Before the Secretary of Commerce

Petition to List Northwest Atlantic Dusky Shark (*Carcharhinus obscurus*) as Threatened under the Endangered Species Act

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February 1, 2013

Executive Summary

The dusky shark is a long-lived, late maturing coastal pelagic shark. The species uses shallow coastal estuaries and bays as nurseries before taking to the ocean as adults, where it undertakes seasonal migrations – in the western Atlantic, moving north during the summer and south in the winter. The dusky shark reaches an average size at maturity of almost 12 feet long and 400 pounds. As an apex predator, the dusky shark plays an important role in maintaining the long-term health of coastal marine ecosystems.

The northwest Atlantic population of dusky sharks, which inhabits the waters of the Gulf of Mexico and the United States (U.S.) Atlantic coast, constitutes a distinct population segment (DPS) of dusky shark because it is both discrete and significant. The northwest Atlantic dusky shark population is discrete because it is markedly separate from other populations based on both genetics and geographic separation; it is significant because of the degree to which the population differs genetically from the species as a whole, because of the ecological uniqueness of its northwestern Atlantic Ocean habitat relative to the species as a whole, and because the loss of this population would result in a significant gap in the species' range.

The northwest Atlantic DPS of dusky shark should be listed as threatened under the U.S. Endangered Species Act (ESA). The northwest Atlantic dusky shark DPS is likely to become an endangered species within the foreseeable future for the following reasons:

First, the DPS is severely depleted, including relative to populations in other portions of the species' range. According to the best available scientific evidence, the current population of the northwest Atlantic dusky shark DPS is estimated to be at 15 to 20% of its mid-1970s abundance (Cortés *et al.* 2006; Southeast Data, Assessment and Review (SEDAR) 2011). This population level is alarming, given the species' very low natural intrinsic rate of population increase.

Second, the DPS continues to face an unsustainable level of fishing mortality, as well as threats from climate change. Changes in management to date have failed to stop ongoing declines and the DPS is currently still undergoing overfishing (SEDAR 2011). The National Marine Fisheries Service (NMFS) has concluded that, if sufficient conservation actions were taken and under the most promising modeling scenarios, an estimated reduction in fishing mortality of approximately 62% is needed to rebuild the population and that such a recovery would still take 90+ years (2011). While management changes have been proposed, they are unlikely to sufficiently reduce fishing mortality. The resiliency of the northwest Atlantic dusky shark DPS in the face of ongoing high fishing mortality and threats from climate change is limited by the species' very low intrinsic rate of population increase, making it extremely vulnerable to population collapse (Romine *et al.* 2009).

In light of the DPS' highly depleted population level, the ongoing threats, and the insufficiency of current management and conservation measures, NMFS should designate the northwest Atlantic DPS of dusky shark as threatened under the ESA. Alternatively, NMFS should designate the entire species of dusky shark as threatened because the waters of the Gulf of

Mexico and the U.S. Atlantic coast constitute a significant portion of its range (SPOIR), and the species is likely to become endangered in this SPOIR within the foreseeable future.

Notice of Petition

The Natural Resources Defense Council (NRDC) hereby petitions the Secretary of Commerce, through NMFS, to list the northwest Atlantic DPS of dusky shark (*Carcharhinus obscurus*) as threatened under the ESA and designate critical habitat to ensure its recovery pursuant to Section 4(b) of the ESA, 16 U.S.C. § 1533(b), section 553(3) of the Administrative Procedures Act, 5 U.S.C. § 533(e), and 50 C.F.R. § 424.14(a). In the alternative, NRDC petitions the Secretary to list the dusky shark as threatened (and designate appropriate critical habitat) because the species is likely to become endangered in a significant portion of its range in the foreseeable future.

NRDC is a national not-for-profit conservation organization with approximately 1.3 million members and activists. One of NRDC's organizational goals is to further the ESA's purpose by preserving our national biodiversity. NRDC's members have a direct interest in ensuring the survival and recovery of northwest Atlantic dusky sharks and in conserving the unique marine communities on which they rely and which they benefit.

NMFS has jurisdiction over this petition. This petition sets in motion a specific process, requiring NMFS to make an initial finding as to whether the petition "presents substantial scientific or commercial information indicating that the petitioned action may be warranted." 16 U.S.C. § 1533 (b)(3)(A). NMFS must make this initial finding "(t)o the maximum extent practicable, within 90 days after receiving the petition." *Id*. A petitioner need not demonstrate that listing is warranted, but rather shall present information demonstrating that such a listing *may* be warranted. While NRDC believes that the best available science demonstrates that listing the northwest Atlantic dusky shark DPS (or dusky sharks as a whole) as threatened is in fact warranted, the available information clearly indicates that listing the DPS or species may be warranted. As such, NMFS must promptly make a positive finding on this petition and commence a status review as required by 16 U.S.C. § 1533 (b)(3)(B).

Respectfully submitted this 31st day of January, 2013.

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Table of Contents

Executive Summary i

Notice of Petition ii

I. Species Account 1

A. Species Information 1

1. Taxonomy and description 1

2. Diet 1

3. Life history, longevity, and growth 1

4. Habitat 2

5. Geographic range 2

II. The northwest Atlantic population of dusky sharks qualifies as a distinct population segment under the Endangered Species Act. 2

A. Discreteness 3

B. Significance 5

III. Population status and abundance trends of the northwest Atlantic population of dusky sharks 7

A. Population trends 7

B. Conservation status 8

IV. Identified threats to the species: criteria for listing 9

A. Overutilization for commercial, recreational, scientific, or educational purposes 9

1. Directed fisheries – historical 10

2a. Indirect fisheries – bycatch 12

2b. Indirect fisheries – bycatch mortality 17

3. Shark fin trade 18

B. The inadequacy of existing regulatory mechanisms 20

1. U.S. state regulatory mechanisms 20

2. U.S. federal regulatory mechanisms 20

3. International regulatory mechanisms 24

C. Other natural or manmade factors affecting dusky sharks' continued existence 24

1. Global climate warming 24

V. Requested Listing 26

A. The Northwest Atlantic Dusky Shark DPS Should be Listed as a Threatened Species 28

B. The Dusky Shark Should be Listed as a Threatened Species Because It Is Likely to Become Endangered Within the Foreseeable Future in a Significant Portion of Its Range 28

VI. Recovery Plan Elements 28

VII. Critical Habitat Designation........ 28
VIII. Conclusion........ 29
IX. Literature Cited........ 30

I. Species Account

A. Species Information

1. Taxonomy and description

The dusky shark, *Carcharhinus obscurus*, is a large requiem shark of the Family Carcharhinidae. It is also known as the bronze or black whaler, and is bronze-gray or blue-gray in color (with a white underbelly). Distinguishing characteristics include a rounded snout (shorter than or equal to the width of the mouth), a low interdorsal ridge, and a first dorsal fin that originates over the free rear tip of moderately large falcate pectoral fins (National Atmospheric and Oceanic Administration (NOAA) 2011).

2. Diet

Dusky sharks are apex predators and generalist feeders (Gelsleichter *et al.* 1999; Musick *et al.* 2009; Hussey *et al.* 2011). As juveniles, dusky sharks consume primarily bony fishes (*e.g.*, anchovies, sardines) and squid (Musick *et al.* 2009). For larger adults, elasmobranchs (*e.g.*, skates and rays) and larger bony fishes (*e.g.*, groupers and jacks) comprise larger proportions of the diet (Simpfendorfer *et al.* 2001; Musick *et al.* 2009; Hussey *et al.* 2011).

3. Life history, longevity, and growth

Dusky sharks are long-lived (> 40 years), slow-growing, and reach reproductive maturity at a relatively late age (20 years) (Musick *et al.* 2009; Romine *et al.* 2009). Juvenile growth rates range from eight to 11 centimeters (cm)/year (Simpfendorfer 2000). The average size of mature dusky sharks is approximately 11.5 feet (ft) long and 400 pounds (lbs) (NOAA 2011). Male dusky sharks mature earlier (19 versus 21 years) and at slightly smaller sizes (9.2 versus 9.3 ft) than females (NOAA 2011). Dusky sharks mate in the spring and have a three-year reproductive cycle (Natanson *et al.*, 1995; Branstetter and Burgess, 1996; Romine *et al.* 2009). Dusky sharks are viviparous, produce few pups (mean = 7.1, standard deviation = 2.05, range = 2-12), and have no documented increase in litter size corresponding with increase in maternal size (Musick *et al.* 2009). Size at birth for dusky shark pups ranges from 33 to 39 inches (NOAA 2011).

Estimates of the intrinsic rate of population increase (r) for dusky sharks range from 1.7% to 5.6% per year, depending on assumed fishing mortality rates, the length of reproduction cycle, and assumptions about the rate of natural mortality (Sminkey 1996; Cortés 1998; Simpfendorfer 1999; Romine *et al.* 2009). Musick *et al.* (2000) noted that species with intrinsic rates of increase below 10% are particularly vulnerable to fishing mortality. Therefore, dusky sharks have inherent biological vulnerability to overexploitation due to their very low natural intrinsic rate of population increase, one of the lowest intrinsic rebound potentials and lowest productivities of all sharks (Simpfendorfer 1999; Musick *et al.* 2000; Romine *et al.* 2009).

4. Habitat

Dusky sharks are coastal-pelagic sharks that occupy continental shorelines ranging from shallow inshore waters to the outer reaches of the continental shelf and adjacent oceanic waters. They occur in tropical and warm temperate waters, preferring water temperatures of 19 to 30 °C (Musick *et al.* 2009; Hoffmayer *et al.* 2011). They are found from the surface to a depth of 400 meters (Musick *et al.* 2009). Adults tend to avoid areas of low salinity and rarely enter estuaries (Musick *et al.* 1993), though juveniles use shallow coastal estuaries and bays as nurseries (Castro 1993). Dusky sharks undertake seasonal migrations in the western Atlantic (and eastern Pacific), moving north during the summer and south in the winter. Males and females migrate separately (Musick and Colvocoresses 1988).

5. Geographic range

Dusky sharks occur along continental coastlines in tropical and warm temperate waters. In the western Atlantic, the species' range extends from Nova Scotia to Cuba (including the northern Gulf of Mexico) and from Nicaragua to southern Brazil (Musick *et al.* 2009). In the eastern Atlantic, dusky sharks have been reported from Spain and Portugal to Sierra Leone (Last and Stevens 1994; Musick *et al.* 2009), but these may be misidentifications of *C. galapagensis* (Musick *et al.* 2009). In the eastern Pacific, dusky sharks range from southern California to the Gulf of California in Mexico. They are also found in the Mediterranean, Indian Ocean and western Pacific, including Madagascar and Australia (Musick *et al.* 2009).

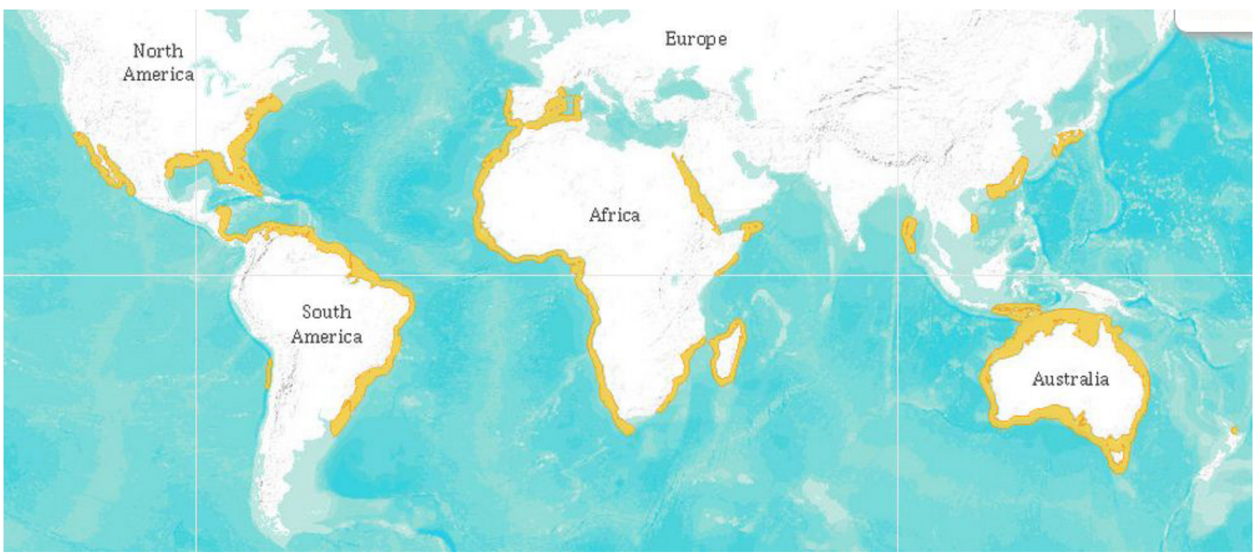

Figure 1. The global distribution of the dusky shark (*Carcharhinus obscurus*). Image from the IUCN Red List of Threatened Species, Version 2011.2 (http://maps.iucnredlist.org/map.html?id=3852).

II. The northwest Atlantic population of dusky sharks qualifies as a distinct population segment under the Endangered Species Act.

The ESA provides for the listing of all species that meet the standards set forth for "endangered" and "threatened" species. The term "species" is defined broadly under the statute to include "any subspecies of fish or wildlife or plants and any distinct population segment of any species of vertebrate fish or wildlife with interbreeds when mature." 16 U.S.C. § 1532(16).

NMFS and the U.S. Fish and Wildlife Service (FWS) have published a policy to define a DPS for the purposes of listing, delisting, and reclassifying species under the ESA. *See* Policy Regarding the Recognition of Distinct Vertebrate Population Segments Under the Endangered Species Act, 61 Fed. Reg. 4722, (Feb. 7, 1996) ("DPS Policy"). 61 Fed. Reg. 4722 (February 7, 1996). Under this policy, a population segment must be found to be both "discrete" and "significant" before it can be considered for listing under the ESA.

