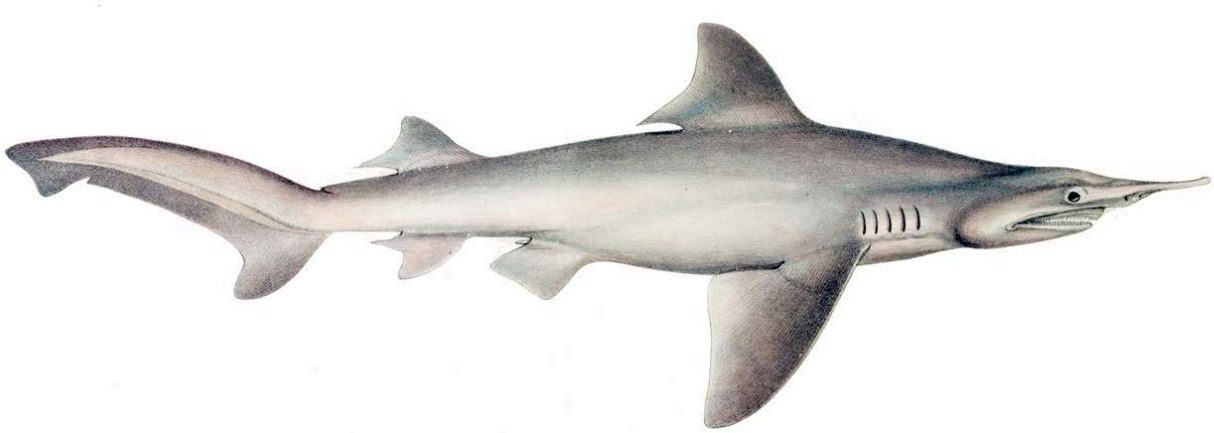
ENDANGERED SPECIES ACT
STATUS REVIEW OF THE DAGGERNOSE SHARK
(*Isogomphodon oxyrhynchus*)



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Executive Summary

This status review report was conducted in response to a petition received from WildEarth Guardians on July 8, 2013 to list 81 marine species as endangered or threatened under the Endangered Species Act (ESA). NMFS evaluated the petition to determine whether the petitioner provided substantial information indicating that the petitioned action may be warranted, as required by the ESA. In a *Federal Register* notice on November 19, 2013 (79 FR 69376), NMFS determined that the petition did present substantial scientific and commercial information, or cited such information in other sources, that the petitioned action may be warranted for 19 species and 3 subpopulations of sharks, and thus NMFS initiated a status review of those species. This status review report considers the biology, distribution, and abundance of and threats to a shark species from the Southwestern Atlantic and Caribbean Sea, *Isogomphodon oxyrhynchus* (daggernose shark).

TABLE OF CONTENTS

INTRODUCTION

Scope and Intent of the Present Document

On July 8, 2013, the National Marine Fisheries Service (NMFS) received a petition from WildEarth Guardians to list 81 species of marine organisms as endangered or threatened species under the Endangered Species Act (ESA) and to designate critical habitat. NMFS evaluated the information in the petition to determine whether the petitioner provided "substantial information" indicating that the petitioned action may be warranted, as required by the ESA.

Under the ESA, if a petition is found to present substantial scientific or commercial information that the petitioned action may be warranted, a status review shall be promptly commenced (16 U.S.C. §1533(b)(3)(A)). NMFS decided that the petition presented substantial scientific information indicating that listing may be warranted and that a status review was necessary for daggernose shark, *Isogomphodon oxyrhynchus*; (79 FR 69376, 19 November 2013). Experts and members of the public were requested to submit information to NMFS to assist in the status review process from November 19 through January 21, 2014.

The ESA stipulates that listing determinations should be made on the basis of the best scientific and commercial information available. This document is a compilation of the best available scientific and commercial information on the biology, distribution, and abundance of and threats to the daggernose shark in response to the petition and 90-day finding. Where available, we provide literature citations to review articles that provide even more extensive citations for each topic. Data and information were reviewed through 30-June 2014.

LIFE HISTORY AND ECOLOGY

Taxonomy and Anatomy

The daggernose shark (*Isogomphodon oxyrhynchus*) is the only species in the genus *Isogomphodon*, in the family Carcharhinidae (Compagno 1988). The species was first described in 1839 based on an 18-inch long type specimen caught in Surinam (Springer 1950). The daggernose shark has common names in several languages other than English. It is called *requin bécune* in French and *cazón picudo* in Spanish (Compagno 1984). It also has a number of different common names in Portuguese including: *cação pato*, *cação bicudo*, *cação quati*, *quati*, and *bico-de-pato* (Lessa et al. 1999b, Silva 2004, Rosa and Lima 2005, Rodrigues-Filho et al. 2009).

