ENDANGERED SPECIES ACT
STATUS REVIEW OF THE ARGENTINE ANGEL SHARK
(*Squatina argentina*)

(www.fishbase.org)

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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, *Squatina argentina* (Argentine angel shark).

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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 Argentine angel shark, *Squatina argentina*; (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 Argentine angel 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

Taxonomy and Anatomy

The Argentine angel shark (*Squatina argentina*) is a chondrichthyan member of the family Squatinidae that can be found in the Southwestern Atlantic Ocean from Southern Brazil to Argentina. In English it is called the Argentine angel shark and the longfin angel shark (Vooren and Chiaramonte 2006). They are called *cação-anjo* in Portuguese (Miranda and Vooren 2003) and *angelito, angelote,* and *pez ángel* in Spanish (Vooren and Chiaramonte 2006, Domingo et al. 2008).

The taxonomy of angel sharks of the southwestern Atlantic Ocean has been a source of ongoing controversy (Vooren and Chiaramonte 2006). Due to similar morphological characteristics, *S. argentina*, *S. guggenheim*, *S. occulta*, and *S. punctata* have been variously synonymized with each other (Compagno 2005, Vooren and Chiaramonte 2006, de Carvalho 2012). Currently, *S. punctata* is considered a junior synonym of *S. guggenheim* (Vooren and da Silva 1991, de Carvalho et al. 2012, Vaz and Carvalho 2013). Extensive studies of the morphotypes that occur in southern Brazil and the southwestern Atlantic concluded *S. argentina*, *S. guggenheim,* and *S. occulta* are three different species that can be distinguished by morphological differences as well as life history characteristics, such as differences in reproductive patterns, overall size, and depth and temperature preference (Vooren and da Silva 1991, Vaz and Carvalho 2013). Isoenzymatic studies concluded that the nominal species *Squatina argentina* was at least two different species based on esterase patterns from heart extracts as well as morphological features (Solé-Cava et al. 1983). An analysis of molecular systematics of angel sharks confirms the validity of *S. guggenheim* and *S. occulta* as separate species (Stelbrink et al. 2010).

The Argentine angel shark can be distinguished from *S. guggenheim* and *S. occulta* by its coloration, dental formula, some neurocranial features, dorsal surface denticle pattern, and pectoral fin shape. Unlike *S. guggenheim*, the Argentine angel shark lacks a dorsal midline of morphologically distinct denticles (Vaz and Carvalho 2013). Dermal denticles densely cover the entire dorsal surface, except for the posterior margins of unpaired fins and the anterior apex of the pectoral fins. No sexual dimorphism in the morphology and distribution of dermal denticles was seen. They have 24 vertical tooth rows in both jaws with a dental formula of 12-12/12-12 (Vaz and Carvalho 2013). Upper jaw teeth are smaller than lower jaw teeth and are spaced more widely apart. There was no sexual dimorphism in teeth. In the neurocrania, the distal portion of the upper postorbital process has a lanceolate shape and the projection of the external canal is in a laterally diagonal position on the octic capsule (de Carvalho et al. 2012). The pectoral fins are large, twice as long as they are wide, with a length 32.4 - 36.7% of the total length (TL). The anterior margins of the pectoral fins are strongly convex, creating a visible “shoulder” area at the base of the head (Figure 1; Vaz and Carvalho 2013). The dorsal coloration is dark to purplish brown with small, round, white spots symmetrically distributed across the entire dorsal surface (Vooren and da Silva 1991, Milessi et al. 2001, Vaz and Carvalho 2013). Spot size ranges, but it is always at least half of the eye length (2.3 – 2.9% TL; Vaz and Carvalho 2013). Small individuals are creamy white over the entire ventral surface, while larger animals develop dark beige on the central region of the head, margins of the pectoral fins, origin of the pelvic fins, and the posterior region of the trunk (Vaz and Carvalho 2013). Unlike *S. guggenheim and S. occulta*,

female Argentine angel sharks have two functional ovaries, which can also serve as an identifying feature (Vooren and da Silva 1991).

