2006) further modeled the demography of smalltooth sawfish using a method for estimating the rebound potential of a population by assuming that maximum sustainable yield was achieved when the total mortality was twice that of natural mortality. This demographic model produced intrinsic rates of population increase that were from two to seven percent per year for both smalltooth and largetooth sawfish. These values are similar to those calculated by Smith et al. (2008) using the same methodology corresponding to elasmobranch species with the lowest productivity. Musick et al. (2000) noted that species with intrinsic rates of increase of less than 10 percent were particularly vulnerable to rapid population declines and a higher risk of extinction.

Some recent studies on the life history of sawfish, however, indicate they are potentially more productive than originally proposed. Growth rates (von Bertalanffy "K") for some species, like narrow sawfish, approach 0.34 per year (Peverell, 2008). Data from tag-recapture studies and analysis of vertebral growth bands from smalltooth sawfish indicate that the first few years after birth represent the time when growth is most rapid (e.g., Simpfendorfer et al., 2008; Scharer et al., 2012). Using updated life history information, Moreno Iturria (2012) calculated intrinsic rates of increase for these five species of sawfish and determined values ranging from a low of 0.02 per year for green sawfish to a high of 0.27 per year for narrow sawfish with dwarf sawfish being second highest at 0.10 per year. Considering this information, and the inferred declining trend in abundance, we conclude productivity is a moderate risk for the narrow sawfish but a high risk for the other four species. We also determined that productivity would remain a moderate risk for the narrow sawfish and is a high risk for the other four species, in the foreseeable future.

We also assessed the species' extinction risk, based on genetic diversity, spatial structure and connectivity. Population structure and levels of genetic diversity have recently been assessed for the green sawfish, dwarf sawfish, and largetooth sawfish across northern Australia using a portion of the mtDNA control region. Phillips et al. (2011) found statistically significant genetic structure within species and moderate genetic diversity among these species. These results suggest that sawfish may be more vulnerable to local extirpation along certain parts of their range, especially in areas where the population has been fragmented and movement between these areas is limited. However, these results do not necessarily suggest a higher risk of extinction throughout the entire range of the species. Chapman et al. (2011) investigated the genetic diversity of the U.S. DPS of smalltooth sawfish that has declined to between one percent to five percent of its abundance at the turn of the twentieth century, while its core distribution has contracted to less than 10 percent of its former range (NMFS, 2009). Surprisingly, given the magnitude of this population decline and range contraction, the U.S DPS of smalltooth sawfish does not exhibit any sign of genetic bottlenecks, and it has genetic diversity that is similar to other, less depleted elasmobranch populations (Chapman et al., 2011). Given that all five species of sawfish considered here have suffered similar abundance declines, we believe this conclusion should serve as a surrogate for the other sawfish species. Because the U.S. DPS of smalltooth sawfish has not undergone a genetic bottleneck, we ranked genetic diversity as a moderate risk for all sawfish species as it is likely, in combination with other factors, to contribute significantly to the risk of extinction. However, we determined that the risk of extinction due to the lack of connectivity was high for all five species, primarily because all populations have undergone severe fragmentation. While genetic results provide optimism for the remaining populations of sawfish, this does not preclude the promotion of management actions to enhance connectivity among populations that have been historically fragmented. We are also somewhat optimistic that sawfish populations may begin to rebuild in some areas and the risk of connectivity was determined to decrease for smalltooth and the narrow sawfish in the foreseeable future, although by only a small amount.

After reviewing the best available scientific data and assessing the extinction risk on the five species of sawfishes based on their status and demography, we conclude the risk of extinction for all five species of sawfish is high.

Summary of Factors Affecting the Five Species of Sawfishes

Next we consider whether any of the five factors specified in section 4(a)(1) of the ESA are contributing to the extinction risk of these five sawfishes.

The Present or Threatened Destruction, Modification, or Curtailment of Its Habitat or Range

We identified destruction, modification, or curtailment of habitat or range as a potential threat to all five species of sawfishes and determined this factor is currently, and in the foreseeable future, contributing significantly to the risk of extinction of these species.

Coastal and Riverine Habitats

Loss of habitat is one of the factors determined to be associated with the decline of smalltooth sawfish in the U.S. (NMFS, 2009). As juveniles, sawfishes rely on shallow nearshore environments, primarily mangrove-fringed estuaries as nurseries (e.g., Wiley and Simpfendorfer, 2010; Norton et al., 2012). Coastal development and urbanization have caused these habitats to be reduced or removed from many areas throughout the species' historic and current range. Habitat loss was identified as one of the most serious threats to the persistence of all species of sawfish, posing high risks for extinction. It is still unclear how anthropogenic perturbations to habitats affect the recruitment of juvenile sawfish, and therefore adequate protection of remaining natural areas is essential. Given the threat from coastal urbanization coupled with the predicted reduction of mangroves globally (Alongi, 2008), we believe the risk of habitat loss would significantly contribute to both the decline of sawfish and their reduced viability.

We expect habitat modification throughout the range of these sawfishes to continue with human population increases. As humans continue to develop rural areas, habitat for other species, like sawfish, becomes compromised (Compagno, 2002b). Habitat modification affects all five species of sawfish, especially those inshore, coastal habitats near estuaries and marshes (Compagno and Last, 1999; Cavanagh et al., 2003; Martin, 2005; **Chin** et al., 2010; NMFS, 2010). **Mining** and mangrove deforestation severely alter the coast habitats of estuaries and wetlands that support sawfish (Vidthayanon, 2002; Polhemus et al., 2004; Martin, 2005). In addition, riverine systems throughout most of these species' historical range have been

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altered or dammed. For example, the potential expansion of the McArthur River Mine would permanently realign channels that would in turn affect the number of pools formed during the wet and dry seasons, many of which are used as refuge areas for dwarf, green, or largetooth sawfish (Polhemus et al., 2004; Gorham, 2006). In addition to the potential expansion of the McArthur River Mine, the Nicaragua government is proposing to build a cross-country canal through habitats currently used by the remaining largetooth sawfish population in Lake Nicaraugua (BBC News, Latin America and Caribbean, 2013).