The most prominent feature of a daggernose shark's anatomy is its elongated snout. Compagno (1984) describes the snout as extremely long and flattened, but not trowel-shaped, ending at an acutely triangular point (Figures 1 and 2). Its eyes are very small and circular with nictitating "eyelids," and its teeth are narrow and serrated with over 45 rows of teeth in each jaw (Compagno 1984, Grace 2001). Sexual heterodonty (tooth dimorphism) appears to be absent, but there is weak ontogenetic heterodonty with stouter tooth cusps on adults (Compagno 1988). It is generally accepted that daggernose sharks lack spiracles (Compagno 1984, 1988), although one specimen was found to have a small spiracle on the left side of its head (Uyeno et al. 1983). The pectoral fins are very large and paddle-shaped (Compagno 1984, Compagno 1988, Grace 2001). The origin of the first dorsal occurs over the midbase or second third of the pectoral fins (Compagno 1984, 1988). The second dorsal is about half the size of the first dorsal with the pelvic fin slightly smaller than the second dorsal (Compagno 1984, 1988). The anal fin is approximately 0.8 of the second dorsal height, with its insertion below or slightly anterior to the second dorsal and a deeply notched posterior margin (Compagno 1988). Daggernose sharks lack an interdorsal ridge (Bigelow and Schroeder 1948, Compagno 1988, Grace 2001). The dorsal side of the body is a uniform gray or gray-brown color (Compagno 1984, Compagno 1988, Grace 2001). The ventral side of the body is white (Compagno 1984, Grace 2001).

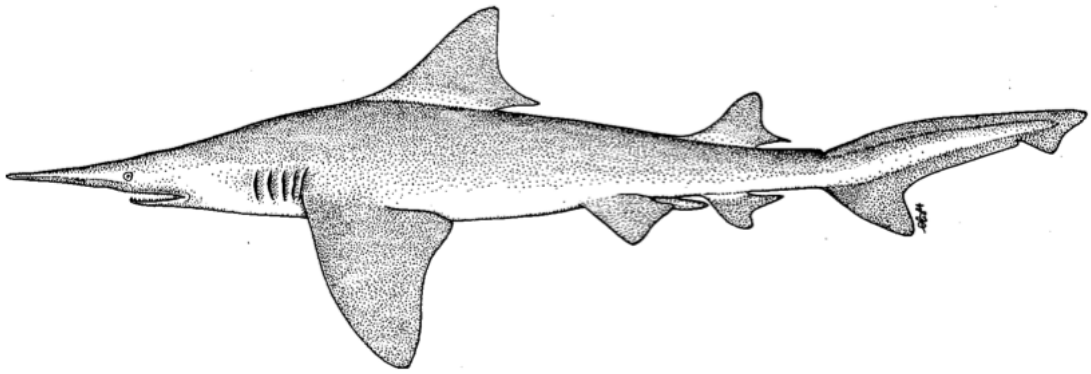

Figure 1. A side view of daggernose shark external anatomy (Compagno 1984).

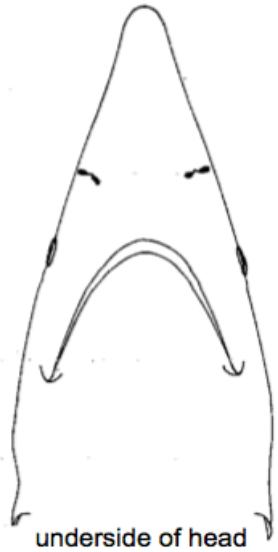

Figure 2. The underside view of the head of a daggernose shark (Compagno 1984).

Range and Habitat Use

The daggernose shark occurs in the central western Atlantic Ocean and Caribbean Sea. It has been reported along the coasts of Venezuela, Trinidad, Guyana, Suriname, French Guiana, and northern Brazil (Figure 3) (Lessa et al. 2006a). Compagno (1984, 1988) reported that the daggernose shark occurred on the eastern, central Brazilian coast in Bahia state. These claims have been unsubstantiated as the species is unknown to local fishermen and has never been caught in fisheries surveys in the area (Lessa et al. 1999a). Currently, the daggernose shark's Brazilian range includes the states of Amapá, Pará, and Maranhão, with Tubarão Bay in Maranhão as its easternmost limit (Silva 2004, Lessa et al. 1999a). The range of the daggernose shark is one of the smallest of any elasmobranch species (Lessa et al. 2000).