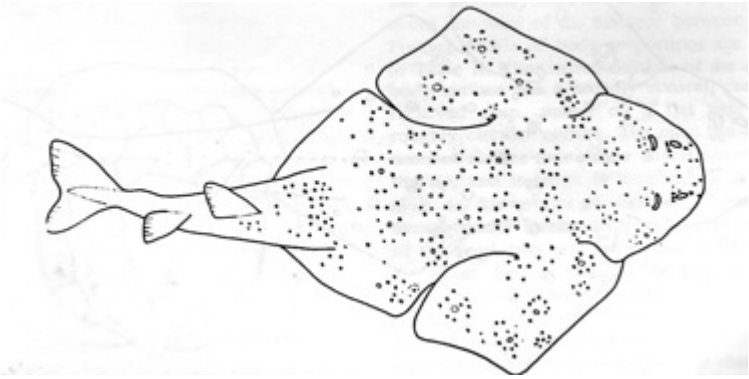

Figure 1. The Argentine angel shark based on its re-description by Vooren and da Silva (1991).

Range and Habitat Use

Conflicting information is available on the exact range of the Argentine angel shark. The IUCN Red List states that they are found from Rio Grande do Sul in southern Brazil to Patagonia, Argentina, but their distribution map indicates that they range from Rio de Janeiro, Brazil to Chubut, Argentina (Vooren and Chiaramonte 2006). Vaz and de Carvalho (2013) state that the Argentine angel shark is distributed from Santa Catarina, Brazil to southern Uruguay, while Milessi et al. (2001) say they range from São Paulo, Brazil, south to Patagonia, Argentina. Records from the GBIF Database, which may be unreliable, indicate that Argentine angel sharks have been found as far south as Chubut, Argentina and as far north as Santa Catarina, Brazil (Table 1). For the purposes of this review and based on peer reviewer recommendations, we have chosen to accept Vaz and Carvalho's (2013) range from the most recent taxonomic review.

Argentine angel sharks live at depths between 100 and 400 m, with a principal depth range of 120-320 m (Cousseau 1973, Vooren and da Silva 1991, Vooren and Klippel 2005). Both sexes and all life stages are found between Rio Grande and Chuí in Brazil (Vooren and Klippel 2005). They live on muddy or sandy bottom substrates on the continental shelf and slope. Angel sharks are active mostly at night, and show limited movement and dispersal migration between neighboring populations, with migrants having no impact on the short term abundance of a population (Vooren and Klippel 2005).

Figure 2. The range of the Argentine angel shark from Santa Catarina, Brazil to Buenos Aires, Argentina based on the most recent taxonomic confirmation by Vaz and Carvalho (2013).

Diet and Feeding

Little information is available regarding the Argenitne angle sharks's diet. The stomach contents of 53 individuals showed that fish made up 68.33% of the diet, crustaceans made up 15% of the diet, and molluscs made up 1.6% of the diet. The rest of the diet contained unidentifiable remains. The most common fish species was *Cynoscion striatus*, while the shrimp *Artemesia longinaris* and *Hymenopenaeus mulleri* where the most common crustaceans, and *Loligo brasiliensis* was the most common mollusc (Cousseau 1973). A study of the foodweb of the short-finned squid (*Illex argentinus*) indicates that they are occasionally preyed upon by Argentine angel sharks (dos Santos and Haimovici 2000). In general, angel sharks are thought to be sit-and-wait predators, lying motionless on sandy or muddy bottom until prey passes closely overhead. The prey is then grasped by an upward bite (Vooren and da Silva 1991).

Growth and Reproduction

Little is known about the growth and reproduction of the Argentine angel shark. Their maximum total length is 138 cm with a size at sexual maturity of 120 cm TL (Vooren and da Silva 1991, Vooren and Klippel 2005). Age at first maturity and size at birth are unknown (Vooren and da Silva 1991, Vooren and Klippel 2005).