For the reasons detailed below, the northwest Atlantic population of dusky sharks is both discrete and significant and thus should be designated a DPS. For purposes of this petition, the northwest Atlantic population encompasses sharks inhabiting waters along the Atlantic coast of the U.S. and the Gulf of Mexico.

A. Discreteness

Under the DPS Policy, a population segment of a vertebrate species is considered discrete if it satisfies either 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.
2. It is delimited by international governmental boundaries within which difference in 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.

See DPS Policy at 4725. The northwest Atlantic population of dusky sharks is markedly separate (discrete) from other populations based on both genetics and geographic range. Recent genetic studies involving mitochondrial control regions, or "mtCR" (Benavides *et al.* 2011), and nuclear microsatellite DNA analysis (Gray *et al.* 2012) support a genetic distinction between the northwestern Atlantic population of dusky sharks and other populations of dusky sharks. (See **Figure 2**). There is specifically preliminary evidence of population structure between dusky sharks in the southwest Atlantic Ocean (off the coast of Brazil) and those in and adjacent to U.S. waters along the U.S. eastern coastline (Benavides *et al.* 2011; Gray *et al.* 2012).

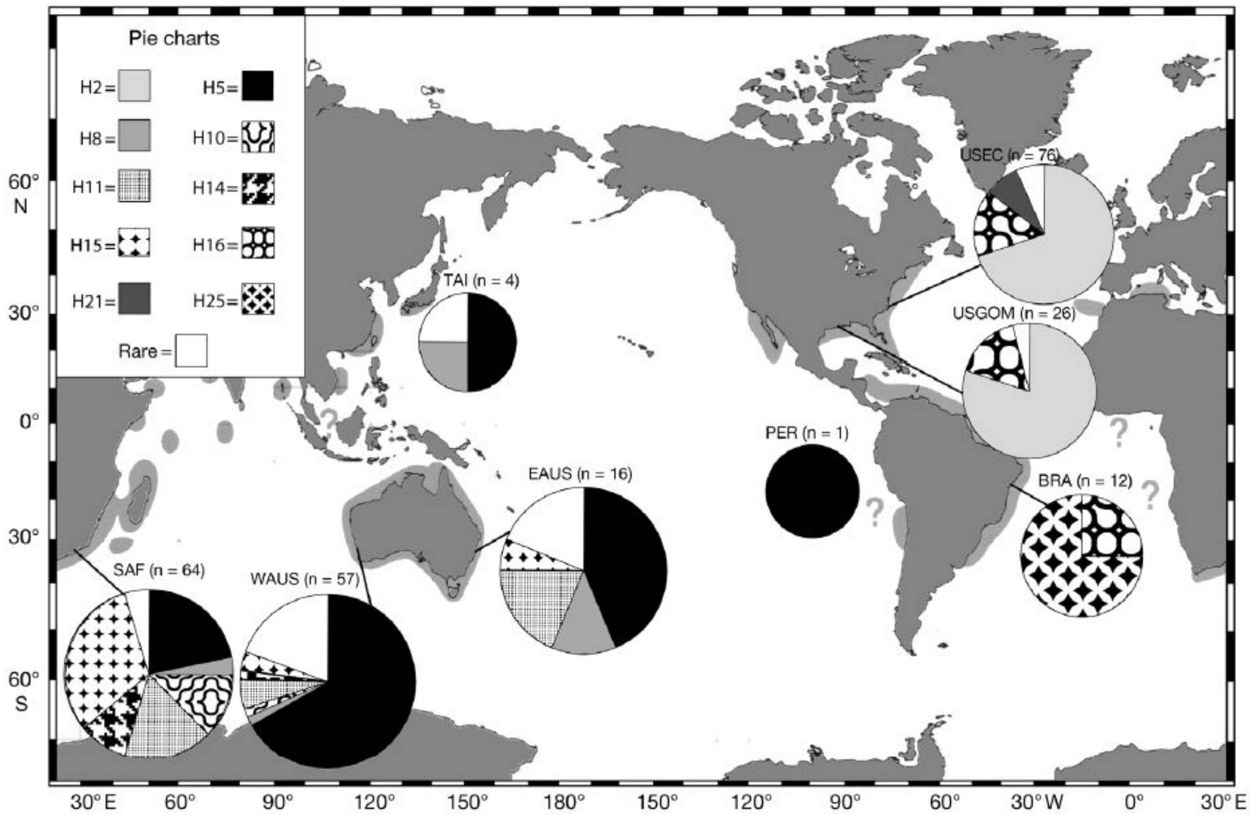

Figure 2. Mitochondrial control region (mtCR) haplotype frequencies obtained from samples collected across the global distribution of the dusky shark, *Carcharhinus obscurus*: U.S. east coast (USEC), U.S. Gulf of Mexico (USGOM), Brazil (BRA), South Africa (SAF), west Australia (WAUS), east Australia (EAUS), Taiwan (TAI), and Peru (PER). Known distribution is in light gray, "?" represents unconfirmed parts of distribution. Note that 10 of 12 samples putatively from Brazil were obtained from Hong Kong-based fin dealers who had indicated that the fins had been purchased directly from Brazil. Haplotype codes are listed in the key (e.g., H2), except that haplotypes that occurred at low frequency are all coded as "Rare." (Figure 1 from Benavides *et al.* 2011).

Further support for the discreteness of the northwest Atlantic population of dusky sharks is found in tagging data from the NMFS Cooperative Shark Tagging Program (CSTP; http://na.nefsc.noaa.gov/sharks/tagging.html). Based on 22 years (1962-93) of tag and recapture data, the documented range of dusky sharks in the northwest Atlantic extends from New England south to the Caribbean Sea and the Gulf of Mexico no farther south than the Yucatan Peninsula (**Figure 3**; Kohler *et al.* 1998). The SEDAR 21 Data Workshop Life History working group also determined that U.S. Atlantic and Gulf of Mexico dusky sharks constitute one stock (SEDAR 2011).

The available evidence suggests that the northwest Atlantic population of dusky sharks is a discrete population. An important implication of this discreteness is that replenishment of this collapsed population via immigration of females from elsewhere is unlikely (Benavides *et al.* 2011; Gray *et al.* 2012).

The northwest Atlantic population of dusky sharks is also discrete because it primarily inhabits U.S. waters, which offers the prospect of greater regulatory protection compared to many other jurisdictions globally where the species is found (*see* Musick *et al*. 2009 (discussing regulatory protections such as landings prohibitions in place in the U.S. and noting lack of data available in many other regions where the sharks are present, including the Mediterranean Sea, the coast of Africa, and around the Indian Sea)).

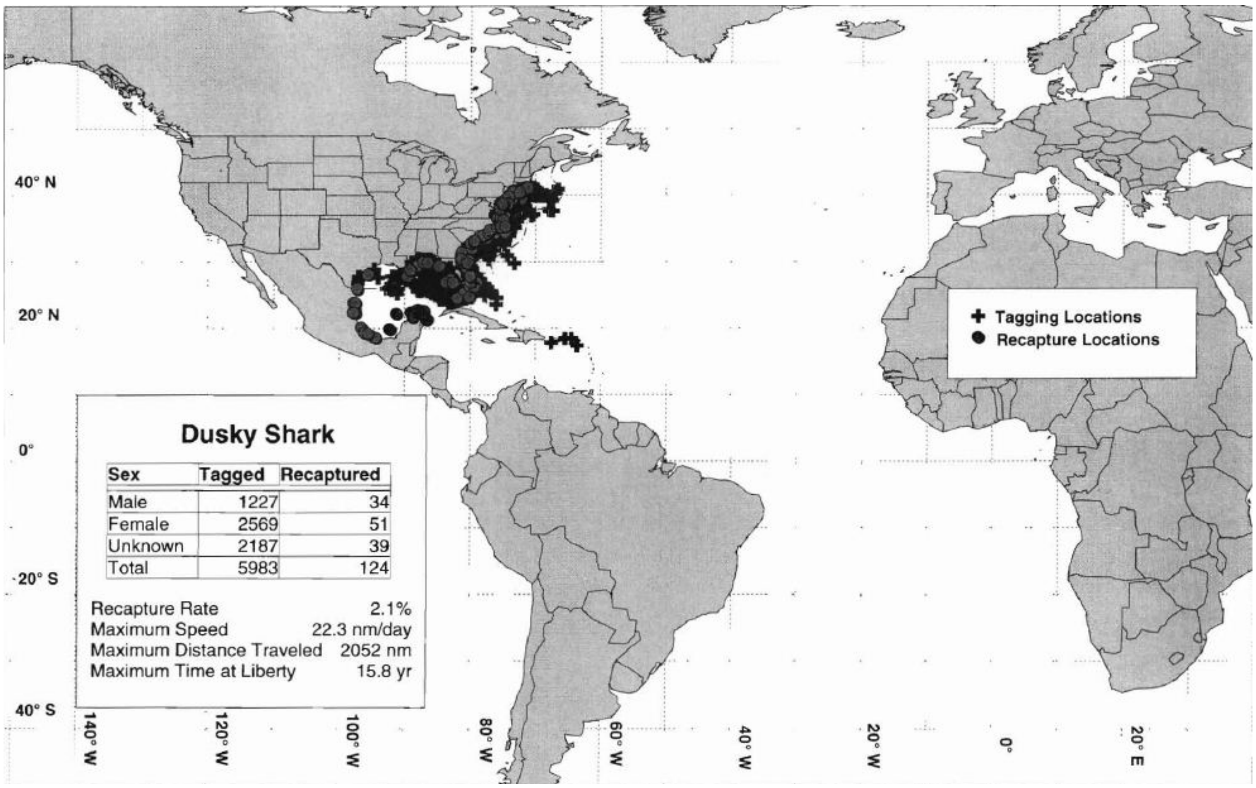

Figure 3. Atlantic distribution of tag and recapture locations for the dusky shark, *Carcharhinus obscurus*, from the NMFS Cooperative Shark Tagging Program during 1962-93. The dotted-dashed line represents the U.S. Exclusive Economic Zone (EEZ). (Figure 91 in Kohler *et al.* 1998).

B. Significance

In order for a discrete population to be a DPS, it must also be significant. A population segment is considered significant based on one or more of the following:

1. Persistence of the discrete population in an ecological setting unusual or unique to this taxon;
2. Evidence that loss of the discrete population would result in a significant gap in the range of a taxon;
3. Evidence that the discrete population represents the only surviving natural occurrence of a taxon that may be more abundant elsewhere as an introduced population outside its historical range; and
4. Evidence that the discrete population differs markedly from other populations of the species in its genetic characteristics.

See DPS Policy at 4725. The northwest Atlantic population of dusky sharks meets three of the four criteria discussed above.

First, the northwest Atlantic continental shelf and adjacent ocean waters including the Gulf of Mexico represent a unique ecological setting; the area is markedly different from other areas that serve as habitat for dusky sharks around the world based on bathymetry, hydrography, productivity, and trophic relationships (*see* **Figure 1;** Sherman and Hempel 2008**)**. Looking at those four factors, the United Nations Environment Program (in collaboration with three other national and international ocean management organizations – NOAA, the Intergovernmental Oceanographic Commission, and the International Union for the Conservation of Nature (IUCN)) distinguished 64 unique large marine ecosystems (LMEs) around the world including three unique LMEs in the northwest Atlantic dusky shark DPS habitat: the Gulf of Mexico LME, the Southeast U.S. Continental Shelf LME, and the Northeast U.S. Continental Shelf LME (UNEP acknowledged linkages between the Gulf of Mexico and Southeast U.S. Continental Shelf LMEs) (Sherman and Hempel 2008: 689-90). All three areas are defined in part by a relationship to the Gulf Stream, which flows from the Gulf of Mexico, along the U.S. Southeast Continental Shelf LME, and defines the outer edge of the Northeast U.S. Continental Shelf LME. The two continental shelf LMEs are highly productive ecosystems, and the Gulf of Mexico is a moderately high productivity system (Sherman and Hempel 2008*:* Chapters XV-50; XV-51; XIX-61). Tagging and recapture studies that show dusky sharks captured in these areas stay within them further support the determination that these areas provide a unique ecological setting for the species (**Figure 3**; Kohler *et al.* 1998).

Second, the loss of the northwest Atlantic population of dusky sharks would result in a significant geographic gap in the range of dusky sharks worldwide. This population encompasses all dusky sharks living in the Atlantic Ocean along the eastern U.S., as well as those in Caribbean waters and in Mexican waters in the Gulf of Mexico (*compare* **Figure 1** *with* **Figure 3**). The population is also significant because it is predominantly found in U.S. waters, which, as noted above, provides it with greater opportunities for regulatory protection. Since 1997, NOAA has identified this population (referring to it as the “western Atlantic population”) as a Species of Concern due to substantial population declines, extremely low rate of population increase, and continued threat from fishing (NOAA 2011).

Third, as discussed above, recent genetic studies clearly support a genetic distinction between the northwestern Atlantic population of dusky sharks and other populations of dusky sharks around the world (Benavides *et al.* 2011; Gray *et al.* 2012; **Figure 2**). The available scientific evidence specifically distinguishes dusky sharks in the southwest Atlantic Ocean (off the coast of Brazil) from those in and adjacent to U.S. waters along its Atlantic coast and in the Gulf of Mexico (Benavides *et al.* 2011; Gray *et al.* 2012).

Because it is both discrete and significant, the population of dusky sharks in the northwestern Atlantic Ocean must be designated a DPS pursuant to the ESA.