The daggernose shark is a coastal species that is commonly found in estuaries and river mouths in tropical climates (Compagno 1984, Compagno 1988, Lessa et al. 1999a, Lessa et al. 1999b, Grace 2001). Different maturity stages occur together in shallow waters between 8 and 40 m deep (Lessa et al. 1999a, Lessa et al. 1999b). Daggernose sharks are most abundant in estuarine and river mouth areas during the Amazonian summer, the rainy season, with males arriving in shallow waters from deeper seamount habitat earlier than females (Lessa 1997, Lessa et al. 1999a, Lessa et al. 2006b). There is no documentation on specific winter habitats of the daggernose shark.

Conflicting reports exist on the preferred substrate type of the daggernose shark. Compagno (1984) states that the species occurs in association with rocky bottoms, but Lessa et al. (1999a) asserts that they are strongly associated with muddy bottoms. They are often found in association with mangrove coastlines, and prefer highly turbid waters (Lessa et al. 1999a). Daggernose sharks seem to prefer low lying and indented coastlines that can have tide changes that vary as much as 7 m (Martins-Juras et al. 1987, Lessa et al. 1999a). They are found in waters ranging from 21.5^{o}C to 31.5^{o}C and salinities between 13.96 and 33.60 ppt (Lessa 1997). Salinity is considered a determining factor for the

distribution of the species, but does not prevent the capture of daggernose sharks in shallow waters during the rainy season when waters are less saline (Lessa 1997).

Figure 3. Range of daggernose shark based on the information gathered in this review.

Diet and Feeding

Little is known about the diet and feeding of the daggernose shark. Bigelow and Schroeder (1948) and Compagno (1984) suggest that they feed on schooling fishes, such as clupeids, sciaenids, herring, anchovies, and croakers. It is speculated that their small eyes and elongated snout emphasize the use of their rostral sense organs over eyesight when hunting in turbid waters (Compagno 1984). In Marajó Bay in Brazil, daggernose sharks were found eating catfish (Family Ariidae) (Barthem 1985).

Growth and Reproduction

Growth is similar between males and females. A von Bertalanffy growth model fit to band counts on vertebrae resulted in growth rate parameters (K) between 0.11 and 0.12/year, with a maximum theoretical size (L_∞) between 171.4 and 173.8 cm total length (TL) (Lessa et al. 2000). A growth rate from birth to age one was calculated to be approximately 14 cm/year (Lessa et al. 2000). This rate then slows to approximately 10 cm/year from age 1 to 5-6 for males and age 1 to 6-7 for females (Lessa et al. 2000). The estimated ages at maturity are 5-6 years for males and 6-7 years for females. After maturity is reached, growth rates decrease to less than 10 cm/year (Lessa et al. 2000).

Maximum age was estimated at 20 years based on converting the length of a 160 cm TL female with parameters from the von Bertalanffy growth equation. The largest male caught was 144 cm TL, corresponding to an age of 13 years old (Lessa et al. 2000). However, the oldest aged individuals from vertebrae were a 7 year old male and a 12 year old female (Lessa et al. 2000).

Male daggernose sharks begin maturing between 90 and 110 cm TL (Lessa et al. 1999a). During this time the claspers grow from 4 cm to 10.5 cm long (Lessa et al. 1999a). In the field, fully adult males were observed at sizes larger than 119 cm TL, with claspers 9 cm or longer (Lessa et al. 1999a). According to von Bertalanffy growth parameters, size at maturity for males is 103 cm TL, and size at maturity for females is about 115 cm TL (Lessa et al. 2000). The smallest pregnant female recorded was 118 cm long (Lessa et al. 1999a).

The reproductive cycle of daggernose sharks in Brazil is synchronized with the rain cycle. The rainy season runs from January to June and the dry season runs from July to December. Ovary weight in non-pregnant adults suggests that follicles develop through the latter part of the year, resulting in heavy ovaries during the rainy season (Lessa et al. 1999a). Vitellogenesis begins in females between 105 and 112 cm TL when ovarian follicles reach 1.3 cm in diameter (Lessa et al. 1999a). Seventy percent of the pregnant females collected in the rainy season were carrying a recently fertilized egg or very small embryo, suggesting that the ovulation period takes place at the end of the dry season or at the beginning of the rainy season (Lessa et al. 1999a, Barthem 1985). Pregnant females are found in deeper waters, but there are no specifics on the exact depth range (Lessa et al. 1999a).