Gravid females and neonates are rarely found, so little is known about the gestation and birth of this species (Vooren 1997). Vooren and Klippel (2005) indicate that like *S. occulta* and *S. guggenheim*, the Argentine angel shark may have cloacal gestation during the latter half of

pregnancy. In May of 1987, at 29°S, in Santa Catarina, Brazil, two neonates, 35 and 37 cm TL, were caught. This could indicate that Argentine angel sharks reproduce on the slope of the southern Brazilian continental shelf (Vooren and Klippel 2005). Gestation is lecithotrophic (Vooren 1997). Litter size ranges from 7-11 pups, most commonly 9 or 10 pups, and litter size is not related to maternal size (Vooren and da Silva 1991, Vooren and Klippel 2005).

Demography

No information is available on natural mortality rates or the intrinsic rate of population increase (r) of the Argentine angel shark.

DISTRIBUTION AND ABUNDANCE

To provide a better understanding of the Argentine angel shark's current distribution and abundance, an extensive search of scientific publications, technical reports, fishery bulletins, and museum specimen records was conducted. We also searched the Global Biodiversity Information Facility Database (GBIF) for museum specimen records. However, there is question on the validity of some records 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

The geographic distribution of the Argentine angel shark is poorly defined, but it is clear that they are present in southern Brazil, Uruguay, and at least the northern part of Argentina (Table 1; see Range and Habitat Use section above). Argentine angel sharks have been documented year round in southern Brazil (Vooren 1997). In the Argentine-Uruguayan Common Fishing Zone, Argentine angel sharks are distributed in the highest densities (from 1 to 11.4 t/nm^2) along the Uruguayan coast, where salinities are higher than the Argentine coast (Díaz de Astarloa et al. 1997). This paper refers to all *Squatina* species as Argentine angel sharks. However, it is likely more applicable to *S. guggenheim*, which is more common than Argentine angel sharks in the Argentine-Uruguayan Common Fishing Zone.

No specific population abundance estimates could be found for Argentine angel sharks. They are considered to be the least common species of angel shark found in the southwestern Atlantic, when compared to *S. guggenheim* and *S. occulta*, particularly in Argentina (Vooren and Klippel 2005). In Brazil, they are most abundant between Rio Grande and Chuí in Rio Grande do Sul, Brazil, and there is no evidence of the existence of abundant populations outside of this region (Vooren and Klippel 2005, Vooren and Chiaramonte 2006). Based on fishery independent research surveys, from 1986-2002, the abundance of both the Argentine angel shark and *S. occulta* has declined by approximately 80% on the outer shelf and upper slope of the southern Brazilian continental shelf (Vooren and Klippel 2005).

According to the GBIF database, there are two records of Argentine angel sharks that were caught in Namibia, well outside of their range in the southwestern Atlantic. Both of these records are from the early 1930s and are from specimens that are now housed in the Zoological Museum at the Natural History Museum of Denmark. It is likely, given the taxonomic controversy over angel shark species and the age of the specimens, that these specimens are misidentified as Argentine angel sharks and are really another angel shark species. It is hypothesized that that these records are actually *S. guggenheim* from the La Plata estuary and the town of Médanos, Argentina. Additionally, there is one undated record from Chile, which is also likely the result of a species misidentification.