Although the status of habitats across the global range of these sawfishes is not well known, we expect the continued development and human population growth to have negative effects on habitat, especially to nearshore nursery habitats. For example, Ruiz-Luna et al. (2008) acknowledge that deforestation of mangrove forests in Mexico has occurred from logging practices, construction of harbors, tourism, and aquaculture activities. Valiela et al. (2001) reported on mangrove declines worldwide. They showed that the area of mangrove habitat in Brazil decreased from 9652 to 5173 square miles (24,999 to 13,398 square kilometers) between 1983 and 1997, with similar trends in Guinnea-Bissau 1837 to 959 square miles (4758 to 2484 square kilometers) from 1953 to 1995. The areas with the most rapid mangrove declines in the Americas included Venezuela, Mexico, Panama, the U.S., and Brazil. Along the western coast of Africa, the largest declines have occurred in Senegal, Gambia, Sierra Leone, and Guinnea-Bissau. World-wide mangrove habitat loss was estimated at 35 percent from 1980 to 2000 (Valiela et al., 2001). These areas where mangroves are known to have decreased are within both the historic and current ranges of these five species.

Hydroelectric and Flood Control Dams

Hydroelectric and flood control dams pose a major threat to freshwater inflow into the euryhaline habitats of sawfishes. Alterations of flow, physical barriers, and increased water temperature affect water quality and quantity in the rivers, as well as adjacent estuaries that are important nursery areas for sawfish. Regulating water flow affects the environmental cues of monsoonal rains and increased freshwater flow for pupping (Peverel, 2008; Morgan et al., 2011). Changes in siltation due to regulated water flow may also affect benthic habitat or prey abundance for these sawfishes (Compagno, 2002; Polhemus et al., 2004; Martin, 2005; Thorburn et al., 2007; **Chin** et al., 2010; Morgan et al., 2010a).

New dams being proposed to provide additional irrigation to farmland upstream may affect sawfish habitat. For example, the Gilbert River, in Queensland, Australia drains into the Gulf of Carpentaria, which is the nursery area for green, dwarf, and largetooth sawfish. Further modification of the McArthur and Gilbert Rivers, along with increased **commercial** fishing in coastal waters, will negatively affect sawfishes by reducing available habitat while increasing bycatch mortality (Gorham, 2006).

Water Quality

Largetooth sawfish in particular, and likely the other sawfishes, have experienced a loss of habitat throughout their range due to the decline in water quality. Agriculture and logging practices increase runoff, change salinity, and reduce the flow of water into freshwater rivers and streams that affects the habitat of the largetooth sawfish (Polhemus et al., 2004; IUCN Red List, 2006); **mining** seems to be the most detrimental activity to water quality. Pollution from industrial waste, urban and rural sewage, fertilizers and pesticides, and tourist development all end up in these freshwater systems and eventually the oceans. Pollution from these **operations** has caused a reduction in the number of sawfish in these freshwater systems (Vidthayanon, 2002; Polhemus et al., 2004).

 

In summary, habitat alterations that potentially affect sawfishes include commercial and residential development; agricultural, silvicultural, and mining land uses; construction of water control structures; and modification to freshwater inflows. All sawfishes are vulnerable to a host of habitat impacts because they use rivers, estuaries, bays, and the ocean at various times of their life cycle. Based on our review of current literature, scientific surveys and anecdotal information on the historic and current distribution, we find that destruction, modification, and curtailment of habitat or ranges are a factor affecting the status of each species. We conclude that this factor is contributing, on its own or in combination with other factors, to the extinction risk of all five species of sawfishes.

Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

We identified overutilization for commercial, recreational, scientific, or educational purposes as a potential threat to all five species of sawfishes and determined that it is currently and in the foreseeable future contributing significantly to their risk of extinction.

Commercial Fisheries

Commercial fisheries pose the biggest threat to these sawfishes, as these species are bycatch from many fisheries. Their unusual morphology and prominent saw makes sawfishes particularly vulnerable to most types of fishing gear, most notably any type of net (Anak, 2002; Hart, 2002; Last, 2002; Pogonoski et al., 2002; Cavanagh et al., 2003; Porteous, 2004; Stevens et al., 2005; Gorham 2006; IUCN Red List, 2006; Chidlow, 2007; Field, 2009; Chin et al., 2010; NMFS, 2010; Morgan et al., 2011). Trawling gear is of particular concern as it is the most common gear used within the range and habitat of sawfishes (Compagno and Last, 1999; Taniuchi, 2002; Walden and Nou, 2008). In Thailand, all sawfish fins obtained and sold to markets are a result of bycatch by otter-board trawling and gillnet fisheries as there are no directed sawfish fisheries in the country (Pauly, 1988; Vidthayanon, 2002). The Lake Nicaragua commercial fishery for largetooth sawfish that collapsed prior to the 1980's was comprised mostly of gillnet boats (Thorson, 1982a), and the commercial small coastal shark fishery in Brazil mainly uses gillnets and some handlines (Charvet-Almeida, 2002). Subadult and adult smalltooth sawfish have been reported as bycatch in the U.S. Gulf of Mexico and south Atlantic shrimp trawl fishery (NMFS SEFSC, 2011); however, if proper techniques are used, all sawfish species, particularly adults, are fairly resilient and can be released alive from most fishing gear (Lack et al., 2009).

Live release of sawfishes from commercial fishing gear does occur but sawfishes are often retained. The meat is generally consumed locally, but the fins and rostra are of high value and sold in markets where these products are unregulated (CITES, 2007). In Brazil, a captured sawfish is most likely retained because of the value of their products, as the rostra, rostral teeth, and fins are valued at upwards of $1,000 U.S. in foreign markets (NMFS, 2010a). The proportion of largetooth sawfish in these markets is unknown, although as many as 180 largetooth sawfish saws were annually sold at a single market in northern Brazil in the early 2000's (McDavitt and Charvet-Almeida, 2004). The Trade Records Analysis of Flora and Fauna in Commerce (TRAFFIC) organization found that meat, liver oil, fins, and skin are among the most

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preferred sawfish products in Asian markets (Anak, 2002; Vidthayanon, 2002). In the Gulf of Thailand, over 5,291 US tons (4,800 tonnes) of rays were caught annually from 1976 to 1989; at the same time over 1,102 US tons (1,000 tonnes) of rays were caught in the Andaman Sea (Vidthayanon, 2002). It is likely that most of these products were sold in Asian markets because of the high demand for sawfish products. Reports of sawfish products in various markets throughout Asia are often inconsistent and inaccurate despite international rules on trade and possession of sawfish products (Fowler, 2002; Clarke et al., 2008; Kiessling et al., 2009).

Recreational or commercial fishing gear may be abandoned or lost at sea. These "ghost nets" are an entanglement hazard for sawfishes and have become an increasing problem in the Gulf of Carpentaria where over 5,500 ghost nets were removed in 2009. Sawfish captures are expected to occur in regions where no quantitative information about ghost nets exists (Gunn et al, 2010).