Female fecundity is low, commonly ranging between 3 to 7 embryos per female, although there has been one report of a female with 8 embryos (Bigelow and Schroeder 1948, Lessa et al. 1999a, Barthem 1985). Lessa et al. (1999a) reported that the largest litter from a dissected female contained 7 embryos. There is no significant relationship between female size and litter size in daggernose sharks (Lessa et al. 1999a). The largest full term embryo recorded was 43.2 cm (Lessa et al. 2000). The average back calculated length for size at birth was 42.3 cm TL for both males and females (Lessa et al. 2000), and Compagno (1984) stated actual birth length was thought to be between 38 and 41 cm TL.

The gestation period is approximately 12 months, with a protracted birthing period throughout the six-month rainy season (Lessa et al. 1999a, Lessa et al. 2006b). Mature females captured with flaccid uteri and white follicles indicate that there is a break in follicle development between two successive pregnancies, which indicates a 2-year reproductive cycle (Lessa et al. 1999a). Mating and gestation periods can be postponed to compensate for climate variability and changing environmental conditions across years (Lessa et al. 1999a).

Demography

The daggernose shark gives birth to 3-7 pups with a year of gestation and a year of resting between pregnancies (Lessa et al. 1999a). Males mature between 5 and 6 years of age, and females mature between 6 and 7 years of age (Lessa et al. 2000). Using these life history parameters and following methods in Cortes (2002) for estimating

survivorship, productivity (as intrinsic rate of population increase, r) was estimated at 0.004 $year^{-1}$ (median) within a range of -0.040-0.038 (5% and 95% percentiles) (Carlson unpublished). Median generation time (T) was estimated at 10.6 years, the mean age of parents of offspring of a cohort (μ_1) is 10.7 years and the expected number of replacements (R_0) is 1.05.

These demographic parameters place daggernose sharks towards the slow growing end of the "fast-slow" continuum of population parameters calculated for 38 species of sharks by Cortés (2002, Appendix 2). These species generally have low potential to recover from exploitation.

DISTRIBUTION AND ABUNDANCE

Records of the daggernose shark have occurred in Trinidad and Tobago, Guyana, Suriname, French Guiana, and the Brazilian states of Amapá, Pará, and Maranhão (Figure 3; Tables 1 and 2). There is no quantitative or qualitative abundance or trend information for daggernose sharks anywhere in their range, though the IUCN Red List Assessment states that the population is declining (Lessa et al. 2006a). The only data available are species catch records and museum collection records, most commonly reported in the GBIF Database. The majority of these records are undated, making it difficult to infer a historical abundance estimate or any current trend in population abundance from our records directly. In addition, there is question on the validity of some records from the GBIF database and the website does not guarantee the accuracy of the biodiversity data. Thus, while we do provide a summary of these records the accuracy of the records is not completely reliable. Most information available on the distribution and abundance of the daggernose shark comes from Brazil. Daggernose shark specimens are housed in several different museums around the world.

Brazil

In Brazil, the daggernose shark can be found in the states of Amapá, Pará, and Maranhão (Barthem 1985, Lessa 1986, Martins-Juras et al. 1987, Lessa 1997, Lessa et al. 1999a, b, Lessa et al. 2000, Sotto and Mincarone 2004, Silva 2004, Lessa et al. 2006b). Daggernose sharks were first formally recorded in Brazil in surveys from the 1960s in the state of Maranhão (Lessa 1986). Recently, they have been caught in two Marine Conservation Areas in northern Brazil, the Parque Nacional Cabo Orange in Amapá, and the Reentrâncias Maranhenses in Maranhão (Lessa et al. 1999b).

Reviews of the species biology state that the population abundance declined by 18.4% per year for ten years from the mid-1990s to mid-2000, resulting in a total population decline of 90% (Rosa and Lima 2005, Kyne et al. 2012), but we were unable to find explicit statistics and studies with data that could support or contradict these statements. In recent years, the absence of daggernose sharks in Brazil in places where they were previously common has been noted. A genetic analysis of sharks being sold in fish markets in northern Brazil, where daggernose sharks were once sold in abundance, found no daggernose sharks in the market between October 2005 and December 2006 (Rodrigues-Filho et al. 2009). Although their absence in fish markets could indicate that artisanal fishermen are following Brazilian law, which prohibits the catch of daggernose

sharks without special research permits, it has been noted that these laws are poorly enforced and frequently ignored (Lessa et al. 1999b, Silva 2004, Amaral and Jablonski 2005, Almeida et al. 2011, Rodrigues-Filho 2012). Additionally, daggernose sharks have been absent in research surveys in Maranhão between November 2006 and December 2007, where they were once caught abundantly prior to 1992 (Almeida et al. 2011).