III. Population status and abundance trends of the northwest Atlantic population of dusky sharks

A. Population trends

There have been two stock assessments for dusky sharks, one in 2006 (Cortés *et al.* 2006) and one in 2011 (SEDAR 2011). Prior to 2006, dusky sharks had been assessed as part of the complex of large coastal sharks. The 2006 stock assessment estimated that dusky shark biomass in 1960 (chosen to represent virgin biomass) ranged from five to nine million kilograms (kg), or approximately 11-20 million lbs (Cortés *et al.* 2006). By 1974, the biomass of dusky sharks was estimated to be around seven million lbs dressed weight (dw) (Cortés *et al.* 2006). After a steady decline, biomass fell below one million lbs dw in 1999, and as of 2006, was estimated at approximately 750,000 lbs dw (Cortés *et al.* 2006). The 2011 stock assessment evaluated data through 2009 and determined that declines in dusky shark biomass and spawning stock biomass (SSB) were continuing (SEDAR 2011: Table 3.4 (showing biomass at approximately 20% of virgin levels, and SSB at 15%). The 2011 stock assessment did not quantify absolute biomass or specific abundances; instead it modeled trends from 1960, based on the assumption that 1960 population numbers approximated those of an unfished population (SEDAR 2011: Table 3.4; page 284 out of 414 ("no absolute estimate of biomass is available . . . inferences about overfished status are only relative")). Between 2006 and 2009, the 2011 stock assessment found additional declines in biomass – from 18.0% of virgin (1960) biomass in 2006 to 15.5% of virgin biomass in 2009 – and in SSB – from 20.9% of virgin levels to 20.3% (SEDAR 2011: Table 3.4; **Figure 4**).

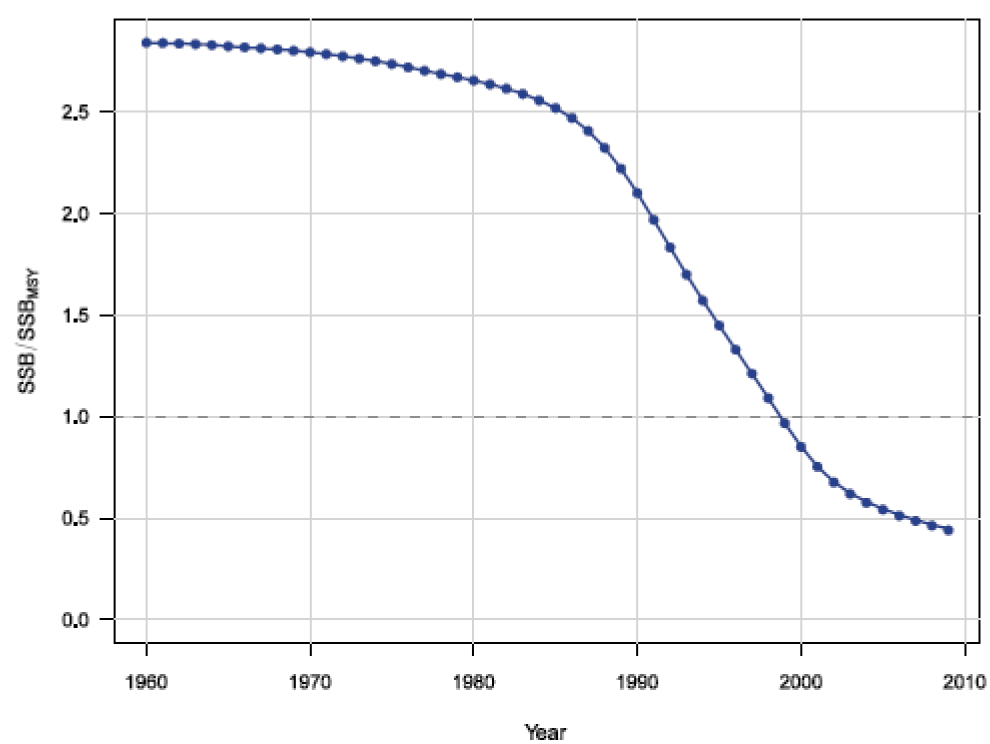

Figure 4. Dusky shark SSB relative to maximum sustainable yield (SEDAR 2011: Figure 3).

The 2011 stock assessment (SEDAR 2011) estimated that declines in SSB are partially compensated for by increases in pup survival (*i.e.*, density dependent recruitment). Specifically, more dusky sharks were observed from 2004-09, though biomass continued to decline, which might be explained by an increase in younger, lighter sharks coincident with the loss of older, heavier individuals. Unfortunately, the significant impacts of continuing fishing pressure – and fishing-related mortality – on juvenile dusky sharks make it unlikely that a slight numerical increase in juveniles will result in an increasing trend in biomass. All ages of dusky sharks (even age-0) are vulnerable to fishing gear, and juvenile sharks currently make up the majority of the catch (Cortés *et al.* 2006). For there to be an increasing trend in biomass and recovery of the population, dusky sharks must evade fishing nets and survive for at least two decades before they can reproduce (the average age of sexual maturity for dusky sharks is 20 years old). Only in this way can more juveniles eventually compensate for the loss of older, reproductively active individuals (Cortés *et al.* 2006). This outcome is unlikely unless current fishing mortality is reduced (Morgan 2008: 55 ("The high exploitation of age-zero and juveniles in both the recreational and commercial fisheries appears to have a substantial impact on the ability of this population to increase in size (in terms of biomass).")).

Several other studies have established evidence of substantial declines in the northwest Atlantic dusky shark population. Baum and Myers (2004), analyzing pelagic longline (PLL) catches in the Gulf of Mexico, estimated that dusky sharks had declined by 79% from the 1950s to the late 1990s. Brooks *et al.* (2010) estimated that the northwest Atlantic DPS in 1974 was at only approximately 80% of virgin levels, *i.e.*, already showing signs of depletion. Strong evidence from two commercial sources, two recreational sources and a fishery-independent survey document average size trends (in both length and weight) decreasing in the 1990s (1989-2003), a trend linked to heavy fishing pressure (Cortés *et al.* 2006). Based on data from PLL fishery observers, Baum and Blanchard (2010) estimated 76% declines in the relative abundance of dusky sharks between 1992 and 2005 in the northwest Atlantic (including the Gulf of Mexico).

B. Conservation status

NOAA identified the western Atlantic (equivalent to the northwest Atlantic population) population of dusky sharks as overfished in 1993 (NOAA 2011). Due to the substantial population declines, extremely low rate of population increase, and continued threat from fishing, the western Atlantic population of dusky sharks was identified as a Species of Concern in 1997 (NOAA 2011). In 2000, the American Fisheries Society listed the status of dusky sharks as vulnerable in the western Atlantic and eastern Pacific (Musick *et al.* 2000). Following an assessment in 2009, the IUCN designated the northwest Atlantic population of dusky sharks as endangered; the global population was designated vulnerable (Musick *et al*. 2009; Kyne *et al*. 2012). According to IUCN "Red List" criteria, the northwest Atlantic population would now be considered "critically endangered" because the most recent stock assessments (Cortés *et al.* 2006; SEDAR 2011) show a population decline of at least 80% in the past three generations (~90 years for dusky shark) from pre-exploitation levels (~1913) (Cortés *et al.* 2006).

IV. Identified threats to the species: criteria for listing

A species is endangered under the ESA if it "is in danger of extinction throughout all or a significant portion of its range." *See* 16 U.S.C. § 1532(6). A species is threatened under the ESA if it "is likely to become an endangered species within the foreseeable future." *See id. at* § 1532(20). To determine whether a species is endangered or threatened, NMFS must consider five statutorily prescribed factors:

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

See 16 U.S.C. § 1533(1)(a). The agency must consider each of the listing factors singularly and in combination with the other factors. *See Carlton v. Babbitt*, 900 F. Supp. 526, 530 (D.D.C. 1995). Each factor is equally important and a finding by the Secretary that a species is negatively affected by just one of the factors warrants a non-discretionary listing as either endangered or threatened. *See Nat'l Wildlife Fed. v. Norton*, 386 F. Supp. 2d. 553, 558 (D. Vt. 2005) (*citing* 50 C.F.R. § 424.11(c)). Likewise, a species must be listed if it is endangered or threatened because of a combination of factors. *See, e.g.*, 50 C.F.R. § 424.11(c).

As discussed below, the northwest Atlantic population of dusky sharks – which represents a significant portion of the range of dusky sharks worldwide – is likely to become endangered within the foreseeable future as a result of at least three of the statutorily-prescribed factors.

A. Overutilization for commercial, recreational, scientific, or educational purposes

Overexploitation by way of directed fisheries and bycatch (and high bycatch mortality rates) in fisheries targeting other species has been the primary cause of continuing declines in dusky sharks in the northwest Atlantic. According to recent stock assessments, the northwest Atlantic dusky shark "population can sustain only very small rates of exploitation" (Cortés *et al.* 2006: 47). According to the best available scientific evidence, dusky sharks in the U.S. Atlantic and Gulf of Mexico continue to undergo overfishing, or an unsustainable rate of fishing mortality, with an estimated fishing rate of 159% of F_{MSY}, or the fishing rate that is estimated to produce maximum sustainable yield ("MSY") (Cortés *et al.* 2006, SEDAR 2011). As of 2009, the dusky shark SSB was estimated to be 15% of virgin (1960) biomass (SEDAR 2011).

As discussed below, regulators have identified bycatch, and its contribution to dusky sharks' fishing-related mortality, as a significant threat to the survival and recovery of dusky sharks in the northwest Atlantic Ocean. Available data likely *underestimate* the threat bycatch poses to this species because sharks, when caught, are often not brought aboard for specific identification and may therefore go unreported (SEDAR 2011: 22).

1. Directed fisheries – historical

Before the 1930s, sharks in the U.S. Atlantic Ocean were not exploited and populations are assumed to have been healthy. In the mid-1930s, a substantial shark fishery developed to harvest vitamin A from shark livers and dusky sharks were among the targeted sharks. This fishery was largely abandoned by 1950 due to the advent of the commercial synthesis of vitamin A (Cortés *et al.* 2006), and it is believed that exploitation levels between the late 1940s and 1960 were negligible, allowing shark stocks to recover somewhat. Fishing effort remained relatively low from 1960 until 1980. The directed shark bottom longline (BLL) fleet began to develop in the 1970s, while the recreational fishery did not develop until the late 1970s. Fishing rates escalated and were very high in the 1980s and 1990s, with catch levels decreasing even as fishing mortality rates escalated (**Figures 5, 6**). For years when data on sources of mortality overlapped and could be compared (1992-2002), commercial landings accounted for 44%, recreational catches accounted for 38%, and discards accounted for the remaining 18% of total catches (Cortés *et al.* 2006). Following the prohibition on possession and landing of dusky sharks in 2000, the estimated fishing mortality rate dropped until 2008 when it leveled off at a level still above F_{MSY} (**Figure 6).** These fishing mortality rates over time corresponded with a steady but continuous decline in the abundance of dusky sharks from about 1980 to 2009, as estimated from multiple catch indices and model predictions (Cortés *et al.* 2006; SEDAR 2011).

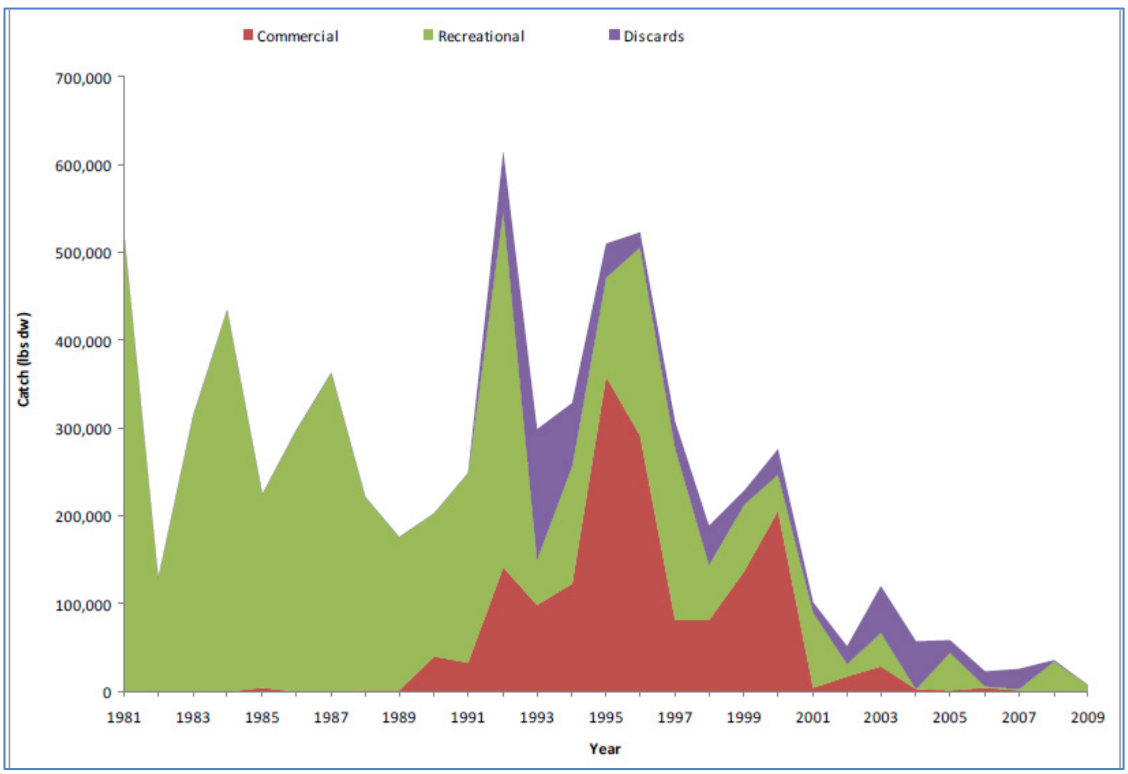

Figure 5. Commercial, recreational, and discard catch (in lbs dw) of dusky sharks in the U.S. Atlantic, 1981-2009 (Figure 1 in SEDAR 21 Data Workshop Report, SEDAR 2011).