Misidentification, general species-composition grouping, and failure to record information are all concerns for reporting sawfish captures in direct or indirect commercial fisheries (Stobutzki et al., 2002b). With little enforcement of regional and international laws, the practice of landing sawfishes may continue (NMFS, 2010a). All sawfish populations have been declining worldwide, partly due to the negative effects of commercial fishing (Stevens et al., 2000; Peverell, 2008).

Recreational Fisheries

Sawfish are bycatch of many recreational fisheries throughout their range, even in areas where they are protected, including many Australian rivers (Walden and Nou, 2008; Field et al., 2009). Peverell (2008) reports that some sawfish are a target sport fish for recreational fishermen in the Gulf of Carpentaria, Queensland. Historical information from the U.S. indicates that recreational hook and line fishers in Texas sometimes target large sharks as trophy fish but may capture sawfish (Burgess et al., 2009). Elsewhere in the United States, the abundance of sawfishes is low and likely never high enough for recreational fishers to encounter sawfish, much less target it (NMFS, 2010a). With the increase in human population along the coast, recreational fishing has the potential to put additional pressure on sawfish species that use coastal habitats (Walden and Nou, 2008).

Indigenous Take

Due to the large populations of various indigenous people throughout the range of these five species, and the lack of data on the animals they harvest, the number of sawfish taken by local peoples is unknown. Elasmobranchs are caught for consumption throughout the Indo-Pacific. In some areas, the meat and fins of these animals are of high market value, and therefore they are **sold** rather than consumed locally. Due to this unregulated consumption, removal of elasmobranchs, which includes sawfishes, is a threat to their population(s) (Compagno and Last, 1999; Pogonoski et al., 2002; Vidthayanon, 2002; Thorburn et al., 2007; Peverell, 2008; Morgan et al., 2010a).

Some studies have been conducted on the use and value of elasmobranch parts to various indigenous groups, particularly those in eastern Sabah, Malaysia. One study (Almada-Villela, 2002) found the majority of natives from Pulau Tetabuan and Pulau Mabul only take what is necessary for subsistence. Sawfish rostra are also valued and kept as decoration or given as gifts at the expense of the animal (Almada-Villela, 2002; McDavitt et al., 1996; Vidthayanon, 2002).

Protective Coastal Nets

Protective gillnets to prevent shark attacks on humans is used in some areas but can have a negative impact due to bycatch. Sawfishes are highly susceptible to capture in nets because their saws are easily tangled in nets. The Queensland Shark Control Program in Australia places nets along beaches during the summer months. From 1970 to 1990, sawfish bycatch in these nets declined despite relatively constant effort; likely due to an overall decline in sawfish populations (Stevens et al., 2005). In South Africa, the first protective gillnets lined the southeast tip of the continent's coast as early as 1952. By 1990, over 27 mi (44 km) of nets lined the area between Richards Bay and Mzamba (Dudley and Cliff, 1993). About 350 sharks and rays were captured in these nets between 1981 and 1990. A high percentage of entangled sawfish are released alive because of their ability to breathe while motionless. Dudley and Cliff (1993) reported that 100 percent of largetooth sawfish and 67 percent of smalltooth sawfish caught during that time were released alive. Still, subsequent mortality post-release due to stress or injury from the process is unknown and potentially detrimental given other fishing pressures (Dudley and Cliff, 1993).

Scientific and Educational Uses

Sawfishes are unique animals that are currently on public display in many large aquariums. Removal of sawfishes from their natural habitats has caused some concern for these sawfish species and their ecosystems. No information is available on the level of mortality that occurs during the capture and transporting of live sawfish to aquaria. Removal of female sawfish from the wild could have an effect on the future reproductive capacity of that population (Anak, 2002; Harsan and Petrescu-Mag, 2008). Limited information is available regarding the number of sawfish that have been removed from the wild for display in aquaria. All sawfish removed from Australian waters for aquaria collections have been reported as juveniles (S. Olson, Association of Zoos and Aquariums (AZA), 2013 pers. comm). The two most recent imports of largetooth sawfish to an Association of Zoos and Aquariums (AZA) accredited facility were in 2007 and 2008 (S. Olson, AZA, 2013 pers. comm).

In July 2011, the Australian CITES Scientific Authority for Marine Species reviewed their 2007 non-detriment finding for the export of P. microdon and found that it was not possible to conclude with a reasonable level of certainty that any harvest for export purposes would not be detrimental to the survival or recovery of the species (DSEWPaC, 2011). Since then, international trade in freshwater sawfish from Australia has ceased.

Worldwide, we are not aware of any narrow sawfish in captivity (Peverell, 2005, 2008). We are aware of 2 dwarf sawfish held in captivity in Japan (McDavitt, 2006). Largetooth sawfish are the most common sawfish species in captivity (NMFS, 2010a). Juvenile largetooth measuring less than 3.5 ft (1 **m**) TL on average are most often caught for the aquaria trade as they are easier to transport than adults (Peter and Tan, 1997).

Globally, scientists are collecting information on sawfish biology. Research efforts began in 2003 on the U.S. DPS population of smalltooth sawfish and no negative impacts have been associated with this research to date.

 

In summary, while no quantitative data on fishery impacts are available, we conclude that given the susceptibility of sawfish to entanglement in gillnets and trawl nets that are commonly used throughout their range, sawfishes are likely captured as incidental take. We are not aware of any fisheries

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specifically targeting sawfishes. This impact from fisheries is the most likely single cause of the observed range contractions and reduced abundance in many areas of their former range. Trade of sawfish parts occurs throughout the world. Sawfish have been exploited for their fins, rostra, and teeth. Sawfish fins have been report in the shark fin trade since the early 1900s (Mountnorris, 1809). Trade of sawfish parts occurs on Internet sites such as eBay and Craigslist. Trade of sawfish parts (e.g., fins, rostral teeth, and rostra) are also ongoing threats to all five species (Harrison et al., 2014). Therefore, we conclude the overutilization for **commercial**, recreational, scientific, or educational purposes, alone or in combination with other factors as discussed herein, is contributing significantly to the risk of extinction of the narrow, dwarf, largetooth, green, and the non-U.S. DPS of smalltooth sawfish.

Disease and Predation

We have determined that disease and predation are not potential threats to any of the five species of sawfish and that it is unlikely that these factors, on their own or in combination with other factors, are contributing significantly to their risk of extinction of all five sawfish species.