Table 1. Records of the Argentine angel shark 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
1925	1		Uruguay	GBIF Database
1933	1	La Plata River	Namibia	GBIF Database
1934	1	Medano	Namibia	GBIF Database
1954	1	--	Brazil	GBIF Database
1966	1	La Paloma	Uruguay	GBIF Database
1966	1	Rio Grande do Sul	Brazil	GBIF Database
1966	1	--	Uruguay	GBIF Database
1966	1	--	Uruguay	GBIF Database
1966	1	Chubut	Argentina	GBIF Database
1966	1	Buenos Aires	Argentina	GBIF Database
1968	1	Paraná	Brazil	GBIF Database
1970	1	Rio Negro	Argentina	GBIF Database
1971	1	Punta del Diablo	Uruguay	GBIF Database
1971	1	Punta del Diablo	Uruguay	GBIF Database
1973	1	Buenos Aires	Argentina	GBIF Database
1973	1	Buenos Aires	Argentina	GBIF Database
1973	1	Chubut	Argentina	GBIF Database
1973	1	Chubut	Argentina	GBIF Database
1973	1	Chubut	Argentina	GBIF Database
1973	1	Chubut	Argentina	GBIF Database
1973	1	Rio Negro	Argentina	GBIF Database
1973	1	Chubut	Argentina	GBIF Database
1976	1	Rawson, Chubut	Argentina	GBIF Database
1976	1	Chubut	Argentina	GBIF Database
1976	1	Rio Negro	Argentina	GBIF Database
1976	1	Buenos Aires	Argentina	GBIF Database
1976	1	Buenos Aires	Argentina	GBIF Database
1976	1	Buenos Aires	Argentina	GBIF Database
1976	1	Buenos Aires	Argentina	GBIF Database
1976	1	Rio Negro	Argentina	GBIF Database
1976	1	Buenos Aires	Argentina	GBIF Database
1976	1	Buenos Aires	Argentina	GBIF Database
1976	1	Buenos Aires	Argentina	GBIF Database
1976	1	Buenos Aires	Argentina	GBIF Database
1976	1	Buenos Aires	Argentina	GBIF Database
1978	1	Buenos Aires	Argentina	GBIF Database

1978	1	Chubut	Argentina	GBIF Database
1978	1	Bahia Blanca, Buenos Aires	Argentina	GBIF Database
1978	1	Chubut	Argentina	GBIF Database
1978	1	Bahia Blanca, Buenos Aires	Argentina	GBIF Database
1978	1	Buenos Aires	Argentina	GBIF Database
1978	1	Buenos Aires	Argentina	GBIF Database
1978	1	Buenos Aires	Argentina	GBIF Database
1978	1	Buenos Aires	Argentina	GBIF Database
1978	1	Golfo San Matias, Rio Negro	Argentina	GBIF Database
1978	1	Buenos Aires	Argentina	GBIF Database
1978	1	Rio Negro	Argentina	GBIF Database
1978	1	Chubut	Argentina	GBIF Database
1978	1	Buenos Aires	Argentina	GBIF Database
1978	1	Neochea, Buenos Aires	Argentina	GBIF Database
1980-1987	160	Rio Grande do Sul	Brazil	Vooren and da Silva 1991
1982	1	Rio Grande do Sul	Brazil	GBIF Database
1982	1	Rio Grande do Sul	Brazil	GBIF Database
1983	1	Buenos Aires	Argentina	GBIF Database
1983	1	Buenos Aires	Argentina	GBIF Database
1983	1	Rawson, Chubut	Argentina	GBIF Database
1983	1	Chubut	Argentina	GBIF Database
1983	1	Chubut	Argentina	GBIF Database
1995-1996	8	Argentine-Uruguayan Common Fishing Zone	Argentina/Uruguay	Milessi et al. 2001
2001	1	Rio Grande do Sul	Brazil	GBIF Database
2002	1	Rio Grande do Sul	Brazil	GBIF Database
2003-2005	2	Rio Grande do Sul	Brazil	Kütter et al. 2009
N/A	1	Rio Grande do Sul	Brazil	GBIF Database
N/A	1	--	Chile	GBIF Database
N/A	1	--	Brazil	GBIF Database
N/A	1	--	Argentina	GBIF Database
N/A	1	Rio Grande do Sul	Brazil	GBIF Database
N/A	1	Rio Grande do Sul	Brazil	GBIF Database
N/A	1	Rio Grande do Sul	Brazil	GBIF Database
N/A	1	Buenos Aires	Argentina	GBIF Database
N/A	1	--	Uruguay	GBIF Database
N/A	1	Rio Grande do Sul	Brazil	GBIF Database
N/A	1	Rio Grande do Sul	Brazil	GBIF Database
N/A	1	Rio Grande do Sul	Brazil	GBIF Database