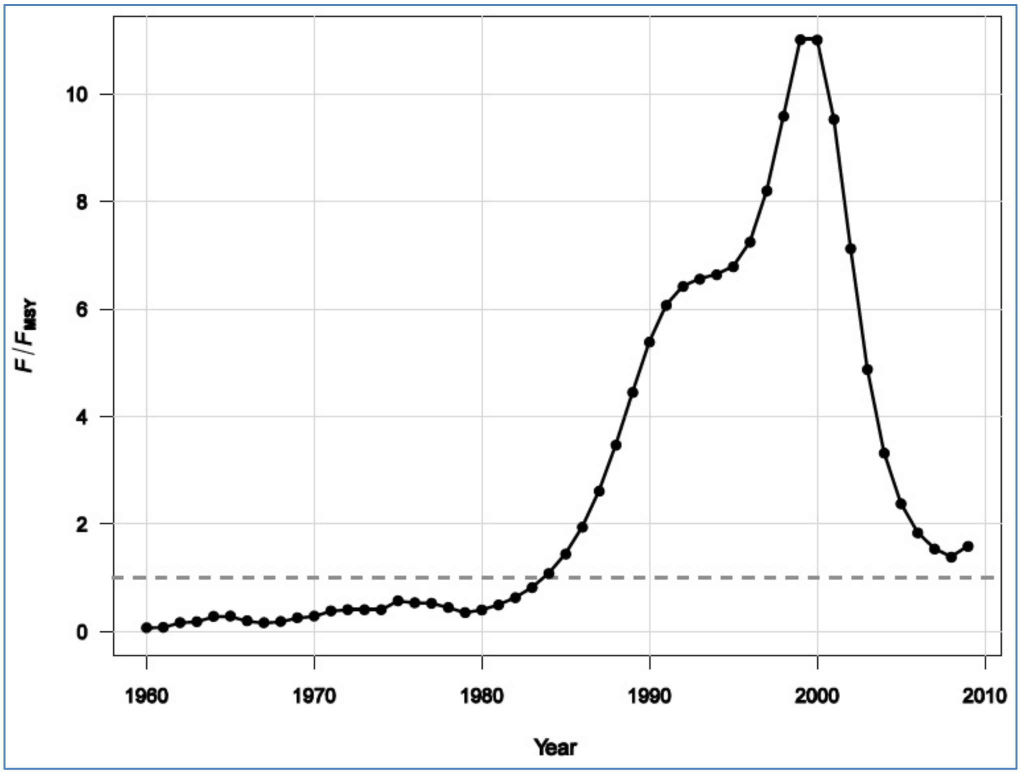

Figure 6. Apical fishing mortality relative to MSY levels for dusky sharks, 1960-2009. The base ASCFM indicated that overfishing has been occurring since 1984 (there is 51% certainty that overfishing occurred during the last several years of the time series). (SEDAR 2011: Figure 2).

Until the retention of dusky sharks in commercial and recreational fisheries was prohibited in federal waters in 2000, commercial catch of dusky sharks occurred primarily in the directed shark BLL fishery, secondarily as bycatch in the surface PLL fishery for swordfish, tuna and tuna-like species, and lastly as bycatch in gill net fisheries (Cortés *et al.* 2006). In 1992-2003, sharks constituted 25% of the catch in the domestic PLL swordfish and tuna fisheries, with dusky sharks comprising 1-18% of the shark catch (**Figure 7**; Mandelman *et al.* 2008). Dusky sharks in recreational fisheries were mainly targeted by private anglers and charter boats (Cortés *et al.* 2006). Historically (based on a variety of sources and averaged over the period 1988-2009), dusky sharks were landed mostly in the mid-Atlantic (Virginia to New Jersey, 49%), with landings in the south Atlantic (east coast of Florida to North Carolina, 28%) and Gulf of Mexico (west coast of Florida to Texas, 23%) in similar proportions (SEDAR 2011). In the mid-Atlantic, longlines (41%) and gillnets (35%) contributed similar proportions to the landings, but longlines were the dominant gear in both the Gulf of Mexico and south Atlantic (88% and 72%, respectively, SEDAR 2011).

Despite the 2000 retention prohibition, recreational and commercial harvests of dusky sharks have continued to be reported (**Figure 5; Table 2**).

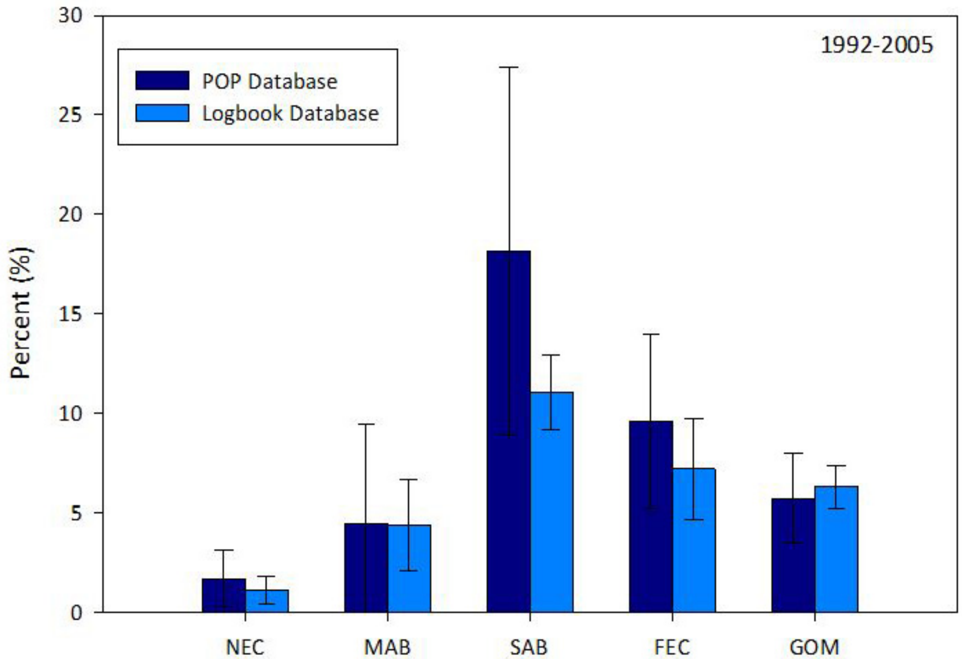

Figure 7. Pairwise comparison (Pelagic Observer Program (POP) versus Logbook databases) of mean dusky shark catch percentages (±95% CI) (of total shark catch) in designated statistical areas (NEC = Northeast Coastal, MAB = Mid-Atlantic Bight, SAB = South-Atlantic Bight, FEC = Florida Coastal, GOM = Gulf of Mexico) for the period 1992–2005 as bycatch in the U.S. PLL fishery. Percentages in a given year were derived by dividing the total number of individuals of dusky sharks by the total number of sharks caught that year represented by the 19 species/categories common to both POP and Logbook (excluding skates/rays, or species that were listed exclusively in one database or the other) (modified from Figure 2 in Mandelman *et al.* 2008: 433).

2a. Indirect fisheries – bycatch

Dusky sharks are regularly caught in commercial BLL gear targeting both other sharks and groupers and snappers, and on surface PLL gear targeting tunas and tuna-like species (**Table 1**; Cortés *et al.* 2006; Hale *et al.* 2007, Mandelman *et al.* 2008*:* **Figures 8 and 9**).

Table 1. Annual bycatch estimates of dusky sharks for U.S. and International Commission for the Conservation of Atlantic Tunas (ICCAT) commercial fisheries in the Atlantic Ocean and Gulf of Mexico. Bycatch estimates are in live pounds (lbs) or number of individuals (#), and reflect the average from the years identified**.** Designated regions are eastern Gulf of Mexico (EGM), Gulf of Mexico (GoM), south Atlantic (SA), Middle Atlantic Bight (MAB).

Year	Bycatch	Unit	Region	Fishery	Source
1990-1997	1,122.0	#	SA/GoM	Pelagic Longline	Hoey and Moore 1999
1992-2005	1,924.0	#	SA/GoM	Pelagic Longline	Baum and Blanchard 2010
2001*	248,240.5	lbs.	SA/GoM	Pelagic Longline	Harrington *et al.* 2005
2002-2006	74.9	#	EGM	Shark Bottom Longline	Morgan *et al.* 2010
2002-2006	20.2	#	SA	Shark Bottom Longline	Morgan *et al.* 2010
2002-2006	107.3	#	MAB	Shark Bottom Longline	Morgan *et al.* 2010
2002-2006	**202.4**	**#**	**SA/GoM**	**Shark Bottom Longline**	**Morgan *et al.* 2010**
2005	1,940.8	#	GoM	Reef Fish Handline	NMFS 2011
2006	798.5	#	GoM	Reef Fish Bottom Longline	NMFS 2011
2005-2006	570,896.8	lbs.	SA/GoM	Shark Bottom Longline**	NMFS 2011
2005-2006	**2,739.3, 570,896.8**	**#, lbs.**	**SA/GoM**	**All gears**	**NMFS 2011**
2009	9.0	#	GoM	Reef Fish Bottom Longline	Hale *et al.* 2010
2009	94.0	#	SA/GoM	Sandbar Shark Bottom Longline	Hale *et al.* 2010
2009	3.0	#	SA/GoM	Mixed Species Bottom Longline	Hale *et al.* 2010
2009	203, 30,864.7	#, lbs.	Atlantic	Pelagic Longline (ICCAT fisheries)	Oceana 2011

*Estimated prediction based on observer data from 1992-2000.
**Bycatch estimates for the shark BLL fishery in this report are currently being refined due to discrepancies in the calculation of total effort.

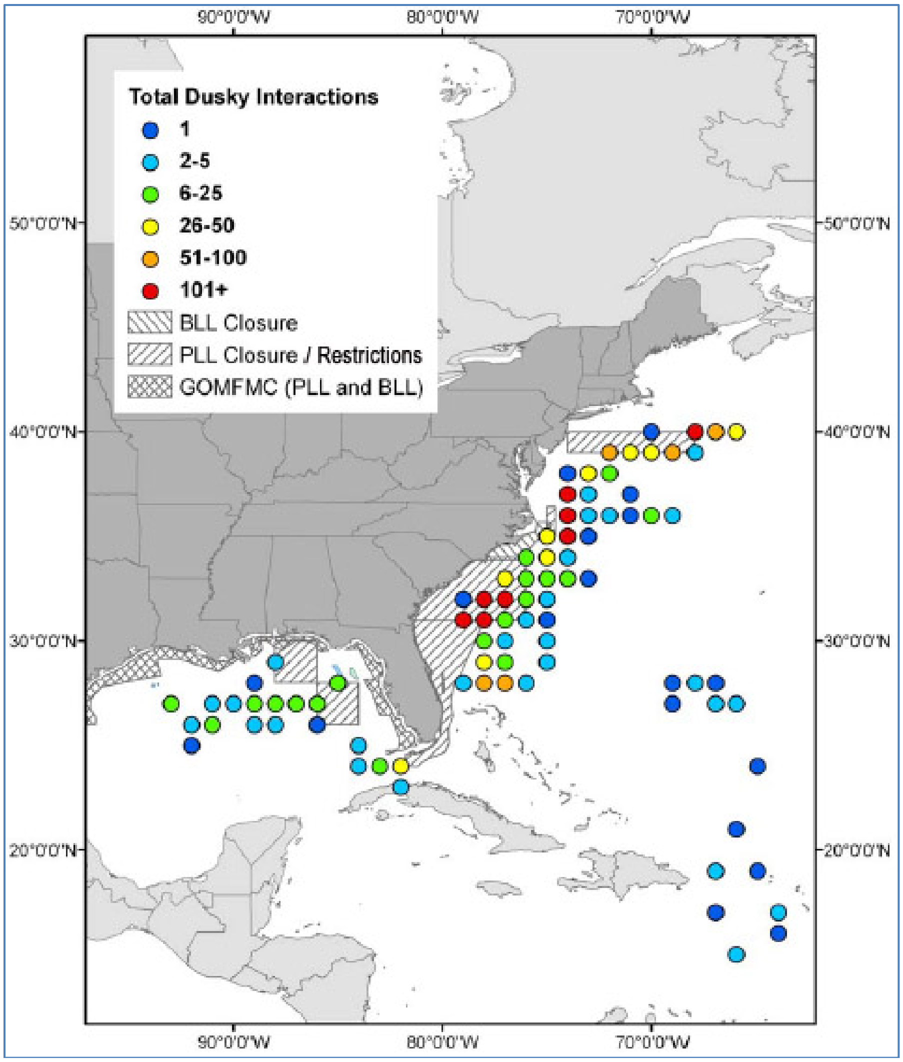

Figure 8. Dusky shark interactions on PLL gear from the HMS Logbook, 2006-2010. Points represent interactions that took place within 1x1 degree grid cells, and are located at the southeast corner of the grids they represent (Figure 2.17 from NMFS 2012a).