These species co-occur with other sawfishes and large sharks, but we are not aware of any studies or information documenting interspecific competition in terms of either habitat or prey (NMFS 2010a). Thorson (1971) speculated that the Lake Nicaragua bull shark population may compete with largetooth sawfish, as both were prevalent, but he offered no additional data. Sawfish have been documented within the stomach of a dolphin (Tursiops truncatus) near Bermuda (Bigelow and Schroeder, 1953; Monte-Luna et al., 2009), in the stomach of a bull shark (C. leucas) in Australia (Thorburn et al., 2004), and evidence of bite marks from what appeared to be a bull shark (C. leucas) on a juvenile smalltooth sawfish in the United States have been reported (T. Wiley-Lescher, Haven Worth Consulting, 2012 pers. comm). Crocodiles also prey on sawfishes (Cook and Compagno, 2005). There is no evidence that unusual levels of disease or predation affect any of the five sawfish species. Based on the information available on disease and predation for all five species of sawfish, we have determined that disease and predation on their own, or in combination with other factors, do not pose an extinction risk to any of these sawfishes.

Inadequacy of Existing Regulatory Mechanisms

We identified inadequacy of existing regulatory mechanisms as a potential threat to each of the five species of sawfish. We determined that this factor alone, or in combination with other factors, is contributing significantly to their risk of extinction.

First, we reviewed general or global regulatory protections for sawfish. The use of turtle exclusion devices (TEDs) in the nets of trawl fisheries to conserve sea turtles occurs throughout much of the range of sawfishes, but TEDs are not efficient in directing sawfish out of nets because sawfish rostra get entangled (Stobutzki et al., 2002a; Brewer et al., 2006) prior to reaching the TED. TEDs are often used when trawling occurs along the sea bottom at depths of 49 ft to 131 ft (15 to 40 **m**), areas where sawfish are likely to be found (Stobutzki et al., 2002a). Most sawfishes show no difference in recovery after going through a trawl net, regardless of the presence or absence of a TED (Griffiths, 2006). Stobutzki et al. (2002a) found that large females are more likely to survive capture after passing through a trawling net and TED compared to smaller males. Only narrow sawfish were found to benefit from the presence of TEDs in nets as 73.3 percent escaped (Brewer et al., 2006; Griffiths, 2006). In general, TEDs tend to have negligible impact on sawfish that get captured by trawling nets (Stobutzki et al., 2002a; Griffiths, 2006), but they do provide an escape route if the animal does not get entangled.

Data reporting agencies (i.e., customs and national fisheries) are often inconsistent in their reporting of wildlife trade (Anak, 2002). Reports are often vague and include general descriptions like "shark fin" or "ray," providing practically no information of trading rates of specific products (Lack and Sant, 2011). Many countries in the Indo-Pacific do not report bycatch statistics or elasmobranchs taken illegally (Holmes et al., 2009). In order for effective management plans to be implemented in fin markets and for sawfish product trade, data need to be consistent.

Next, we reviewed regional or country specific regulatory protections for sawfish. Many countries in the Indo-Pacific and the Middle East do not have formal legislation for management or national protection of the sawfish that may occur in their waters. Presently, Thailand has regulated some fisheries, but has no protective legislation for any elasmobranch in the country except for export of marine species for aquaria (Vidthayanon, 2002). Among Middle Eastern countries that fish for sharks, only Iran has implemented an International Plan of Action for the Conservation and Management of Sharks (IPOA Shark Plan). Nine

Arab countries have recently signed a Memorandum of Understanding on the Conservation of Migratory Sharks to improve shark conservation measures under the United Nations Environment Programme Convention on Migratory Species. Countries in Africa face similar circumstances as enforcement for sawfish protection is unknown (NMFS, 2010a). Countries that do have protective legislation are often unable to effectively patrol their waters, and fishing restrictions are routinely violated by foreign vessels (Lack. and Sant, 2008). In one study, genetic testing (DNA barcoding) was used to identify fins from green sawfish confiscated from foreign boats illegally fishing in northern Australian waters (Holmes, 2009).

The Australian government listed the largetooth, green, and dwarf sawfishes as vulnerable on their Environmental Protection and Biodiversity Conservation (EPBC) Act list. The EPBC Act protects these sawfish and prohibits killing, injuring, taking, trading, keeping, or moving an individual without a permit. Even with these protections in place, the Draft Recovery Plan for Sawfish and River Sharks (Department of the Environment, 2014) reports that these three sawfish species have experienced substantial population declines.

In summary, several organizations are trying to regulate and manage sawfish but often these regulations and management initiatives are inadequate. Illegal exploitation by foreign fishers often occurs when regulations exist but are not enforced (Kiessling et al., 2009). Preventative measures on existing fishing mechanisms to avoid sawfish catch, international monitoring of trade and bycatch, and governmental influence on fisheries are not presently sufficient to protect sawfishes. Specific regulation and monitoring of sawfishes by country would provide better protection (Vidthayanon, 2002; Walden and Nou, 2008). Therefore, we conclude the inadequacy of existing regulatory mechanisms has and continues to significantly contribute to the risk of extinction of the narrow, dwarf, largetooth, green, and the non-U.S. DPS of smalltooth sawfish.

Other Natural or Manmade Factors Affecting Its Continued Existence

In the proposed rule, we determined this was not a factor contributing

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significantly to the risk of extinction of all five species of sawfish. We re- evaluated the information for this factor and changed our conclusion from the proposed rule based on the fact that sawfish life history traits, which consists of slow growth rates, late maturity, long life spans, and low fecundity rates. These life history traits do not enable them to respond rapidly to additional sources of mortality, such as overexploitation and habitat degradation. Scientific information available on all five species of sawfish indicates that other natural or manmade factors are potential threats to all of the five species of sawfish. We conclude it is likely that these factors, on their own or in combination with other factors, are contributing significantly to the risk of extinction for all five sawfish species.

An increase in global sea-surface temperature and sea level may already be influencing sawfish populations (Clark, 2006; Walden and Nou, 2008; **Chin** et al., 2010). Fish assemblages are likely to change their distribution and could affect the prey base for sawfishes. Estuaries, including sawfish pupping grounds, may be affected as climate change changes patterns in freshwater flow due to rainfall and droughts. Skewed salinities in these areas or extreme tide levels might discourage adults from making up-river migrations (Clark, 2006). Saltwater marsh grass and mangrove areas play important roles in sawfish habitat as well (Simpfendorfer et al., 2010); any disruption to these areas may affect sawfish populations. There is little agreement, however, on the effects that climate change will have on sawfish and their environments specifically (Clark, 2006; **Chin** et al., 2010).