N/A	1	Rio Grande do Sul	Brazil	GBIF Database
N/A	1	Rio Grande do Sul	Brazil	GBIF Database
N/A	1	Rio Grande do Sul	Brazil	GBIF Database
N/A	1	Coquimba	Chile	GBIF Database
N/A	1	Rio Grande do Sul	Brazil	GBIF Database
N/A	1	La Paloma	Uruguay	GBIF Database
N/A	1	Buenos Aires	Argentina	GBIF Database
N/A	1	--	Uruguay	GBIF Database
N/A	1	Rio Grande do Sul	Brazil	GBIF Database
N/A	1	Bahia Blanca, Buenos Aires	Argentina	GBIF Database
N/A	1	Rio Grande do Sul	Brazil	GBIF Database
N/A	8	--	Argentina, Uruguay, and Brazil	Vaz and de Carvalho 2013
N/A	1	--	Uruguay	Bigelow and Schroeder 1948
N/A	2	Rio Grande do Sul	Brazil	de Carvalho et al. 2012

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

Trawl fisheries occur throughout the Argentine angel shark's range. Studies show that the interaction of bottom trawling gears with bottom substrate can have negative effects on benthic fish habitat (Valdemarsen et al. 2007). These impacts are often the most serious on hard substrates with organisms that grow up from the bottom such as corals and sponges, but alterations to soft substrates have also been seen. The trawl doors on bottom otter trawls often cause the most damage to the ocean bottom, but other parts of trawling gear, such as weights, sweeps, and bridles that contact the bottom can also be damaging. Intense fishing disturbance from trawling has reduced the abundance of several benthic species (Valdemarsen et al. 2007). Though there is no specific information available on how trawling has affected the Argentine angel shark's habitat, the existence of trawl fisheries within its range makes it likely that damage to bottom substrate has occurred.

Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

Commercial Fishing

The vast majority of fisheries information available on angel sharks from Argentina, Uruguay, and Brazil comes in the form of *Squatina* spp., which includes *S. guggenheim*, *S. argentina*, and *S. occulta*. All information in this section that refers simply to angel sharks includes multiple angel shark species, while information specific to *S. argentina* will specifically reference Argentine angel sharks. There is some evidence that *S. guggenheim* is the most abundant angel shark species from southern Brazil to Argentina and could make up the majority of angel shark landings data, while the Argentine angel shark is much less common (Vooren and da Silva 1991, Cousseau and Figueroa 2001, Vooren and Klippel 2005).

There is no directed fishery for angel sharks in Argentina, but historically they were captured in multispecies artisanal shark fisheries and were considered a valuable bycatch species (Chiaramonte 1998). In the early 2000s, angel sharks were one of the main cartilaginous fish landed in Argentine ports and were mostly caught along the coasts of Buenos Aires and Uruguay (Massa et al. 2004). In 2007, angel shark export revenue in Argentina was $2,732,274 U.S. dollars (NPOA – Argentina). Angel sharks were widely consumed as fresh product called *pollo de mar* (chicken of the sea) and as dried and salted product called *bacalao argentino* (Argentine cod) (Chiaramonte 1998). Historically, in Mar del Plata, they were caught for the sale of their liver oil (Cousseau 1973). In the 1990s angel sharks were considered commercially important bycatch, particularly in the Necochea school shark (*Galeorhinus galeus*) gillnet fishery. In the spring, the majority of angel sharks caught in this fishery were gravid females (Chiaramonte 1998). Argentine angel shark landings between 1992 and 1998 remained stable, but declines in CPUEs were recorded (Massa and Hozbor 2003). A decline in landings has been seen since 1998 (Massa et al. 2004). Though *S. guggenheim* was the most commonly landed species of angel shark in Argentina, captures of Argentine angel sharks were also frequently reported (Massa et al. 2004). Incorrect species identification of angel sharks is a problem that persists in the Argentine-Uruguayan Common Fishing Zone, particularly in the Argentine landings (Milessi et al. 2001).