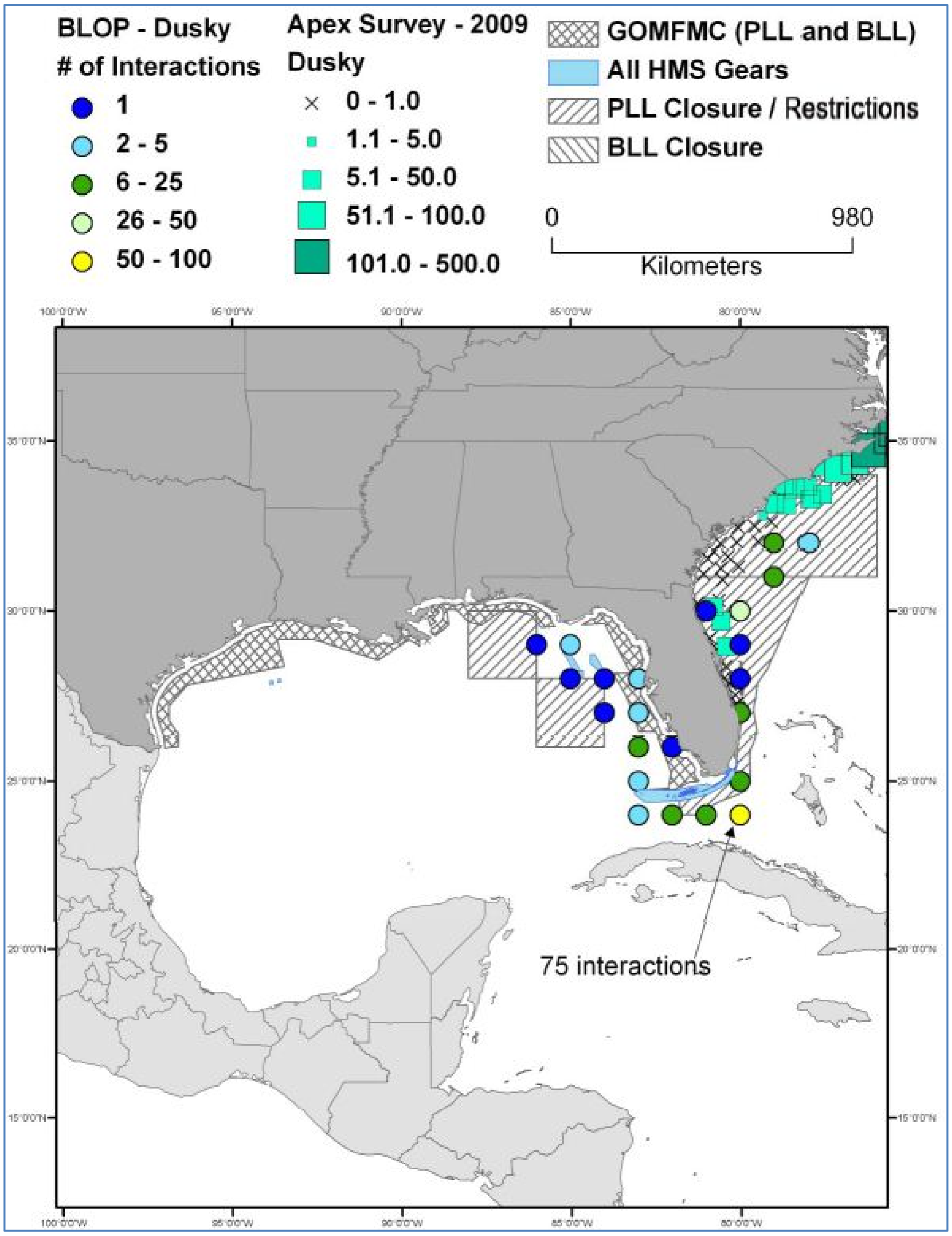

Figure 9. Dusky shark interactions observed on BLL sets in by the Bottom Longline Observer Program (BLLOP), 2006-2010 and dusky shark CPUE (number of dusky/10,000 hook hours) from the 2009 Apex Predators Coastal Shark Survey (April 6 – May 20, 2009). BLLOP points represent interactions that took place within 1x1 degree grid cells, and are located at the southeast corner of the grids they represent (Figure 2.24 from NMFS 2012a).

In the BLL shark research fishery, 21 interactions were observed (100% coverage) during 2008, 106 during 2009 and 198 during 2010 (Hale et al. 2011; NMFS 2012c). In the PLL fishery, 396 dusky sharks were reported captured in 2008, 624 during 2009, and 737 during 2010 (NMFS 2012c).

In addition, dusky sharks are still regularly caught and even landed in recreational (primarily hook-and-line) fisheries (**Table 2**; SEDAR 2011). The recreational fishery caught 2,391, 447 and 546 dusky sharks during 2008, 2009 and 2010 respectively (NMFS 2012c). Since 2001, the average annual recreational catch has constituted a steady 47% of the total catch, a slightly larger proportion than before the ban (41% for 1992-2000). This has been attributed to a lack of awareness of current recreational shark regulations and improper shark identification in the recreational fishery (NMFS 2012a).

Table 2. Total annual catches of dusky shark (in lbs dw), 1981-2009. (Table 1 from Section 10, 3.10, SEDAR 2011).

Year	Commercial	Recreational	Discards	Total
1981		518,858		518,858
1982	40	128,571		128,612
1983	11	313,662		313,673
1984	0	434,626		434,626
1985	4,963	219,271		224,234
1986	0	296,907		296,907
1987	83	362,765		362,848
1988	1,691	220,273		221,964
1989	994	174,117		175,111
1990	39,951	162,857		202,808
1991	33,138	215,404		248,542
1992	141,730	405,806	66,338	613,874
1993	98,273	51,473	148,807	298,553
1994	122,404	134,110	72,738	329,253
1995	357,920	113,547	38,731	510,198
1996	290,820	215,416	16,047	522,283
1997	80,930	195,928	29,650	306,508
1998	81,124	63,332	44,786	189,241
1999	137,650	75,825	15,382	228,856
2000	205,746	40,923	29,751	276,419
2001	4,463	85,226	11,980	101,669
2002	16,905	14,516	20,689	52,110
2003	27,907	38,793	53,552	120,251
2004	2,997	343	53,439	56,779
2005	874	43,064	15,334	59,272
2006	4,209	1,891	16,127	22,227
2007	2,064	879	23,116	26,059
2008	0	33,750	2,039	35,789
2009	486	6,090	0	6,576

Accurate information on bycatch is essential for quantifying fishing mortality, assessing the stock, and ultimately, implementing appropriate management strategies. The level of reported discards (**Table 2**) is especially uncertain and most likely an underestimate because sharks are often not brought aboard for positive identification and may therefore go unreported (SEDAR 2011: 22).

2b. Indirect fisheries – bycatch mortality

Understanding the magnitude of current dusky shark bycatch in commercial fisheries is particularly important because at-vessel mortality is exceptionally high for all age groups of dusky sharks, and particularly for juveniles (immature individuals) which often make up the majority of the catch (Cortés *et al.* 2006). Between 1994 and 2005, at-vessel mortality rates of dusky sharks caught in commercial bottom longlines in the south Atlantic and Gulf of Mexico averaged 81.1% for all ages (87.7% young, 82.4% juvenile, and 44.4% adult), and were highest with the longest soak time and warmest bottom water temperatures (Morgan and Burgess 2007). Similar rates were found in a separate study that examined dusky sharks caught in commercial bottom longlines in the south Atlantic and Florida region of the Gulf of Mexico from 1994-2000 (Romine *et al.* 2009). Romine *et al. (*2009) found that at-vessel mortality rates decreased with increasing size/age and decreasing soak time, and ranged between 37-79% (**Figure 9**). However, as most of the catch was composed of the two smallest size classes (**Figure 9**), typical at-vessel mortality rates were 71-79% (Romine *et al.* 2009).

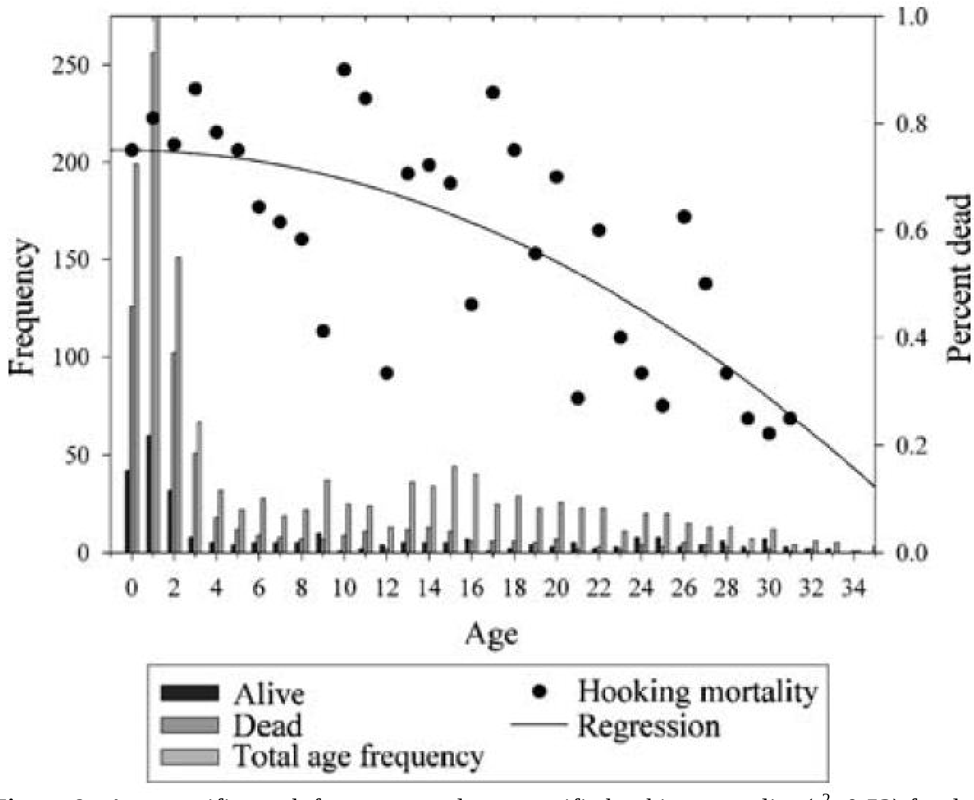

Figure 9. Age-specific catch frequency and age-specific hooking mortality (r^2=0.53) for dusky sharks caught on commercial shark BLL sets in the south Atlantic and Florida region of the Gulf of Mexico, 1994-2000. Data were collected by the Florida Natural History Museum Commercial Shark Fishery Observer Program (CSFOP). Observer coverage was 35-40 days within each biannual commercial shark harvest season. (Figure 1 from Romine *et al.* 2009)

In the 2011 stock assessment, estimates of discard mortality (at-vessel plus post-release mortality) were based on a review of 16 papers generally involving sharks other than dusky sharks (SEDAR 2011: Section 11, p. 18). At-vessel and post-release mortality estimates for dusky sharks specifically were limited to estimates from BLL fishery data and a hook-and-line study, respectively (SEDAR 2011). Because the blue shark "was the only species for which actual post-release discard mortality data were available" (SEDAR 2011: 32), post-release mortality rates were based on a study that found post-release mortality of blue sharks to be 6% higher than at-vessel mortality (Campana *et al.* 2009). This "6% rule" was adopted to calculate discard mortality for their models under the assumption that this relationship is applicable to other shark species (SEDAR 2011). Expert opinion from the Life History Working Group was that, compared to blue sharks, the post-release mortality rate "would most likely be higher for… dusky sharks due to increased water temperatures in the western North Atlantic Ocean and the notable robustness of blue sharks" (SEDAR 2011: 32).

Final estimates for discard mortality used in the 2011 assessment were, by fishery, 44.2-65.1% for bottom longlines, 44.2% for pelagic longlines, 50% for gillnet, and 6% for recreational hook-and-line catch (SEDAR 2011). These mortality estimates represent average values across age classes and are substantially lower than capture mortality rates for juvenile dusky sharks, a major source of bycatch (Morgan and Burgess 2007; Romine *et al.* 2009). Therefore, although the most recent stock assessment determined that overfishing was likely still occurring because of high levels of bycatch and bycatch mortality (and despite the 2000 harvest ban) (**Figure 6**; SEDAR 2011), it is likely that the stock assessment is, in fact, underestimating fishing-related mortality because of these underestimates of bycatch-related mortality.

3. Shark fin trade

Shark finning is the practice of taking a shark while at sea and removing a fin or fins (sometimes including the tail); because the meat of the shark is usually of low value, the finless sharks are thrown back into the sea and subsequently die (NMFS 2010: 1). The best available information indicates that dusky sharks in the northwest Atlantic continue to face threats from shark finning and the international shark fin trade.

NMFS first banned finning of all sharks in the U.S. Atlantic Ocean as part of a 1993 fishery management plan for sharks; the ban was extended by federal law in 2000 (SEDAR 2011: 5; NMFS 2004: 2; Shark Finning Prohibition Act of 2000, Public Law 106-557). According to the prohibition, sharks must be landed whole, with fins attached, by boats fishing in U.S. waters and by vessels registered in the U.S. (but not foreign-registered vessels not fishing in the U.S. Exclusive Economic Zone (EEZ)).

Internationally, Mexico prohibited shark finning in 2007 (Humane Society International (HSI) 2010), and the sixty-three member countries of the International Commission for the Conservation of Atlantic Tunas (ICCAT) adopted a shark finning ban in 2004 in the Atlantic Ocean. The ICCAT finning ban requires retention by the fishing vessel of all parts of the shark excepting head, guts and skins, to the point of first landing of entire shark catches. Fins should not total more than 5% of the weight of the sharks onboard (Shark Coalition 2010). However, a recent study shows that this 5% ratio-based regulation is insufficient for many species, including dusky sharks (Biery and Pauly 2012). The mean (± standard error) wet-fin-to-round-mass ratio for dusky shark is 1.80%, which means that a 5% ratio would allow fishers to land extra shark fins without needing to keep or report the carcasses, and without consequences (Biery and Pauly 2012). The degree of implementation and enforcement of the ICCAT prohibition is also unclear, as is the extent of finning in fisheries outside the jurisdiction of ICCAT in international waters within the range of the northwest Atlantic population of dusky sharks.