Table 1. Records of the daggernose shark caught in Brazilian waters based on an extensive search of scientific publications, technical reports, museum specimen records, and the Global Biodiversity Information Facility Database (GBIF).

Year	Total Number	Area	Country	Source
1969 and 1976	--	Ilha de Santana and Baia de Lencois	Brazil	Lessa 1986
1982	--	Marajo Bay	Brazil	Barthem 1985
1982	1	Foz do Rio Pará, Cabo Maguari, Baía de Marajó	Brazil	GBIF Database
1982	1	Rio Amazonas, Cabo Maguari, Baía de Marajó	Brazil	GBIF Database
1982-1986	--	Ilha de Sao Luis, Maranhao	Brazil	Martins-Juras et al. 1987
1984-1986	--	Maranhao coast	Brazil	Lessa 1997
1984-1987; 1990-1991; 1998	105	between Turiacu and Tubarao Bays, Maranhao coast	Brazil	Lessa et al. 2000
1984-1987; 1990-1991; 1999	1135	between Turiacu and Tubarao Bays, Maranhao coast	Brazil	Lessa et al. 2000
1984-1987; 1998	--	Maranhao coast	Brazil	Lessa et al. 2006
1985-1987; 1989-1990	201	between Turiacu and Tubarao Bays, Maranhao coast	Brazil	Lessa et al. 1999
N/A	1	--	Brazil	GBIF Database
N/A	1	Ilha de Mangunca	Brazil	GBIF Database
N/A	1	Amazonas River, Marajo Bay	Brazil	Soto and Mincarone 2004
N/A	1	Para River, Marajo Bay	Brazil	Soto and Mincarone 2004

Other Countries

There is very little information available on the distribution and abundance of the daggernose shark outside of Brazil. Undated catch records exist across the entire coastline of French Guiana, but records are few throughout Suriname, Guyana, and Trinidad and Tobago (Table 2; GBIF Database, Bigelow and Schroeder 1948, Springer 1950, Compagno 1988). No information could be found on the existence of the daggernose shark in Venezuela. However, the IUCN red list assessment indicates Venezuela is part of their range (Lessa et al. 2006b). Increased levels of artisanal fishing pressure are likely to have caused dramatic population declines in the last decade, similar to the levels documented in Brazil, but scientific data on population trends is severely lacking for this region (Kyne et al. 2012).

Table 2. Records of the daggernose shark caught in Trinidad and Tobago, Guyana, Suriname, and French Guiana based on an extensive search of scientific publication, technical reports, museum specimen records, and the Global Biodiversity Information Facility Database (GBIF).

Year	Total Number	Area	Country	Source
1830	1	--	French Guiana	GBIF Database
1908	1	Georgetown market	Guyana	GBIF Database
1949	1	--	Trinidad	Springer 1950
1959	1	Georgetown	Guyana	GBIF Database
1961	1	Kitty Jetty	Guyana	GBIF Database
1968	1	--	Suriname	GBIF Database
1968	1	--	Suriname	GBIF Database
1968	1	Cayenne	French Guiana	GBIF Database
1968	1	Paramaribo	Suriname	GBIF Database
1981	1	--	Suriname	GBIF Database
1986	1	Port of Spain fish market	Trinidad and Tobago	GBIF Database
N/A	1	--	French Guiana	GBIF Database
N/A	1	--	French Guiana	GBIF Database
N/A	1	--	French Guiana	GBIF Database
N/A	1	--	French Guiana	GBIF Database
N/A	1	--	French Guiana	GBIF Database
N/A	1	--	French Guiana	GBIF Database
N/A	1	--	French Guiana	GBIF Database
N/A	1	--	French Guiana	GBIF Database
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N/A	1	--	French Guiana	GBIF Database
N/A	1	--	French Guiana	GBIF Database
N/A	1	--	French Guiana	GBIF Database
N/A	1	--	French Guiana	GBIF Database
N/A	1	Cayenne	French Guiana	GBIF Database
N/A	1	--	French Guiana	GBIF Database
N/A	1	--	French Guiana	GBIF Database
N/A	1	--	French Guiana	GBIF Database
N/A	1	--	French Guiana	GBIF Database
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N/A	1	--	French Guiana	GBIF Database
N/A	1	--	French Guiana	GBIF Database
N/A	1	--	French Guiana	GBIF Database
N/A	1	Cayenne	French Guiana	GBIF Database
N/A	1	--	French Guiana	GBIF Database
N/A	1	--	French Guiana	GBIF Database
N/A	1	--	French Guiana	GBIF Database
N/A	1	Cayenne	French Guiana	GBIF Database
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N/A	1	--	French Guiana	GBIF Database
N/A	1	--	French Guiana	GBIF Database
N/A	1	--	French Guiana	GBIF Database
N/A	1	British Guyana	Guyana	GBIF Database
N/A	1	--	French Guiana	GBIF Database