Red tide is the common name for a harmful algal bloom (HAB) of marine algae (Karenia brevis) that can make the ocean appear red or brown. Karenia brevis is one of the first species ever reported to have caused a HAB and is principally distributed throughout the Gulf of Mexico, with occasional red tides in the mid- and south-Atlantic United States. Karenia brevis naturally produces a brevetoxin that is absorbed directly across the gill membranes of fish or through ingestion of algal cells. While many HAB species are nontoxic to humans or small mammals, they can have significant effects on aquatic organisms. Fish mortalities associated with K. brevis events are very common and widespread. The mortalities affect hundreds of species during various stages of development. Red tide toxins can cause intoxication in fish, which may include violent twisting and corkscrew swimming, defecation and regurgitation, pectoral fin paralysis, caudal fin curvature, loss of equilibrium, quiescence, vasodilation, and convulsions, culminating in death. However, it is known that fish can die at lower cell concentrations and can also apparently survive in much higher concentrations. In some instances, mortality from red tide is not acute, but may occur over a period of days or weeks after exposure to subacute toxin concentrations. There is no specific information on red tide effects on sawfish, but a single report exists of a smalltooth sawfish that was found dead along the west coast of Florida, during a red tide event (International Sawfish Encounter Database, 2009). Therefore, we conclude that sawfishes occurring in the U.S. Gulf of Mexico are vulnerable to red tide, but there is little information documenting direct mortality resulting from exposure to red tide (NMFS, 2010a). Harmful algal blooms also exist in waters outside of the U.S. Gulf of Mexico therefore, it is probable that all sawfishes are vulnerable to harmful algal blooms wherever they occur. Collectively, these other natural or manmade factors may be affecting the continued existence of the narrow, dwarf, largetooth, green, and the non-U.S. DPS of smalltooth sawfish. Based on the results from our extinction risk analysis and information on other man-made factors affecting all five species of sawfish, this factor is contributing to their extinction risk.

Overall Risk Summary

After considering the extinction risks, both threat-based and demographic, for each of the five species of sawfish, we have determined the narrow, dwarf, largetooth, and green sawfish and the non-U.S. DPS of smalltooth sawfish are in danger of extinction throughout all of their ranges due to (1) present or threatened destruction, modification or curtailment of habitat, (2) overutilization for **commercial**, recreational, scientific, or educational purposes, (3) inadequacy of existing regulatory mechanisms, and (4) other natural or manmade factors affecting their continued existence, and low abundance, lack of connectivity, and genetic diversity.

Protective Efforts

Section 4(**b**)(1)(A) of the ESA requires the Secretary, when making a listing determination for a species, to take into consideration those efforts, if any, being made by any State or foreign nation to protect the species. In judging the effectiveness of efforts not yet implemented, or those existing protective efforts that are not yet fully effective, we rely on the Services' joint "Policy for Evaluation of Conservation Efforts When Making Listing Decisions" ("PECE"; 68 FR 15100; March 28, 2003). The PECE policy is designed to ensure consistent and adequate evaluation on whether any conservation efforts that have been recently adopted or implemented, but not yet proven to be successful, will result in recovering the species to the point at which listing is not warranted or contribute to forming the basis for listing a species as threatened rather than endangered. The purpose of the PECE policy is to ensure consistent and adequate evaluation of future or recently implemented conservation efforts identified in conservation agreements, conservation plans, management plans, and similar documents when making listing determinations. The PECE provides direction for the consideration of conservation efforts identified in these documents that have not yet been implemented, or have been implemented but not yet demonstrated effectiveness. The policy is expected to facilitate the development of conservation efforts by states and other entities that sufficiently improve a species' status so as to make listing the species as threatened or endangered unnecessary.

Two basic criteria were established in the PECE to use in evaluating efforts identified in conservations plans, conservation agreements, management plans or similar documents: (1) The certainty that the conservation efforts will be implemented; and (2) the certainty that the efforts will be effective. When we evaluate the certainty of whether or not the formalized conservation effort will be implemented, we may consider the following: Do we have a high level of certainty that that the resources necessary to carry out the conservation effort are available? Do the parties to the conservation effort have the authority to carry it out? Are regulatory or procedural mechanisms in place to carry out the efforts? If the conservation effort relies on voluntary participation, we will evaluate whether the incentives that are included in the conservation effort will ensure the level of participation necessary to carry out the conservation effort. In evaluating the certainty that a conservation effort will be effective, we may consider the following: Does the effort describe the nature and extent of the threats to the species to be addressed and how these threats are reduced by the conservation effort? Does the effort establish specific conservation objectives? Does the effort

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identify the appropriate steps to reduce the threats to the species? And does the effort include quantifiable performance measures to monitor both compliance and effectiveness? Overall, we need to be certain that the formalized conservation effort improves the status of the species at the time we make a listing determination. The PECE Policy also states that last-minute agreements (i.e., those that are developed just before or after a species is proposed for listing) often have little chance of affecting the outcome of a listing decision. Last-minute efforts are also less likely to be able to demonstrate that they will be implemented and effective in reducing or removing the threats to a species. In addition, there are circumstances in which the threats to a species are so imminent and/or complex that is will be almost impossible to develop an agreement or plan that includes conservation efforts that will result in making the listing unnecessary. A conservation effort that satisfies the criteria for implementation and effectiveness is considered when making a listing determination, but may not ultimately change the risk assessment for the species. Using the criteria identified in our PECE Policy we evaluated conservation efforts to protect and recover the five sawfish species that are either underway but not yet fully implemented, or are only planned.

 

CITES restricts the trade of live animals to a vast array of wildlife products derived from them, including food products, musical instruments, tourist curios and medicines. Many wildlife species in trade are not endangered, but the existence of an agreement to ensure the sustainability of the trade is important in order to safeguard these resources for the future. All sawfishes in the family Pristidae were listed on Appendix I of CITES at the 14th Conference of the Parties meeting in 2007. An Appendix I listing bans all **commercial** trade in parts (e.g., rostral teeth, rostra, liver, and fins) or derivatives of sawfish with trade in specimens of these species permitted only in exceptional circumstances (e.g., for research purposes). At that time, an annotation to the Appendix I listing allowed the largetooth sawfish P. microdon (herein P. pristis) to be treated as Appendix II "for the exclusive purpose of allowing international trade in live animals to appropriate and acceptable aquaria for primarily conservation purposes." The annotation was accepted on the basis that Australian populations of P. microdon were robust relative to other populations in the species' range, and that the capture of individuals for aquaria was not likely to be detrimental to the population. Later, at the CITES 16th Annual Conference of the Parties meeting in March of 2013, Australia proposed the transfer of P. microdon from Appendix II to Appendix I, and the measure was adopted and became effective on 12 June 2013. Therefore, live trade of P. pristis (P. microdon) is currently banned and all **commercial** trade of all sawfishes is banned per CITES Appendix I listing.