In Uruguay, Argentine angel sharks are targeted in the Atlantic gillnet fishery and bottom trawl fisheries. They are also caught as bycatch in bottom long line, estuarine gillnet, and bottom trawl fisheries (Domingo et al. 2008). Uruguayan artisanal and industrial trawling fleets operate at depths between 10 and 200 m, but incorrect species identification, due to the aforementioned taxonomic controversy, makes it difficult to determine which species of angel shark, the Argentine angel shark (*S. argentina*), *S. guggenheim*, or *S. occulta*, is the most vulnerable to fishing pressure within the Argentine-Uruguayan Common Fishing Zone (Milessi et al. 2001). Catches of angel sharks in Uruguay were less than 100 t from 1977 to 1996 and ranged between 200 and 400 t between 1997 and 2005. It is likely that the majority of reported angel shark landings are *S. guggenheim* (Domingo et al. 2008).

Historically, in Brazil, double rig trawlers fished for angel sharks on the outer shelf down to 140 m, and *S. guggenheim* maked up the majority of the catch (Haimovici 1998). Mean annual landings of angel sharks have been over 2000 t since 1985 (Figure 3). Although landings were still high between 1990 and 1994, falling CPUEs signaled the approach of a decline in landings (Haimovici 1998). Argentine angel sharks have been reported to be the least captured angel shark species in Brazilian fisheries (Perez and Wahlrich 2005).

Argentine angel sharks are caught as bycatch in the monkfish (*Lophius gastrophysus*) fishery off southern Brazil. For every 100 nets set 1.052 Argentine angel sharks are caught and 49.3% of them are retained and processed. This makes them the second most retained bycatch species in this fishery, second to Geryonid crabs (Perez and Wahrlich 2005). It is estimated that 8,698 Argentine angel sharks were caught in the monkfish fishery in 2001 (Perez and Wahrlich 2005).

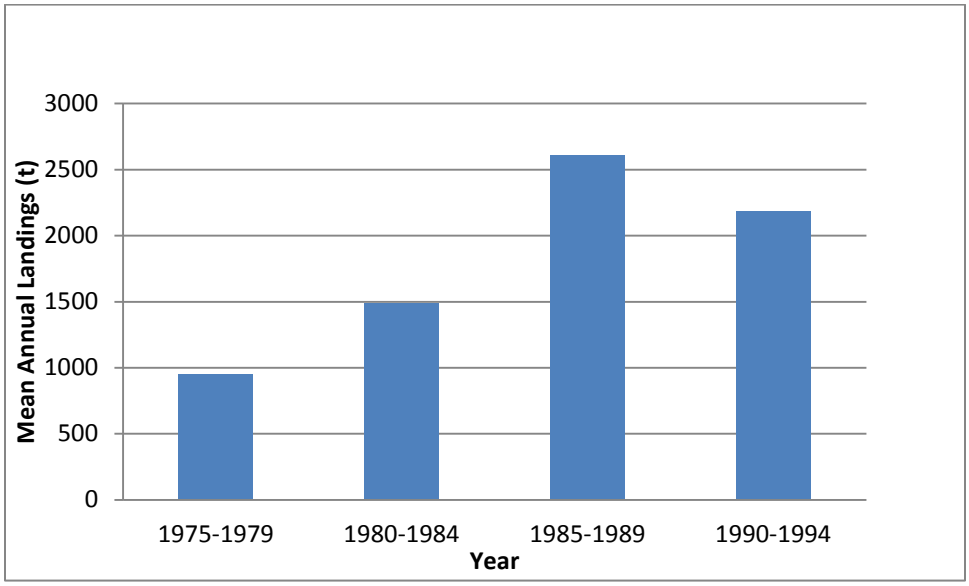

Figure 3. Mean annual landings of angel sharks in southern Brazil between 35°S and 28°S (Haimovici 1998).