N/A	1	--	French Guiana	GBIF Database
N/A	1	--	French Guiana	GBIF Database
N/A	1	--	French Guiana	GBIF Database
N/A	1	--	French Guiana	GBIF Database
N/A	1	--	French Guiana	GBIF Database
N/A	1	--	French Guiana	GBIF Database
N/A	1	--	French Guiana	GBIF Database
N/A	2	Georgetown	Guyana	Compagno 1988
N/A	1	Paramaribo	Suriname	Compagno 1988
N/A	1	--	French Guiana	Compagno 1988
N/A	1	--	Suriname	Bigelow and Schroeder 1948

ANALYSIS OF THE ESA SECTION 4(a)(1) FACTORS

NMFS is required to assess whether this candidate species is threatened or endangered because of one or a combination of the following five threats listed under section 4(a)(1) of the ESA: (A) destruction, modification or curtailment of its habitat or range; (B) overutilization for commercial, recreational, scientific, or educational purposes; (C) disease or predation; (D) inadequacy of existing regulatory mechanisms; or (E) other natural or human factors affecting its continued existence. Below we consider the best available information on each of the threat factors in turn.

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

Daggernose sharks are frequently found in shallow waters along mangrove-lined coasts from Trinidad and Tobago to northern Brazil. There has been a dramatic decline in mangrove forests around the world for decades. It is estimated that between 1980 and 2000 there was a 20-35% decline in global mangrove forest area (FAO 2007, Giri et al. 2011). The current estimate for mangrove forest area in the world is less than half of what it once was, and the forests that still exist are degraded (Giri et al. 2011). Of the countries where daggernose sharks are found, all but French Guiana showed declines in mangrove forest areas between 1980 and 2005 (FAO 2007). However, the available data on mangrove forest area in both French Guiana and Guyana were poor, and it is likely that forest loss occurred in French Guiana and was more severe than estimated in Guyana (FAO 2007).

The main cause of mangrove forest decline thus far has been anthropogenic disturbance (FAO 2007, Gilman et al. 2008, Giri et al. 2011). Coastal areas are under high population pressure and this has led to the clearing of mangrove forests for infrastructure, aquaculture, agriculture, and tourism (FAO 2007). Historically mangroves were harvested for the use of their wood, but that is rarely the main cause of contemporary permanent mangrove loss (FAO 2007). Improper shrimp farming practices pose a huge threat to the survival of mangroves and the surrounding ecosystems (FAO 2007). When done incorrectly, shrimp aquaculture can lead to significant eutrophication and ultimately dead zones in the surrounding waters (FAO 2007). Pollution in developed coastal zones also poses a threat to mangrove survival. This is particularly a problem in

Suriname, where the flow of pesticides into coastal zones threatens mangrove survival (FAO 2007).

Climate change and human's response to climate change pose a major threat to the future survival of the remaining mangrove forests (Gilman et al. 2008). It is thought that the biggest threat to mangroves will be sea level rise (Gilman et al. 2008, Giri et al. 2011). As sea level rises, mangrove's seaward margins will retreat (Gilman et al. 2008). The survival of mangrove forests will depend on the mangrove species' ability to colonize the newly submerged habitat at a rate equal to or greater than sea level rise (Gilman et al. 2008). The slope of the land farther inland could create a natural barrier to the landward expansion of mangrove forests, and manmade obstacles such as sea walls and roads could also inhibit landward expansion (Gilman et al. 2008). Rising sea levels due to climate change are likely to increase the number of manmade seawalls used to protect existing coastal structures (Gilman et al. 2008). Not only will this act as a barrier to landward mangrove expansion, it will also cause erosion and scouring of the mangroves immediately adjacent to the wall (Gilman et al. 2008). There are many other uncertain variables that could arise with changing climate (including increased rainfall, temperature, and CO_2 levels). There is uncertainty about how mangroves will handle these stressors, how human responses to these changes could affect mangrove growth, and how mangroves will respond to the synergistic effects of climate change and anthropogenic disturbances (Gilman et al. 2008).