The recent banning of all trade of P. pristis (P. microdon) for aquaria trade is a good conservation measure for the species and meets all of the criteria for implementation and effectiveness. The recently adopted CITES Appendix I listing for largetooth sawfish only bans the live trade of the fish from Australia to approved foreign aquaria, all other trade was banned with the 2007 listing. Only 11 largetooth sawfish were approved for aquaria trade when the largetooth sawfish was listed under CITES Appendix I with the annotation for aquaria trade. The recent CITES Appendix I listing for largetooth sawfish is not likely to significantly affect the species outside of the limited area (Australia) where they were removed from the wild for aquaria display. Given live trade of P. pristis (P. microdon) for aquaria use is not a threat leading to the extinction risk of the species, we conclude the full CITES Appendix I listing may satisfy the PECE policy's standards for implementation and effectiveness, but the impact of this measure is considered insignificant. Australia may be effective at enforcing trade policies, but the recent Appendix I listing of P. microdon (largetooth sawfish) alone, is not sufficient to protect the species throughout its range.

The IUCN Shark Specialist **Group**, in collaboration with a large number of the national and international stakeholders in sawfish conservation, developed A Global Strategy for Sawfish Conservation (Harrison and Dulvy, 2014). The strategy identifies the actions required to achieve recovery for all sawfishes. The strategy outlines seven objectives that are necessary to achieve recovery of all sawfishes: Fisheries management, species protection, habitat conservation, trade limitation, strategic research, education and communication, and responsible husbandry. We evaluated the certainty of whether or not the strategy would be implemented and determined that (1) the strategy does not have a high level of certainty that the resources necessary to carry out the conservation effort are available, (2) that the strategy team members do not have the authority to carry out all of the objectives, (3) regulatory or procedural mechanisms are not in place to carry out the objectives, (4) and the conservation efforts rely on voluntary participation that does not have incentives that are included in the conservation effort that will ensure the level of participation necessary to effectively carry out the conservation effort. Based on the lack of certainty that the conservation efforts will be implemented we determined the strategy does not satisfy the PECE policy's standards for certainty of implementation and effectiveness.

The Australian Government, Department of the Environment, published a Draft Recovery Plan for Sawfish and River Sharks (Plan) in 2014 (Department of Environment, 2014). The Draft Plan covers three sawfish species (P. pristis, P. zijsron, and P. clavata). The Plan identifies specific actions and objectives necessary to stop local decline of sawfish and river sharks and promotes their recovery. The goal of the Draft Plan is to assist with the recovery of sawfish in Australian waters in two ways: (1) Improving the population status leading to the removal of the sawfish from the protected species list of EPBC; and (2) ensuring anthropogenic actives do not hinder the recovery in the near future, or impact the conservation status of the species in the future. We evaluated the certainty of whether or not the Draft Plan would be implemented. We determined that the strategy has a high level of uncertainty regarding implementation because: (1) The Draft Plan does not have dedicated funding so the resources necessary to carry out the conservation efforts may not be available, and (2) the Draft Plan is dependent on the participation of voluntary groups or organizations (e.g., indigenous community groups and non-governmental organizations) to carry out some of the actions. Based on the lack of certainty that the Draft Plan will be implemented, we determined the Draft Plan does not satisfy the PECE policy's standards for certainty of implementation and effectiveness.

Listing Determinations

Section 4(**b**)(1) of the ESA requires that we make listing determinations based solely on the best scientific and **commercial** data available after conducting a review of the status of the species and taking into account those efforts, if any, being made by any state or foreign nation, or political subdivisions thereof, to protect and conserve the species. We have reviewed the best available scientific and commercial information including the petition, and the information in the

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review of the status of the five species of sawfishes, and we have consulted with species experts.

We are responsible for determining whether narrow sawfish (A. cuspidata), dwarf sawfish (P. clavata), largetooth sawfish (P. pristis), green sawfish (P. zijsron), and the non-U.S. DPS of smalltooth sawfish (P. pectinata) are threatened or endangered under the ESA (16 U.S.C. 1531 et seq.). We have followed a stepwise approach as outlined above in making this listing determination for these five species of sawfish. We have determined that narrow sawfish (A. cuspidata); dwarf sawfish (P. clavata); largetooth sawfish (P. pristis); green sawfish (P. zijsron); and the non-U.S. DPS of smalltooth sawfish (P. pectinata) constitute species as defined by the ESA. We have conducted an extinction risk analysis and concluded that the risk of extinction for all five species of sawfish is high, now and in the foreseeable future. We have assessed the threats affecting the status of each species using the five factors identified in section 4(a)(1) of the ESA and concluded the narrow, dwarf, largetooth, green, and the non-U.S. DPS of smalltooth sawfish face ongoing threats from habitat alteration, overutilization for commercial and recreational purposes, inadequacy of existing regulatory mechanisms, and other natural or manmade factors affecting their continued existence throughout their ranges. Therefore, we find that all five species of sawfishes are in danger of extinction throughout all of their ranges. After considering efforts being made to protect these sawfishes, we could not conclude the proposed conservation efforts would alter the extinction risk for any of these five sawfishes.

Effects of Listing

Conservation measures provided for species listed as endangered or threatened under the ESA include recovery actions (16 U.S.C. 1533(f)); Federal agency requirements to consult with NMFS and to ensure its actions do not jeopardize the species or result in adverse modification or destruction of critical habitat should it be designated (16 U.S.C. 1536); designation of critical habitat if prudent and determinable (16 U.S.C. 1533(a)(3)(A)); and prohibitions on taking (16 U.S.C. 1538). An additional benefit of listing beyond these legal requirements is that the recognition of the species' plight through listing promotes conservation actions by Federal and state agencies, foreign entities, private groups, and individuals.

Recovery Plans

NMFS may develop a recovery plan or plans for these species after considering the conservation benefit to the species per ESA sections 4(f)(1) and 4(f)(1)(A). Section 4 (f)(1) of the ESA directs NMFS to develop and implement recovery plans for the conservation and survival of listed species, unless we find that such a plan will not promote the conservation of the species. Section 4(f)(1)(A) further directs us, to the maximum extent practicable, to give priority in developing plans to those species that will most likely benefit from such plans.