Both shark finning and the shark fin trade continue to result in significant fishing pressure on dusky sharks. First, illegal finning has been documented in U.S. and Gulf of Mexico waters (HSI 2010 (in the Gulf of Mexico as recently as 2007); NMFS 2004: 11). Second, pressure is exerted by the shark fin trade even in the absence of finning in much of the northwest Atlantic dusky shark's range. This is because, although, as discussed below, the U.S. has banned the retention of dusky sharks, the range of the northwest Atlantic population of dusky sharks extends outside of U.S. waters into Mexican waters in the Gulf of Mexico and international waters west of the U.S. EEZ in the Atlantic Ocean where dusky sharks can be harvested (Kohler *et al.* 2008: Table 2, Figures 91-95(showing range outside the U.S. EEZ)). Thus, even without finning, the high value of shark fins and of dusky shark fins in particular (Clarke *et al.* 2006a) increases the demand for, and thus fishing pressure on, the northwest Atlantic population of dusky sharks.

The U.S. currently both imports and exports shark fins. The U.S. imports shark fins primarily from Hong Kong, China, New Zealand and Canada, although shark fins are not necessarily produced in the same country as that from which they are exported (NMFS 2004: 12). From 2005-2009, the U.S. imported between 21 and 29 metric tons (mt) of dried shark fins annually, the mean value of which ranged from $28,000/mt to $59,000/mt (NMFS 2010a*:* Table 3.1.1). Most of the shark fins exported by the U.S. go to Hong Kong, China, Canada, and Poland. From 2005-2009, the U.S. exported between 36 and 77 mt of dried shark fins annually, the mean value of which ranged from $49,039/mt to $81,000/mt (NMFS 2010a*:* Table 3.2.1); it is unclear whether any of the exports are dusky shark fins, *i.e.*, whether the reported commercial and recreational landings of dusky sharks since the U.S. implemented its retention ban in 2000 find their way into the shark fin trade.

Dusky shark fins are among those traded internationally, and are among the most highly valued (Clarke *et al.* 2006a). Clarke et al. (2006b), in the first fishery-independent estimate of the scale of shark catches worldwide, calculated that shark biomass in the fin trade is three to four times higher than the biomass represented by shark catch figures reported in the only global database, suggesting significant unreported catches. Specifically, estimates for the amount, number and biomass of dusky sharks utilized per year in the global shark fin trade are ~200,000-600,000 individuals, and ~9-23 thousand tones (from Figure 1, Clark *et al.* 2006b).

Recent studies have used genetics to identify the origin of shark fins in international fin trade markets. While the primer used for dusky shark was not completely specific (it also identified (amplified) up to two other congeners (for Galapagos and oceanic whitetip shark)), dusky shark fins were identified in both the Hong Kong (Clarke *et al.* 2006a) and Chilean fin trade (Sebastian *et al.* 2008). Newer molecular techniques have since been developed that help improve the specificity of dusky shark identification (Benavides *et al.* 2011; Gray *et al.* 2012). Using these new microsatellite markers and genetic assignment techniques, Gray et al. (2012) found that 15 of 21 Hong Kong market fins (acquired in 2000-2002) likely originated from the endangered northwest Atlantic dusky shark population.

B. The inadequacy of existing regulatory mechanisms

The catch and harvest of dusky sharks in the northwest Atlantic Ocean, including the Gulf of Mexico, is managed by multiple countries and governmental entities. The existing management measures put in place by these entities have failed to stop the ongoing population decline of the northwest Atlantic DPS of dusky sharks (**Figure 4**; SEDAR 2011: Figure 3 (showing decline in dusky shark population (SSB)).

1. U.S. state regulatory mechanisms

In U.S. Atlantic coastal waters, individual states' management of ocean waters from their shorelines to three miles offshore (nine miles in the case of Florida's Gulf of Mexico coastline) is coordinated by the Atlantic States Marine Fisheries Commission (ASMFC) (ASMFC 2008). The ASMFC was formed in 1942 and has the authority, pursuant to the 1993 Atlantic Coastal Fisheries Management Act and its 2000 amendments, 16 U.S.C. Ch. 71 *et seq.,* to develop and implement interstate fishery management plans (FMPs) for inshore fisheries; the FMPs are then administered by state agencies, and the ASMFC helps coordinate such management with management in federal waters (ASMFC 2009). ASMFC member states are Maine, New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Delaware, Maryland, Virginia, North Carolina, South Carolina, Georgia, and Florida.

In 2000, the ASMFC formed the Spiny Dogfish and Coastal Sharks Management Board; that board initiated development of an interstate FMP for Atlantic coastal sharks in 2005 on the recommendation of federal fishery managers at NOAA (ASMFC 2008: iii). Under that FMP, finalized in August 2008 and implemented in 2009 and early 2010, dusky sharks are a "prohibited species" (ASMFC 2008: vi). Many ASMFC member states had already prohibited retention of dusky sharks, generally between 2004 and 2006 (SEDAR 2011: Section 1, Table 7).

States bordering the Gulf of Mexico that are not ASMFC member states – Texas, Alabama, Mississippi, and Louisiana – also prohibit the retention of dusky sharks caught in state waters, three miles off the coastline in Alabama, Mississippi, and Louisiana, and nine miles in Texas (Texas Parks and Wildlife ND; Alabama Department of Natural Resources ND; Mississippi Department of Marine Resources 2012; Louisiana Department of Wildlife and Fisheries ND). Texas prohibited retention in 2009, Alabama in 2006, Mississippi in 2008, and Louisiana in 2006 (SEDAR 2011: Table 7).

2. U.S. federal regulatory mechanisms

In the U.S. EEZ, NOAA, through the Highly Migratory Species Management Division (HMS) of NMFS, regulates fishing for dusky sharks. NMFS also regulates tuna, swordfish and billfish fisheries, as well as other shark fisheries, in which dusky sharks may be caught as bycatch.

NMFS manages federal fisheries in partnership with regional fishery management councils pursuant to the Magnuson-Stevens Fishery Conservation and Management Act (MSA), 16 U.S.C. §§ 1801 et seq. The MSA requires that NMFS and councils prevent and end overfishing. Where federally-managed fish stocks are declared as overfished or approaching an overfished condition, NMFS must take action to end or prevent overfishing in the fishery and to implement conservation and management measures to rebuild overfished stocks within two years of making this determination. This action must include implementing a rebuilding plan through an FMP amendment or regulations, which must end overfishing immediately and rebuild the fishery within the shortest time possible in accordance with 16 U.S.C. § 1854(e)(3)-(4) as implemented by 50 C.F.R § 600.310(j)(2)(ii).

In 1989, several regional fishery management councils requested that NMFS take the lead in developing a FMP for sharks under its authority (NMFS 1993: 1). In response to that request, NMFS completed the first FMP for sharks in 1993 (NMFS 1993). The retention of dusky sharks in commercial and recreational fisheries in federal waters was prohibited in a combined FMP for Atlantic Tunas, Swordfish, and Sharks that NMFS completed in 1999; the management plan was renamed the Consolidated Atlantic Highly Migratory Species FMP in 2006 (2006 HMS FMP) when the management of billfish was added to the plan (NMFS 1999: 150; NMFS 2006). Although commercial and recreation retention of dusky sharks was prohibited in 2000, reports of landings continue to appear in commercial logbooks and recreational landings statistics (SEDAR 2011: Section 1, page 42; Section 3, Table 1).[1]

The 1999 FMP also identified essential fish habitat and habitat areas of particular concern for sharks, including areas off the coasts of North Carolina; Chesapeake Bay, Virginia and Maryland; Delaware Bay, Delaware; and Great Bay, New Jersey (NMFS 1999; ASMFC 2008: Figures 1.4.3.1.10a, 1.4.3.1.10b, and 1.4.3.1.10c). The area off North Carolina's coast was closed to shark BLL gear from January through July beginning in 2005 due to concerns about bycatch of juvenile sandbar and dusky sharks (NMFS 2003: 2-22; 4-54 - 4-63 (closing area to all vessels issued a directed shark limited access permit that have BLL gear on board)). Although other coastal bays and estuaries were identified as important pupping and nursery areas for sandbar and dusky sharks (notably Delaware Bay, Chesapeake Bay, and Great Bay), these areas

[1] Reports of recreational catches and landings are derived from three recreational surveys: the Marine Recreational Fisheries Statistics Survey (MRFSS) dockside intercept survey data from May through October, for the Mid-Atlantic, South Atlantic, and Gulf of Mexico, and trips using hook and line gear; a headboat survey (HBOAT) with data from 1986-2009, and a Texas Parks and Wildlife Department (TXPWD) survey with data from 1983-2009 (SEDAR 2011*:* Section 3, pages 40, 57). U.S. commercial landings of dusky sharks were compiled from multiple data sources, presented in SEDAR21-DW-09. Southeast general canvass landings data were available for 1985-2009 and Quota Monitoring System (QMS) data for 1992-2009. Both pelagic dealer weigh-out reports of dealers holding swordfish and tuna permits (1982-2009) and logbook information from the Coastal Fishery Logbook program (1991-2009) were utilized as well. The largest annual value reported in these four sources was taken as the annual value of dusky shark landings for the southeast region. Landings from the northeast general canvass data (1993-2009) were then added to the southeast landings to produce total U.S. commercial estimates (SEDAR 2011*:* Section 3, page 30).

were primarily within state waters and not closed to shark fishing gear (NMFS 2003: 2-21). Although other areas have been closed to PLL and other gear, these closures have not been designed specifically to address gear interactions with dusky sharks (NMFS 2012a: 67; SEDAR 2011: 16, 18-19).

Through 2011, efforts under the MSA to stop overfishing of dusky sharks and rebuild the fishery focused on reducing targeted catch, culminating in the prohibition on retention of dusky sharks caught in federal waters. In the 2011 SEDAR, however, NMFS acknowledged that these prohibitions had failed to stop overfishing, and indicated that fishing mortality must be reduced by approximately 62% from 2009 levels (SEDAR 2011).

As a result, NMFS has proposed new management measures via an amendment (draft Amendment 5) to the 2006 HMS FMP (NMFS 2012c). Although a schedule presented in March 2012 indicated that the proposed rule (amendment) and related environmental impact statement would be published in mid-2012 they were not released until November 2012 (NMFS 2012b). Thus, the schedule presented in March indicating that a final EIS would be published in late 2012 or early 2013 and that the rule would be finalized in early 2013 (NMFS 2012b) is no longer accurate.

The law is clear that NMFS may not consider future plans in a decision whether to list a species under the ESA.[2] This is particularly true in situations like that here, i.e., where there is significant uncertainty about what conservation measures may be included in Amendment 5 and ongoing delays in the development of Amendment 5.

Moreover, the measures NMFS proposes in draft Amendment 5, including closed areas and recreational size limits, are unlikely to reduce fishing mortality sufficiently to end overfishing or rebuild the northwest Atlantic population of dusky sharks on a timeline that avoids excessive extinction risk. NMFS states in draft Amendment 5 that dusky shark mortality must be reduced by an aggregate amount of 62% in the PLL, BLL shark research and recreational fisheries to allow for a reasonable likelihood that the species can rebuild and recover from an overfished

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[2] *See Oregon Natural Resources Council v. Daley*, 6 F. Supp. 2d 1139, 1153-55 (D. Or. 1998) (NMFS's decision not to list the Oregon Coast evolutionarily significant unit of coho salmon improperly relied on future and voluntary measures); *Center for Biological Diversity v. Morgenweck*, 351 F. Supp. 2d 1137, 1140 (D. Colo. 2004) ("the law is clear that FWS cannot consider future conservation efforts in its review of the Petition"); *Southwest Center for Biological Diversity v. Babbitt*, 939 F. Supp. 49 (D.D.C 1996) (remanding action to Secretary and instructing him to eliminate the promises of proposed future actions of the Forest Service from the listing determination); *see also* FWS & NMFS, Endangered Species Petition Management Guidance (July, 1996) at 9 (listing must be based on the "here-and-now of a species' current status" and cannot be rejected "on the basis of an unproven promise of future favorable management"); Department of the Interior Fish and Wildlife Service and Department of Commerce National Oceanic and Atmospheric Administration, Policy for Evaluation of Conservation Efforts When Making Listing Decisions, 68 Fed. Reg. 15100-02, 15115 (Mar. 28, 2003) ("conservation efforts that are not sufficiently certain to be implemented and effective cannot contribute to a determination that listing is unnecessary or a determination to list as threatened rather than endangered").

state within approximately 100 years. However, because of uncertainties associated with the assessment (*i.e.*, indices of abundance and life history characteristics and underreporting/misreporting of bycatch), it is likely that the fishing mortality rate in 2009 was actually higher and therefore the percent reductions needed to end overfishing (a 36% reduction) as well as rebuild the fishery (62%) are underestimated (Morgan 2013).

If the preferred alternative relating to the PLL fisheries is adopted, it is unlikely to achieve a 62% reduction in fishing mortality in those fisheries for several reasons, including: (1) the proposed closures are quite small and it is very likely that a highly mobile species such as the dusky shark will move out of these closed areas into open areas; (2) catch rates of dusky sharks in specific areas can vary significantly from year to year, and there is no information in draft Amendment 5 to support the assumption that dusky sharks will continue to use the proposed hot spots year after year in the same way they did (in aggregate) over the period from 2008 through 2010; (3) NMFS' assumptions with respect to where fishing effort will be displaced to are unsupported (e.g., it is quite likely that fishing effort could be displaced disproportionally to areas immediately proximate to the closed areas); and (4) changes to water temperature, food availability, and other habitat factors in these hot spot closures over time are more than likely to influence use of the proposed hot spot areas by dusky sharks (and other species) (Morgan 2013).

NMFS itself acknowledges that the measures proposed for the PLL fisheries are likely to fall short of the targeted – 62% – fishing mortality reduction (NMFS 2012c: 4-98). It suggests that measures it proposes in the recreational and BLL fisheries will overshoot the target, thus offsetting the acknowledged shortcomings of its PLL proposals (NMFS 2012c: 4-98). This is unsupported.