Many countries now have conservation efforts in place in response to the decline in the world's mangroves. Of the countries where daggernose sharks are found, Brazil is the only one that has laws in place to protect mangrove forests (FAO 2007). Additionally, Brazil has established new coastal protected areas to preserve existing mangrove forests (FAO 2007). According to the FAO (2007), between 2000 and 2005, there was no mangrove loss in Brazil. The majority of mangrove loss in Brazil before 2000 took place in the South, outside of the daggernose shark's range. The low human population in northern Brazil has minimized mangrove loss in that area, but shrimp farming in the region still poses a risk (FAO 2007).

Despite the FAO's findings, a socio-economic survey of mangrove use in northern Brazil found trends of expanding tourism, intensified fishing, and increased urban growth in coastal Pará threatened the mangrove forest (Saint-Paul 2006). Though laws protect the mangroves in the area, extensive deforestation occurred during the study for both subsistence and industrial purposes. It is unclear whether the level of usage of the mangrove forest resources is currently a sustainable practice (Saint-Paul 2006).

Aside from mangrove loss, general coastal development and population increase could negatively affect all of the daggernose shark's habitat. Because coastal areas are so productive, nearshore waters have high economic value, which leads to heavy colonization (Bates et al. 2008). It is estimated that by 2020, 75% of the world's population will live within 60 km of the coast (Knip et al. 2010). Increased human populations and coastal development near the shore will lead to habitat degradation, increased pollution from terrestrial runoff, and increased fisheries exploitation (Knip et al. 2010). Shoreline degradation has already led to some coastlines being less productive and unable to support the nutritional demands of the shark species that utilize them (Knip et al. 2010). Increased runoff and pollution has led to eutrophication and dead zones due to low oxygen levels, thus reducing the health of the ecosystem. This in turn decreases

productivity and lowers prey levels, reducing shark foraging success (Knip et al. 2010). As human populations increase in South America, increasing coastal development could pose a large threat to daggernose shark habitat.

Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

According to Nascimento and Asno (1999), directed fisheries for daggernose sharks have been developing off the northern coast of Brazil during the dry season. These fisheries use 6000 m long gillnets with 18 cm mesh size. These landings are common in Baía do Marajó, Pará (Isaac and Barthem 1995). However, we could find no information on daggernose shark landings or effort for these fisheries.

Daggernose sharks are caught as bycatch in Brazilian artisanal gillnet fisheries for Spanish mackerel (*Scomberomorus brasiliensis*) and king weakfish (*Cynoscion acoupa*) inside or near estuary mouths (Lessa et al. 1999a, Lessa et al. 2000). This incidental catch occurs primarily during the dry season, when daggernose sharks are more abundant in shallow coastal waters (Lessa et al. 1999a). Harvest begins in October and peaks in January when the highest catch per unit effort (CPUE) for daggernose sharks is recorded (71 $kgkm^{-1}h^{-1}$ prior to 1999; Lessa et al. 1999a). On the Maranhão coast, 96,500 tonnes of elasmobranchs were landed each year in artisanal fisheries in the 1990s, while the estimated sustainable total catch is estimated at 23,450 tonnes/year (Lessa 1997). Demographic analyses suggest that mortality as a result of these fisheries is causing the daggernose shark population to decrease at 18.4% per year with declines >90% observed in the 1990s (Lessa et al. 2006a citing Santana and Lessa 2002, which could not be found during the course of this review). We could not locate any recent information on landings of daggernose shark for these fisheries.

Daggernose sharks make up about 7-10% of the elasmobranch incidental catch in artisanal gillnet fisheries on the Maranhão coast in Brazil during the dry season (Lessa et al. 1999b; Lessa et al. 2000). The total elasmobranch incidental catch could not be found. Presumably these fishing practices are similar in Venezuela, Trinidad and Tobago, Guyana, Suriname, and French Guiana, but there is virtually no information available on the artisanal fishing practices, and the daggernose shark in general, in these countries (Lessa et al. 2006a). The value of daggernose shark fins is low, but its meat has been sold in markets from artisanal fisheries for decades (Lessa et al. 2006a). Bigelow and Schroeder (1948) also noted that, though daggernose shark meat was not considered a desirable food, it was sold in markets in Trinidad and was likely sold in the Guyanas.

Information on the catch of daggernose sharks in fisheries is very limited. At this time, we are unable to provide any further information on potential changes in fishing effort, fishing methods, and fishing grounds over time.