Identifying Section 7 Consultation Requirements

Section 7(a)(2) (16 U.S.C. 1536(a)(2)) of the ESA and NMFS/USFWS regulations require Federal agencies to consult with us to ensure that activities authorized, funded, or carried out are not likely to jeopardize the continued existence of listed species or destroy or adversely modify critical habitat. The requirement to consult applies to these Federal agency actions in the United States and on the high seas. The five sawfishes all occur in the waters of foreign nations, where there would be no consultation requirement. It is possible, but highly unlikely, that the listing of the five species of sawfish under the ESA may result in a minor increase in the number of Section 7 consultations for high seas activities.

Critical Habitat

Critical habitat is defined in Section 3 of the ESA (16 U.S.C. 1532(5)) as: (1) The specific areas within the geographical area occupied by a species, at the time it is listed in accordance with the ESA, on which are found those physical or biological features (a) essential to the conservation of the species and (b) that may require special management considerations or protection; and (2) specific areas outside the geographical area occupied by a species at the time it is listed upon a determination that such areas are essential for the conservation of the species. Critical habitat shall not be designated in foreign countries or other areas outside U.S. jurisdiction (50 CFR 424.12 (h)).

The best available scientific and commercial data show that the geographical areas occupied by the narrow sawfish (A. cuspidata), dwarf sawfish (P. clavata), green sawfish (P. zijsron), largetooth sawfish (P. pristis), and the non-U.S. DPS of smalltooth sawfish (P. pectinata) are entirely outside U.S. jurisdiction, so we cannot designate critical habitat for these species in their occupied range.

We can designate critical habitat in unoccupied areas in U.S. jurisdiction, if we determine the areas are essential for the conservation of the species. Only the largetooth sawfish (P. pristis, formerly P. perotteti) has a range that once included occasional use of U.S. waters, with approximately 39 confirmed records (33 in Texas) from 1910 through 1961. All records of P. pristis in U.S. waters were adults, mostly during the summer months. U.S. waters were a limited part of the historic range, likely used for periodic, seasonal foraging movements. There is no evidence of U.S. waters supporting any other biological functions like breeding or nursery areas. Therefore, we believe reestablishment back into U.S. waters is not required for the recovery of P. pristis. Based on the best available information we have not identified unoccupied areas in U.S. jurisdiction that are essential to the conservation of any of the five sawfish species. Therefore, we do not intend to designate critical habitat for the narrow, dwarf, largetooth, green, or the non-U.S. DPS of smalltooth sawfish.

Identification of Those Activities That Would Constitute a Violation of Section 9 of the ESA

On July 1, 1994, NMFS and FWS published a policy (59 FR 34272) that requires us to identify, to the maximum extent practicable at the time a species is listed, those activities that would or would not constitute a violation of section 9 of the ESA. Because we are listing all five sawfishes as endangered, all of the prohibitions of section 9(a)(1) of the ESA will apply to all five species. These include prohibitions against the import, export, use in foreign commerce, and "take" of the species. Take is defined as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct." These prohibitions apply to all persons subject to the jurisdiction of the United States, including in the United States or on the high seas. The intent of this policy is to increase public awareness of the effects of this listing on proposed and ongoing activities within the species' range. Activities that we believe could result in a violation of Section 9 prohibitions of these five sawfishes include, but are not limited to, the following:

(1) Take within the U.S. or its territorial sea, or upon the high seas;

(2) Possessing, delivering, transporting, or shipping any sawfish part that was illegally taken;

(3) Delivering, receiving, carrying, transporting, or shipping in interstate or

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foreign commerce any sawfish or sawfish part, in the course of a **commercial** activity, even if the original taking of the sawfish was legal;

(4) Selling or offering for **sale** in interstate commerce any sawfish part, except antique articles at least 100 years old;

(5) Importing or exporting sawfish or any sawfish part to or from any country;

(6) Releasing captive sawfish into the wild. Although sawfish held non- commercially in captivity at the time of listing are exempt from certain prohibitions, the individual animals are considered listed and afforded most of the protections of the ESA, including most importantly the prohibitions against injuring or killing. Release of a captive animal has the potential to injure or kill the animal. Of an even greater conservation concern, the release of a captive animal has the potential to affect wild populations of sawfish through introduction of diseases or inappropriate genetic mixing. Depending on the circumstances of the case, NMFS may authorize the release of a captive animal through a section 10(a)(1)(a) permit; and

(7) Engaging in experimental or potentially injurious veterinary care or conducting research or breeding activities on captive sawfish, outside the bounds of normal animal husbandry practices. Normal care of captive animals necessarily entails handling or other manipulation of the animals, and NMFS does not consider such activities to constitute take or harassment of the animals so long as adequate care, including adequate veterinary care is provided. Such veterinary care includes confining, tranquilizing, or anesthetizing sawfishes when such practices, procedures, or provisions are not likely to result in injury. Captive breeding of sawfish is considered experimental and potentially injurious. Furthermore, the production of sawfish progeny has conservation implications (both positive and negative) for wild populations. Experimental or potentially injurious veterinary procedures and research or breeding activities of sawfish may, depending on the circumstances, be authorized under an ESA 10(a)(1)(a) permit for scientific research or the enhancement of the propagation or survival of the species.

We have identified, to the extent known at this time, specific activities that will not be considered likely to result in a violation of Section 9. Although not binding, we consider the following actions, depending on the circumstances, as not being prohibited by ESA Section 9:

 

(1) Take of a sawfish authorized by a 10(a)(1)(a) permit authorized by, and carried out in accordance with the terms and conditions of an ESA section 10(a)(1)(a) permit issued by NMFS for purposes of scientific research or the enhancement of the propagation or survival of the species;

(2) Incidental take of a sawfish resulting from Federally authorized, funded, or conducted projects for which consultation under section 7 of the ESA has been completed, and when the otherwise lawful activity is conducted in accordance with any terms and conditions granted by NMFS in an incidental take statement in a biological opinion pursuant to section 7 of the ESA;

(3) Continued possession of sawfish parts that were in possession at the time of listing. Such parts may be non-commercially exported or imported; however the importer or exporter must be able to provide sufficient evidence to show that the parts meet the criteria of ESA section 9(**b**)(1) (i.e., held in a controlled environment at the time of listing, non-**commercial** activity);

(4) Continued possession of live sawfish that were in captivity or in a controlled environment (e.g., in aquaria) at the time of this listing, so long as the prohibitions under ESA section 9(a)(1) are not violated. Again, facilities should be able to provide evidence that the sawfish were in captivity or in a controlled environment prior to listing. We suggest such facilities submit information to us on the sawfish in their possession (e.g., size, age, description of animals, and the source and date of **acquisition**) to establish their claim of possession (see For Further Information Contact);

(5) Provision of care for live sawfish that were in captivity at the time of listing. These individuals are still protected under the ESA and may not be killed or injured, or otherwise harmed, and, therefore, must receive proper care. Normal care of captive animals necessarily entails handling or other manipulation of the animals, and we do not consider such activities to constitute take or harassment of the animals so long as adequate care, including adequate veterinary care is provided. Such veterinary care includes confining, tranquilizing, or anesthetizing sawfish when such practices, procedures, or provisions are not likely to result in injury; and

(6) Any importation or exportation of live sawfish or sawfish parts with all accompanying CITES import and export permits and an ESA section 10(a)(1)(a) permit for purposes of scientific research or the enhancement of the propagation or survival of the species.