In fact, NMFS's proposal to address recreational bycatch of dusky sharks – increasing the recreational size limit for sharks to 96 inches to protect immature dusky sharks that are caught and improperly identified – is also unlikely even to meet NMFS's target. Available data indicate that, since 2000, approximately half of dusky sharks caught recreationally were *more* than 96 inches (SEDAR 21 Data workshop; Morgan 2013). Thus, even assuming all dusky sharks landed recreationally under the 96 inches are released and there is no post-release mortality, mortality would only be reduced by approximately half. And the available science does *not* support an assumption of no post-release mortality. While dusky sharks appear to survive the initial capture by hook and line, Cliff and Thurman (1984) determined dusky sharks continued to deteriorate after capture and required 24 hrs of recovery after capture on hook and line gear; in the last assessment, a 6% post-release mortality rate was assigned to recreational live releases (SEDAR 2011).

Nor will NMFS's proposals for BLL fisheries necessarily reduce dusky shark bycatch. NMFS offers no specific proposals to address dusky shark bycatch in the shark research fishery at all – instead simply identifying potential measures, presenting preliminary data, and restating its goal of reducing dusky shark fishing mortality by 62% (NMFS 2012c: 4-109). Its proposals for other BLL fisheries are aimed at rebuilding other shark stocks *(i.e.,* not included in the measures aimed at reducing dusky shark interactions in the BLL shark research fishery by 62%). Although it might appear that these proposed TACs and quotas – because they are set close to current catches for fisheries in which dusky sharks are caught as bycatch – would be unlikely to affect dusky shark bycatch, additional analyses are needed to show that dusky shark bycatch will not *increase* with the new measures. For instance, if there is a significant relationship between blacktip and dusky shark catches on individual sets, the proposed TACs and quotas could increase dusky shark bycatch (Morgan 2013).

In short, in the absence of additional information, NMFS's apparent determination that its proposed measures will in the aggregate stop dusky sharks from being subject to overfishing and result in rebuilding is unreasonable (Morgan 2013).

3. International regulatory mechanisms

The harvest of dusky sharks in the northwest Atlantic Ocean outside of U.S. waters is generally allowed. Limited exceptions are Mexico's ban, instituted in 2011, on shark fishing from May-August each year and the Bahamas' ban on all shark fishing, as well as sale and trade in shark products (HSI 2011; Shark Savers UD).

Shark finning has been prohibited in Mexico since 2007 (HSI 2010), and by ICCAT (in accordance with the 5% rule) in northwest Atlantic Ocean tuna fisheries since 2004 (Shark Coalition 2010).

C. Other natural or manmade factors affecting dusky sharks' continued existence

1. Global climate warming

Global climate warming poses additional threats to the recovery of the severely depleted dusky shark population in the northwest Atlantic. According to NMFS (2009b: 74 Fed, Reg. 29344, 29356), "[s]ince the 1970s, there has been a historically significant change in climate (Greene *et al.* 2008). Climate warming has resulted in increased precipitation, river discharge, ocean temperatures, and glacial and sea-ice melting (Greene *et al.* 2008)." The Intergovernmental Panel on Climate Change (IPCC) (2007) has concluded that global warming caused by humans is already impacting the habitats and life history of species worldwide. Furthermore, such effects are occurring faster than scientists had previously predicted (Boesch *et al.* 2007). Impacts of global climate warming on northwest Atlantic dusky sharks will be both direct, such as a result of temperature-mediated increases in capture mortality, and indirect, such as the result of food web disruptions, adverse modification of nursery habitat, and distributional shifts that will impact vulnerability to fishing mortality.

Between 1948 and 1998, global ocean temperatures increased by 0.31° C on average in the upper 300 m (Levitus *et al.* 2000). Locally, some ocean regions are experiencing even greater warming (Bindoff *et al.* 2007). Notably, the largest increases in global ocean temperature have occurred in the upper ocean where primary production is concentrated and warming appears to be affecting global ocean productivity (Behrenfeld *et al.* 2006). Warming water temperatures pose a direct threat to dusky sharks as they may exacerbate at-vessel mortality rates, which increase as bottom water temperatures increase. Between 1994 and 2005, at-vessel mortality rates of dusky sharks caught in commercial bottom longlines in the south Atlantic and Gulf of Mexico were highest with the longest soak time and warmest bottom water temperatures (Morgan and Burgess 2007).

More recently, the IPCC (2007: 275) stated that it has a high level of confidence that "[r]egional changes in the distribution and productivity of particular fish species are expected due to continued warming and local extinctions will occur at the edges of ranges." In a recent NMFS study, clear shifts in spatial distribution were linked to ocean temperatures in multiple fish stocks on the northeast U.S. continental shelf (Nye *et al.* 2009: 124). Twenty-four of the 36 stocks studied displayed statistically significant changes consistent with warming, as indicated by a poleward shift in the center of biomass, an increase in mean depth of occurrence, and/or an increase in mean temperature of occurrence (Nye *et al.* 2009: 124). As mentioned above, dusky sharks occur in tropical and warm temperate waters, preferring water temperatures of 19 to 30 °C (Musick *et al.* 2009; Hoffmayer *et al.* 2011). As ocean temperatures warm, potential shifts in spatial distribution may include a more northerly extent to dusky sharks' migratory range, an increasing use of deeper and/or more offshore waters, and shifts in their preferred breeding, nursery, and foraging habitats. Furthermore, because of the influence of temperature as a migratory and reproductive cue (Musick 2009), increased temperatures are also likely to substantially alter reproductive timing and possibly reproductive success of dusky shark, as is believed to likely be the case for many fish species (Kerr *et al.* 2009).

Shifts in spatial distribution of dusky shark threaten to undermine management for several reasons. First of all, a northern expansion of the shark's range may expose the species to increased bycatch threats from additional fisheries. Distributional shifts will also decrease the efficacy of existing and proposed time/area closures unless these closures are flexible and linked to up-to-date distribution data. For example, the time/area closure intended to protect neonate and juvenile dusky sharks in the mid-Atlantic may become less effective if their migratory and reproductive timing and spatial distribution shift.

While adult dusky sharks tend to avoid areas of low salinity and rarely enter estuaries (Musick *et al.* 1993), neonates and juveniles rely on shallow coastal estuaries and bays as nursery areas (Castro 1993). Global warming is adversely impacting estuary systems along the U.S. Atlantic coast. Specifically, climate warming is causing increased precipitation in many of these estuary systems (Kerr *et al.* 2009). In the northeastern United States, annual precipitation is expected to increase by 10 percent (Kerr *et al.* 2009), winter precipitation by 10 to 15 percent (Hayhoe *et al.* 2007), with higher increases in certain areas like Maryland (Center for Integrative Environmental Research (CIER) 2008). Precipitation in the northeast U.S. has increased 3.3 inches, or 8 percent, over the past 100 years, with eight of the ten wettest years occurring since 1970 and the greatest increases tending to be either near the Atlantic coast or major bodies of water (Wake and Markham 2005: 16-17). Further, global warming increases the occurrence of and/or severity of hypoxic conditions in estuaries, bays, and rivers (Boesch *et al.* 2007). The capacity of water to absorb oxygen decreases as it warms; in the Chesapeake Bay, for example, the capacity to dissolve oxygen decreases by about 1.1 percent with each degree Fahrenheit that the water warms (EPA ND: 5). Greater precipitation also results in greater discharges of nutrient pollution into rivers and estuaries, leading to increased eutrophication and hypoxic conditions (Howarth *et al.* 2006). These effects have been accelerating in recent years and are expected to continue to accelerate (Howarth *et al.* 2006). These climate-related threats to estuaries on the U.S. Atlantic coast will likely limit the quantity and quality of nursery habitats for dusky sharks, further threatening this depleted population.

Ocean surface warming as a result of global climate warming is also believed to have caused recent sharp declines in phytoplankton levels, which are down by 40% since the 1950s (Behrenfeld *et al.* 2006; Borenstein 2010). A sustained decline of phytoplankton threatens the health of the entire marine food web that depends on forage fish species to convert energy from zooplankton and phytoplankton to sustain larger predatory species. As an apex predator, dusky shark are particularly vulnerable to reductions in the productivity and carrying capacity of marine ecosystems.

The ability of dusky shark to adapt to climate change and other threats is limited by the species' very low natural intrinsic rate of population increase. While exploitation is the primary threat to this inherently vulnerable shark, the threats associated with climate warming substantially increase the risk of extinction for dusky sharks in the northwest Atlantic.

V. Requested Listing

NMFS must list a species as "threatened" under the ESA if the species is "likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range." See 16 U.S.C. § 1532(20).

Appropriate Time Frames
In choosing a time frame, *e.g.*, what is the "foreseeable future" in which a species is likely to become endangered for classification purposes, NMFS must choose a time frame that is reasonable, given the species' characteristics and the nature of the threats. *Cf.* Black's Law Dictionary, 8th ed. 2004 (definition of foreseeable is "reasonably anticipatable"). The time frame should also ensure protection of the petitioned species, and give the benefit of the doubt regarding any scientific uncertainty to the species.

The timeframe for dusky shark should be similar to that used for other long-lived species. Because fishing mortality and global warming are the foremost threats to dusky shark, NMFS should also use a timeframe that is appropriate for such impacts. The minimum time period that meets these criteria is 100 years. The 100 year time frame has been used for fish with shorter lifespans, such as Columbia River steelhead, Chinook salmon, and, most recently, the Gulf of Maine DPS of Atlantic Salmon (NMFS 2009b: 74 Fed. Reg. 29344, 29356). Courts have approved the use of the 100 year timeframe for multiple other species as well. *See Western Watersheds Project v .United States Fish and Wildlife Service*, 535 F. Supp. 2d 1173, 1184 (D. Id. 2007) (To be a "threatened species under the ESA, the sage-grouse must be likely 'to be in danger of extinction' within 100 years"); *Southwest Center for Biological Diversity v. Norton*, 2002 WL 1733618, at *12 (D.D.C. July 29, 2002) (for the Queen Charlotte goshawk, the FWS determined that the goshawk would be "threatened" if at any point in the next 100 years there is a 20% chance that the species would become extinct.); *Western Watersheds Project v. Foss*, 2005 WL 2002473, at *15 (D. Id., Aug. 19, 2005) (court ruled that FWS's decision not to list a plant with 64 percent chance of extinction within 100 years as threatened was untenable).

The IUCN species classification system also uses a timeframe of 100 years. For example, a species must be classified as "vulnerable" under the IUCN system if there is a probability of extinction of at least 10% within 100 years. Further, a species must be listed as "endangered" if the probability of extinction is at least 20% within 20 years or five generations, whichever is the longer (up to a maximum of 100 years).

In planning for species recovery, agencies also routinely consider a 75-200 year foreseeable future threshold (Suckling 2006). For example, the FWS used 100 years in connection with recovery of the Steller's Eider (*e.g.*, the Alaska-breeding population of the species will be considered for delisting from threatened status when it has <1% probability of extinction in the next 100 years, and certain populations have <10% probability of extinction in 100 years and are stable or increasing) and 200 years in connection with recovery of the Utah prairie dog, and NMFS used 150 years in connection with the recovery of the Northern right whale (Suckling 2006).

Perhaps most importantly, the time period that NMFS uses in its listing decision must be long enough so that actions can be taken to ameliorate the threats to the petitioned species and prevent extinction. For all these reasons, Petitioner recommends a minimum of 100 years as the time frame for analyzing the threats to the continued survival of dusky shark.

Significant Portion of Its Range

A "significant portion of [a species'] range" (SPOIR) can include both current and historical habitat. *See, e.g., Northwest Ecosystem Alliance v. United States Fish and Wildlife Serv.*, 475 F.3d 1136, 1148 (9th Cir. 2007) ("major geographical areas in which it is no longer viable but once was"), *citing Defenders of Wildlife v. Norton*, 258 F.3d 1136, 1145 (9th Cir. 2001). A danger of extinction to a species within a SPOIR is sufficient to require listing. 16 U.S.C. § 1532(6); *Defenders*, 258 F.3d at 1141-42.

Cumulative Impacts of Stressors

Consistent with the ESA's requirements, while each factor and each individual stressor may be discussed separately, they must be considered together in making listing decisions. To only consider them "piecewise, one or two at a time . . . is flawed because the interaction among components may yield critical insight into the probability of extinction. . . . the synergism among processes – such as habitat reduction, inbreeding depression, demographic stochasticity, and loss of genetic variability – is exactly what will be overlooked by viewing only the pieces." *Boyce* (1992: 495-6); *see also Western Watersheds Project v. Fish and Wildlife Serv.*, 535 F. Supp. 2d 1173, 1179 (D. Id. 2007)("It is the cumulative impacts of the disturbances, rather than any single source, [that] may be the most significant influence on the trajectory of sagebrush ecosystems.'"). NMFS has considered cumulative risk in prior listing determinations (NMFS 2009b: 74 Fed. Reg. 29344, 29382-83).

A. The Northwest Atlantic Dusky Shark DPS Should be Listed as a Threatened Species

For the reasons set forth in this petition, NMFS should list the northwest Atlantic DPS of dusky sharks as a threatened species because this DPS is likely to become endangered in the foreseeable future throughout all or a significant portion of its range. The precipitous and sustained decline of the northwest Atlantic DPS of dusky sharks despite efforts to stabilize and rebuild this population indicate that it is necessary to use the protections available under the ESA to save and recover this population.

B. The Dusky Shark Should be Listed as a Threatened Species Because It Is Likely to Become Endangered Within the Foreseeable Future in a Significant Portion of Its Range.