Competition, Disease, or Predation

At this time, there is no information available regarding diseases or predators that pose a risk to the survival of the daggernose shark.

Adequacy of Existing Regulatory Mechanisms

Throughout the species' range, species-specific protection for daggernose sharks is only found in Brazil. In 2004, the daggernose shark was first listed in Annex 1 on Brazil's endangered species list (Silva 2004). An Annex 1 listing prohibits the catch of the species except for scientific purposes, which requires a special license from the Brazilian Institute of Environment and Renewable Resources (Silva 2004). This protection was renewed in December, 2014, when the daggernose shark was listed as critically endangered on the most recent version of the Brazilian Endangered Species List approved by the Ministry of the Environment (Directive N^{o} 445). Brazil also has an extensive system of state and federal marine protected areas (Lessa et al. 1999b). Of these, the daggernose shark is found in the Parque Nacional Cabo Orange and the Reentrâncias Maranhenses (Lessa et al. 1999b). The expansion of both of these areas was proposed by Lessa et al. (1999b) in a Brazilian Ministry of the Environment document in order to improve the protection of daggernose shark habitat.

Though Brazil has some regulations in place to protect endangered or threatened species but they are poorly enforced, particularly with artisanal fishermen (Lessa et al. 1999b, Amaral and Jablonski 2005, Almeida et al. 2011, Rodrigues-Filho et al. 2012). Though protective legislation and marine protected areas exist, effective conservation is lacking in Brazil (Lessa et al. 1999b, Amaral and Jablonski 2005). Poverty, lack of education for artisanal fishermen, and increased artisanal fishing effort in Maranhão, Brazil, have contributed to the decline of many elasmobranch populations, potentially including the daggernose shark (Lessa et al. 1999b).

In December, 2014, the Brazilian Government's Chico Mendes Institute for Biodiversity Conservation approved the National Plan of Action for the Conservation of Elasmobranchs of Brazil (N^{o} 125). The plan considers the daggernose shark to be one of the country's 12 species of concern and recommends a moratorium on fishing with the prohibition of sales until there is scientific evidence in support of recovery (N^{o} 125, Lessa et al. 2005). Additionally it proposes the expansion of the Reentrâncias Maranhenses to include the marine coastal zone and banks. The plan recommends increased effort monitoring of vessels using nets in the area and increased education to encourage the release of live daggernose sharks and prevent the landing of the species. In general the plan sets short term goals for improved data collection on landings and discards, improved compliance and monitoring by the Brazilian Institute of Environment and Renewable Natural Resources (IBAMA), supervision of elasmobranch landings to ensure fins are landed with carcasses, the creation of a national port sampler program, and intensified on board observer monitoring programs. Mid-term goals include increased monitoring and enforcement within protected areas as well as the creation of new protected areas based on essential fish habitat for the 12 species of concern. They also call for improved monitoring of fishing from beaches in coastal and estuarine environments. Long term goals call for improved ecological data and stock assessments for key species as well as mapping of elasmobranch spatiotemporal distributions. This data will be used to better inform the creation of protected areas and seasonal fishing closures.

There is limited information on shark fishing regulations within the daggernose shark's range outside of Brazil. Both Trinidad and Tobago and Guyana reported shark

landings to the FAO in the 1990s, but daggernose sharks were not specifically included in the catches (Shing 1999). Artisanal gillnet fisheries operate in both countries and have been known to partially target sharks while fishing for *Scomberomorus* spp. (Shing 1999). Gillnet fisheries in Guyana and Trinidad and Tobago are restricted to using nets of 900 ft or less with no more than a 15-foot depth (Shing 1999). Currently there are no minimum size restrictions or catch quotas for sharks in both countries (Shing 1999). In the late 1990s a fisheries management plan was drafted for Trinidad and Tobago. This plan prohibited the use of monofilament gillnets less than 4.75" stretch mesh and developed a licensing system (Shing 1999). No further details about the plan could be found. In the summer of 2013, Guyana's Fisheries Department within the Ministry of Agriculture passed a five-year Fisheries Management Plan for Guyana to run from 2013 to 2018 (gina.gov.gy/wp/?p=12293). One aspect of this plan is meant to address shark fishing, but no further details could be found at this time. No pertinent information could be found on shark fishing regulations in Venezuela, Suriname, and French Guiana. There is no information available on daggernose shark conservation efforts in Venezuela, Trinidad and Tobago, Guyana, Suriname, and French Guyana.

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