In southern Brazil, angel shark landings are recorded in single trawl, pair trawls, oceanic drift nets, and coastal artisanal fisheries. In the early 1990s, single trawls recorded up to 53% of angel shark landings, but since 1993, oceanic drift nets have reported between 41 and 65% of annual landings. Total annual landings increased from 1,648 t in 1986 to 2,296 t in 1993. Landings then fell in 1997 to 607 t. Declines in CPUE were seen in single and pair trawls. CPUE for single trawls peaked in 1984 at 3 t/trip and then declined rapidly to 0.5 t/trip from 1995-1997, an 83% decline. Declines of 85% were seen in pair trawls where CPUE fell from 1 t/trip in 1986 to 0.15 t/trip from 1994-1997. It is estimated that overall the angel shark population has declined by 85% since 1985. CPUEs have remained high in the oceanic drift net fishery, between 1.93 t/trip to 5.20 t/trip, despite the decline in abundance seen with other fishing gear (Miranda and Vooren 2003). Miranda and Vooren (2003) state that the angel shark species included in the reported landings are only *S. guggenheim* and *S. occulta*, not the Argentine angel shark. However, the IUCN Red List assessment for the Argentine angel shark includes these data in their report (Vooren and Chiaramonte 2006), implying that Argentine angel sharks were part of these landings. Due to the above mentioned taxonomic controversy, Argentine angel sharks may also make up a portion of the landings mentioned by Miranda and Vooren (2003).

Landings of angel sharks in Argentina, Uruguay, and Brazil have been reported to the FAO. The FAO Aquatic Species Fact Sheets consider *S. guggenheim* and *S. punctata* to be synonyms for the Argentine angel shark (*S. argentina*) (www.fao.org). These FAO reported landings are presumably a combination of two valid species, *S. guggenheim* and the Argentine angel shark, and may also include landings of *S. occulta* (Figure 4).

At this time, more detailed information could not be provided regarding changing fishing effort or fishing grounds for Argentine angel sharks over time throughout their range. As noted above, there has been a shift in gear usage, with angel shark catches coming more frequently in oceanic drift nets than in single trawls since 1993 (Miranda and Vooren 2003).

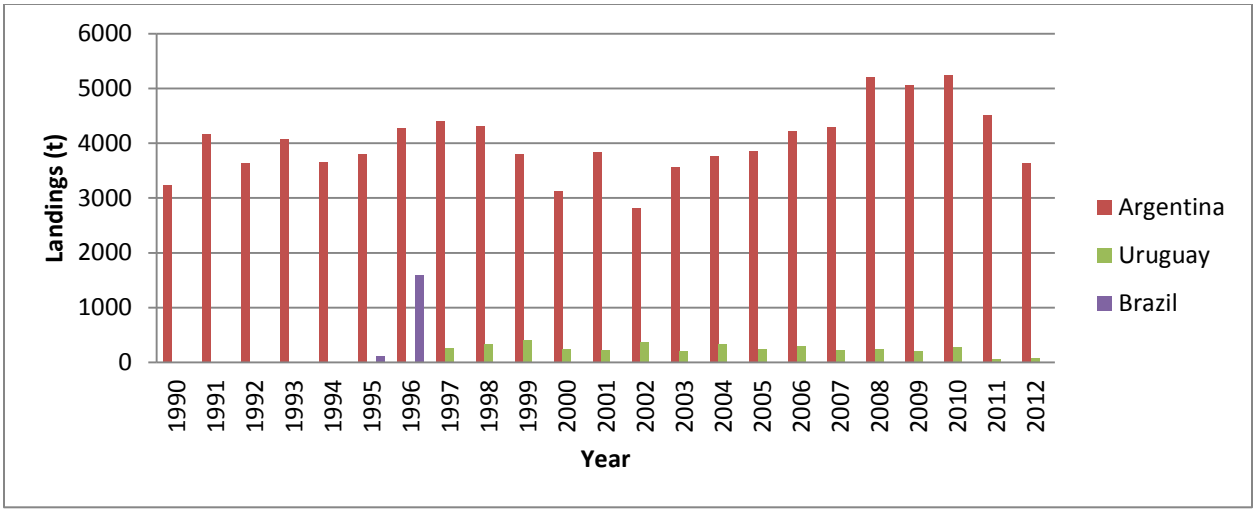

Figure 4. FAO reported landings for angel sharks from Argentina, Uruguay, and Brazil (www.fao.org).