Section 11(f) of the ESA gives NMFS authority to promulgate regulations that may be appropriate to enforce the ESA. Future regulations may be promulgated to regulate trade or holding of sawfish, if necessary. The public will be given the opportunity to comment on future proposed regulations.

Policies on Peer Review

In December 2004, the Office of Management and Budget (OMB) issued a Final Information Quality Bulletin for Peer Review establishing a minimum peer review standard. Similarly, a joint NMFS/FWS policy (59 FR 34270; July 1, 1994) requires us to solicit independent expert review from qualified specialists, concurrent with the public comment period. The intent of the joint peer review policy is to ensure that listings are based on the best scientific and **commercial** data available. We formally solicited expert opinion of three appropriate and independent specialists regarding the scientific and **commercial** data or assumptions related to the information considered for listing.

We considered peer reviewer comments in making our determination. We conclude that these experts' reviews satisfy the requirements for "adequate [prior] peer review" contained in the Information Quality Bulletin for Peer Review and the joint NMFS/FWS policy (59 FR 34270; July 1, 1994).

References

A complete list of the references used in this final rule is available on the Internet at http://sero.nmfs.noaa.gov/protected_resources/sawfish/.

Classification

National Environmental Policy Act

The 1982 amendments to the ESA, in section 4(**b**)(1)(A), restrict the information that may be considered when assessing species for listing. Based on this limitation of criteria for a listing decision and the opinion in Pacific Legal Foundation v. Andrus, 675 F. 2d 825 (6th Cir. 1981), NMFS has concluded that ESA listing actions are not subject to the environmental assessment requirements of the National Environmental Policy Act (NEPA) (See NOAA Administrative Order 216-6).

Executive Order 12866, Regulatory Flexibility Act, and Paperwork Reduction Act

 

As noted in the Conference Report on the 1982 amendments to the ESA, economic impacts cannot be considered when assessing the status of a species. Therefore, the economic analysis

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requirements of the Regulatory Flexibility Act are not applicable to the listing process. In addition, this final rule is exempt from review under Executive Order 12866. This final rule does not contain a collection-of-information requirement for the purposes of the Paperwork Reduction Act.

Executive Order 13132, Federalism

In accordance with E.O. 13132, we determined that this final rule does not have significant Federalism effects and that a Federalism assessment is not required.

List of Subjects in 50 CFR Part 224

Administrative practice and procedure, Endangered and threatened species, Exports, Imports, Reporting and recordkeeping requirements, and Transportation.

Dated: December 8, 2014.

Samuel D. Rauch, III,

Deputy Assistant Administrator for Regulatory Programs, National Marine Fisheries Service.

For the reasons set out in the preamble, 50 CFR part 224 is amended as follows:

PART 224--ENDANGERED MARINE AND ANADROMOUS SPECIES

1. The authority citation for part 224 continues to read as follows:

Authority: 16 U.S.C. 1531-1543 and 16 U.S.C 1361 et seq.

2. In [Section] 224.101, paragraph (h), amend the table by:

A. Removing the "Sawfish, largetooth" and the "Sawfish, smalltooth (United States DPS)" entries.

B. Adding entries for five new sawfish species in alphabetic order by Scientific name under "Fishes":

[Section] 224.101 Enumeration of endangered marine and anadromous species.

* * * * *

(h) The endangered species under the jurisdiction of the Secretary of Commerce are:

| Species *1 | | | | | |
|---|---|---|---|---|---|
| Common name | Scientific name | Description of listed entity | Citation(s) for listing determination(s) | Critical habitat | ESA rules |
| * * * * * * * | | | | | |
| Fishes | | | | | |
| * * * * * * * | | | | | |
| Sawfish, dwarf | Pristis clavata | Entire species | [Insert Federal Register citation] 12/12/2014 | NA | NA |
| Sawfish, green | Pristis zijsron | Entire species | [Insert Federal Register citation] 12/12/2014 | NA | NA |
| Sawfish, largetooth | Pristis pristis (formerly | Entire species | [Insert Federal Register citation] | NA | NA |

 

| | | | | | |
|---|---|---|---|---|---|
| | Pristis perotteti, Pristis pristis, and Pristis microdon) | | 12/12/2014 | | |
| Sawfish, narrow | Anoxypristis cuspidata | Entire species | [Insert Federal Register citation] 12/12/2014 | NA | NA |
| Sawfish, smalltooth (Non-U.S. DPS) | Pristis pectinata | Smalltooth sawfish originating from non-U.S. waters | [Insert Federal Register citation] 12/12/2014 | NA | NA |

* * * * * * *

*1 Species includes taxonomic species, subspecies, distinct population segments (DPSs) (for a policy statement, see 61 FR 4722, February 7, 1996), and evolutionarily significant units (ESUs) (for a policy statement, see 56 FR 58612, November 20, 1991).

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**RF** Part III|50 CFR Part 224; [Docket No 101004485-4999-03]; RIN 0648-XZ50

**CO** chdrwu : Charles Darwin University | fishws : U.S. Fish and Wildlife Service

**NS** gnatcn : Nature Conservation | c13 : Regulation/Government Policy | gpres : Preschool | nsur : Surveys/Polls | ccat : Corporate/Industrial News | gcat : Political/General News | gedu : Education | genv : Environmental News | ncat : Content Types | nfact : Factiva Filters | nfcpin : C&E Industry News Filter

**RE** usa : United States | africaz : Africa | saustr : South Australia | usfl : Florida | waustr : Western Australia | apacz : Asia Pacific | ausnz : Australia/Oceania | austr : Australia | namz : North America | uss : Southern U.S.

**IPD** DEPARTMENT OF COMMERCE (DOC)

**IPC** COM

**PUB** U.S. Government

**AN** Document FREG000020141212eacc0002k

 