Competition, Disease, or Predation

Predation

Studies of South American sea lion (*Otaria flavescens*) diet in Uruguay found that they consume Argentine angel sharks, particularly in Cabo Polonio (Szteren 2006). No other publications could be found that specifically indicate other animals as Argentine angel shark predators.

Adequacy of Existing Regulatory Mechanisms

Since 2012, the Comisión Técnica Mixta del Frente Marítimo has set a catch limit of 2,600 t for *Squatina* spp. within the Argentine-Uruguayan Common Fishing Zone (Res. N°8/14, Res. N°10/13, Res. N°10/12). In November, 2012, this limit was met and landings of *Squatina* were banned for the month of December (Res. N° 13/12). In 2013, an additional reserve of 400 t was proposed to be allowed if the 2,600 t limit was reached, and for 2014 a 10% increase in total allowable catch may be added if the commission sees fit (Res. N°10/13, Res. N°8/14).

In Brazil, the gillnet monkfish fishery, which is the source of significant Argentine angel shark bycatch, is being monitored in several ways, including 100% observer coverage and the implementation of two "no take" zones, which could help lower bycatch numbers (Vooren and Chiaramonte 2006). The IUCN Red List listing notes that successful conservation of the Argentine angel shark will be highly dependent upon the successful management of the gillnet monkfish fishery (Vooren and Chiaramonte 2006).

In December 2014, the Brazilian Ministry of the Environment approved a new version of the Brazilian Endangered Species List, which listed the Argentine angel shark as critically

endangered in Annex I (Directive N^{o} 445). An Annex I Listing forbids the capture, transport, storage, and handling of Argentine angel sharks, except for conservation research purposes that are authorized by the Instituto Chico Mendes de Conservação da Biodiversidade. Additionally in December, 2014 the Instituto Chico Mendes de Conservação da Biodiversidade approved the National Action Plan for the Conservation and Management of the Elasmobranchs of Brazil (N^{o} 125, Lessa et al. 2005). The Argentine angel shark is not listed as one of the twelve species of concern, but the plan includes general short term, mid-term, and long term goals for elasmobranch conservation. 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.

Uruguay's FAO National Plan of Action for the conservation of chondrichthyans lists the Argentine angel shark as a species of high priority (Domingo et al. 2008). It sets a short-term goal of 12-18 months to investigate distribution and habitat use, mid-term goals of 24-30 months to generate time series of effort and catch, conduct an abundance assessment, and conduct age, growth, reproduction, and diet studies, and a long term goal of 36-48 months to determine maximum sustainable catch limits. Uruguay made it a priority to review current fishing licenses that allow for the catch of Argentine angel sharks and possibly modify them and grant no new fishing licenses. No updated results from the goals and priorities of this plan could be found. Argentina's FAO National Plan of Action for the conservation of chondrichthyans does not consider the Argentine angel shark to be a species of high priority (NPOA-Argentina 2009). Brazil's National Plan of Action could not be found, but as of 2012 an unapproved draft version did exist (Fischer et al. 2012). The contents of the unapproved draft could not be found.

Other Natural or Manmade Factors Affecting the Species

Two Argentine angel sharks sampled from fish markets in southern Brazil between October 2003 and June 2005 had an average mercury concentration of 30.4 ng/g. This is below the World Health Organization's recommended limits for consumption, but these levels of mercury could be harmful to angel sharks living in the environment, continuously consuming contaminated fish (Kütter et al. 2009). Major sources of mercury contamination in the area come from industries and domestic effluents as well as atmospheric emissions (Kütter et al. 2009).

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