In the alternative, NMFS should designate the dusky shark as threatened because the species is threatened throughout a significant portion of its range – throughout the habitat of the northwest Atlantic population of dusky sharks, an area spanning the eastern coastline of the U.S. and adjacent ocean waters and the Gulf of Mexico. For the reasons discussed above, this area constitutes a significant portion of the species' range in which the species is likely to become an endangered species within the foreseeable future.

VI. Recovery Plan Elements

NMFS should establish a recovery plan for the dusky sharks in the northwest Atlantic Ocean that addresses bycatch, fishing mortality, inadequacy of existing regulatory mechanisms, climate change, and other key threats, including the following components:

- Changes in fisheries management, including better bycatch monitoring, gear changes and restrictions, time/area closures, and bycatch caps;

- Research aimed at reducing fishing mortality (capture and post-release mortality) and/or improving our knowledge of the effects of time/area closures

- Measures to address the current and future effects of global warming on dusky sharks, including measures to protect coastal habitats used as nursery areas; and

- Enhanced implementation and enforcement of fishery restrictions.

VII. Critical Habitat Designation

Petitioner requests the designation of critical habitat for dusky sharks in the northwest Atlantic Ocean concurrent with the requested listings, as required by 16 U.S.C. § 1533(b)(6)(C). *See also*

16 U.S.C. § 1533(a)(3)(A). Critical habitat should encompass all estuarine and marine habitats in which dusky shark are known to forage and reproduce.

Critical habitat is defined by Section 3 of the ESA as: (i) the specific areas within the geographical area occupied by the species, at the time it is listed in accordance with the provisions of section 1533 of this title, on which are found those physical or biological features (I) essential to the conservation of the species and (II) which may require special management considerations or protection; and (ii) specific areas outside the geographical area occupied by the species at the time it is listed in accordance with the provisions of section 1533 of this title, upon a determination by the Secretary that such areas are essential for the conservation of the species. *See* 16 U.S.C. § 1532(5).

The designation and protection of critical habitat is one of the primary ways to achieve the fundamental purpose of the ESA, "to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved." *See* 16 U.S.C. § 1531(b). In adding the critical habitat provision to the ESA, Congress clearly saw that species-based conservation efforts must be augmented with habitat-based measures: "It is the Committee's view that classifying a species as endangered or threatened is only the first step in insuring its survival. Of equal or more importance is the determination of the habitat necessary for that species' continued existence . . . If the protection of endangered and threatened species depends in large measure on the preservation of the species' habitat, then the ultimate effectiveness of the Endangered Species Act will depend on the designation of critical habitat." *See* House Committee on Merchant Marine and Fisheries, H.R. Rep. No. 887, 94th Cong. 2nd Sess. at 3 (1976).

The dusky shark will benefit from the designation of critical habitat in all of the ways described above. Designated critical habitat will allow NMFS to designate reasonable and prudent alternatives to activities that are impeding recovery but not necessarily causing immediate jeopardy to the continued survival of the species. For these reasons and as already stated, we request critical habitat designation concurrent with species listing.

VIII. Conclusion

For all of the reasons discussed in this petition, NMFS should list the northwest Atlantic DPS of dusky shark as a threatened species under the ESA. In the alternative, NMFS should list dusky shark as threatened because it is likely to become endangered in the foreseeable future throughout a significant portion of its range.

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Appendix A.

Review of Draft Amendment 5 to the Consolidated Atlantic Highly Migratory Species Fishery Management Plan

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For: Natural Resources Defense Council

Introduction

Dusky sharks in the northwest Atlantic Ocean have experienced intense fishing pressure over the past several decades, first reaching an overfishing status in 1984 and then overfished status in 1999. The previous two stock assessments deemed the species to still be overfished and undergoing overfishing, thus requiring managers to implement strategies that will result in the rebuilding of this species (Cortés et al. 2006; SEDAR 2011). Overfishing is considered to still be occurring because dusky sharks continue to be incidentally caught and discarded in the pelagic longline (PLL), bottom longline (BLL) and recreational fisheries. Currently the population is estimated to have been depleted to around 85% of virgin levels and the latest assessment indicated that there was 70% probability, with a large amount of uncertainty surrounding the projection of relative spawning biomass, of rebuilding the population with only a small amount of fishing mortality. NMFS considers a population rebuilt when it reaches B_{msy}.

Historically the main fishery for dusky sharks in the United States, prior to dusky sharks being classified as a prohibited species, was the BLL fishery. In recent years (2010 and 2011) no dusky shark interactions have been observed (2-3% coverage) in the BLL non-sandbar fishery, while in the BLL shark research fishery 21 interactions were observed (100% coverage) during 2008, 106 during 2009 and 198 during 2010 (Hale et al. 2011; NOAA 2012a). While the PLL fishery does not typically target large coastal shark species, dusky sharks are often incidentally caught and therefore management measures to protect dusky sharks should also be implemented in this fishery (SEDAR 2011). For example, in 2008, 396 dusky sharks were reported captured in this fishery, 624 during 2009 and 737 during 2010 (NOAA 2012a). The recreational fishery caught 2,391, 447 and 546 dusky sharks during 2008, 2009 and 2010 (NOAA 2012a). These are likely significant underestimates because of underreporting and misreporting.

Amendment 5 has attempted to identify management measures that will reduce dusky shark mortality by an aggregate amount of 62% in the PLL, BLL shark research and recreational fisheries, allowing the species to rebuild and recover from an overfished state within the projected timelines. However, because of uncertainties associated with the assessment (i.e., indices of abundance and life history characteristics and underreporting/misreporting of bycatch), it is likely that the fishing mortality rate in 2009 was actually higher and therefore the total percent reduction needed to end overfishing may also be underestimated. Several preferred alternatives intended to reduce fishing mortality of dusky sharks have been identified, namely various time/area closures, changes to the BLL shark research fishery and recreational measures. In addition, Total Allowable Catch (TAC) and quota measures have been suggested for the BLL fishery that could impact dusky shark interactions. The strength of methods used to develop the proposed hot spot time area closures are assessed below and comments have been made on the likelihood that the combined Preferred Alternatives will end overfishing of the dusky shark. In addition, some aspects of Non-Preferred Alternatives that could also prove beneficial have been highlighted.

Preferred Alternative A2 – TAC and Commercial Quota Measures

This Preferred Alternative would create species specific TACs for scalloped hammerhead, Atlantic blacknose, Gulf of Mexico (GOM) blacknose and GOM blacktip sharks and would also create regional commercial quota complexes for all hammerhead sharks (great, scalloped and smooth), non-blacknose small coastal sharks (SCS), aggregated large coastal sharks (LCS) and commercial quotas for blacknose and GOM blacktip. The TACs and quotas would be set at or close to recent annual averages for the targeted species. This alternative also links quotas of species commonly caught together so that the fisheries for those species would open/close at the same time. For example, if the Atlantic hammerhead quota is reached (the smaller of the two) before the LCS aggregate quota than targeted fishing for both would shut down. The primary fisheries impacted by these TACs/quotas would be the BLL fisheries for hammerheads, blacktip, LCS and to a lesser degree SCS, while the gillnet fishery would be impacted by the SCS quotas. The PLL fishery does not typically target sharks and would therefore only be moderately impacted by these TACs and quotas measures. Over-quota discarding and "high-grading" are commonly employed by fishermen when only individual quotas are used (Poos et al. 2010). Therefore, linking quotas is an excellent and popular way to reduce the bycatch of unwanted non-target species, in this case scalloped hammerhead and blacknose sharks, in multispecies fisheries (Zeller and Reinert 2004; Abbott and Willen 2009). If these measures are put into place, fishers in the BLL fisheries will likely try to avoid hammerheads so they can fill the entire LCS aggregate quota in both the Atlantic and GOM and the blacktip (the primary target species outside of the research fishery) quota in the GOM. While these measures are aimed at rebuilding the scalloped hammerhead stock (i.e., not included in the measures aimed at reducing dusky shark interactions in the BLL shark research fishery by 62%), understanding the possible effects, both positive and negative, of these measures on dusky shark bycatch must still be investigated. Although it might appear that the proposed TACs and quotas – because they are set close to current catches – would be unlikely to affect dusky shark bycatch, additional analyses are needed to show that dusky shark bycatch will not increase with the new measures. Analyzing the data to see if there is a common relationship between dusky shark bycatch and other target species is one technique that could be used. If there is a significant relationship between blacktip and dusky shark catches on individual sets, then this measure would possibly increase dusky shark bycatch.

Also included in this Alternative is increasing the recreational size limit for sharks to 96 in (fork length) to protect immature dusky sharks, allowing them to reproduce at least once (in theory). According to headbook data, since 2000 50% (N=4) of dusky sharks caught recreationally were under 96 in and according to MRFSS 60% (N=20) were under 96 in since 2000 (SEDAR 21 Data workshop). Since dusky sharks are already prohibited from being caught this would help protect immature dusky sharks that are caught and improperly identified (very common/easy to do) because they would still be required to be released. At-vessel mortality rates are high in fisheries such as the BLL (Morgan et al. 2009) but lower in the PLL (SEDAR 2011). There is limited information on post-release mortality rates for dusky sharks caught in hook and line fisheries. While dusky sharks appear to survive the initial capture by hook and line, Cliff and Thurman (1984) determined dusky sharks continued to deteriorate after capture and required 24 hrs of recovery after capture on hook and line gear; in the last assessment, a 6% post-release mortality rate was assigned to recreational live releases (SEDAR 2011). The success of this measure would also be dependent on the behavior of fishers (Homans and Ruliffson 1999; Woodward and Griffin 2003). One possibility is that fishers could be forced further offshore in search of larger sharks, leading to a reduction in overall fishing effort in this fishery (i.e., inexperienced fishers may be less inclined to venture further offshore). Alternatively, effort could increase because fishers spend more time fishing in an attempt to locate larger sharks (Woodward and Griffin 2003). In the second case, the success of this measure will be dependent on NMFS outreach program aimed at improving identification issues with dusky sharks and on the assumption that post-release mortality rates for dusky sharks caught in hook and line fisheries are low.

<u>Preferred Alternatives B3a-h- Pelagic Longline Effort Control Measures</u>

The National Marine Fisheries Service states their goals with respect to time/area closures are to 1) maximize reductions in bycatch, 2) minimize reductions in target catch and 3) consider impacts on non-target species. As such, NMFS has identified and proposed seven individual hot spot areas to be closed from 1 to 2 months. These hot spots include easily defined discrete areas where more than 10 dusky sharks were incidentally caught by the PLL fishery between 2008 and 2010. NMFS has not shown that these time/area closures are likely to significantly reduce fishing mortality of dusky sharks because:

1. NMFS has relied on the use of the HMS logbook to determine areas where more than 10 dusky sharks were caught by the PLL fishery between 2008 and 2010. This dataset is known to vastly underestimate true catches within this fishery and it is more than likely that after the prohibition of dusky sharks, reporting of incidental captures

diminished (Morgan 2008). It is possible that dusky sharks are caught in large numbers in additional areas and are just not reported and therefore not included in this analysis. NMFS chose to use this dataset instead of the PLL observer data to avoid having to extrapolate out over the whole fishery. The observer program only monitors a fraction of the fishery and therefore any dusky shark interactions would need to be extrapolated across the whole fishery. Extrapolation is commonly done for bycatch species such as marine mammals and sea turtles. To demonstrate the reasonableness of the proposed closures, NMFS must compare the datasets to see if they match up or have distinct differences.

2. NMFS appears to have relied on capture data from three years (2008-10) in the aggregate to support its proposed closures (draft Amendment 5 only provides a figure that shows the sum of all PLL dusky shark interactions). As discussed below, dusky sharks are highly migratory, and their use patterns are affected by myriad factors related to habitat. To verify that "hot spots" for dusky shark capture do not vary significantly from year to year, NMFS must evaluate and present captures of dusky sharks individually in the available years. For example, the data presented from the Apex Predator program shows large differences in CPUEs at various stations within the current Mid-Atlantic closed area between years and shows years were no dusky sharks were caught south of South Carolina and other years when they were.
    a. It would be beneficial to have a figure representing the total dusky shark interactions in each hot spot closure for the proposed month by year as well as the plotted interactions of dusky sharks outside of this area.
3. Not only does NMFS not evaluate data from individual years in draft Amendment 5, it bases its proposed closures on a very short time series for the PLL dataset – from 2008 to 2010. A longer time series is needed to support the claim that the proposed hot spot closures – especially given the degree to which they are temporally and geographically limited – will significantly reduce fishing mortality of dusky sharks. More generally, the development of area closures requires a full understanding of the spatial structure of individual fisheries (Hilborn et al. 2004). NMFS originally presented a dataset from 2006- 2010 in the Predraft Amendment (NOAA 2012b). Other than the fact that management measures have changed over the years, which could influence trends in the fishery, no reason for this change is given in discussions of this Preferred Alternative. It is difficult to compare the graphs of the two datasets (2006-2010 and 2008-2010) to determine what differences there may be. A longer time series would provide a better understanding of the relationship between prior management changes and effects on fishing mortality, which would aid in evaluating the impact of further regulations on the fishery.
4. When evaluating the potential for redistribution of fishing effort, NMFS makes only two assumptions: 1) all effort (i.e., number of hooks) from within a proposed hot spot closure would be redistributed to the remaining open area of the statistical region it

was assigned to (i.e., Mid Atlantic Bight Canyons effort would be redistributed to the remaining open area of the Mid-Atlantic region – see figure 4.1 for statistical areas); or 2) fishermen would stop fishing and their effort would not need to be redistributed. Based on their calculations, these closures will result in an approximate 49% reduction in dusky shark discards when effort is redistributed and 55% when it is not. The success of short and long term closures is highly dependent on the subsequent redistribution of fishing effort (Powers and Abeare 2009) and there are several problems with the redistribution assumptions made in draft Amendment 5:

a. NMFS assumes that the displaced fishermen will not move to another statistical area. For example, in the Mid-Atlantic region there are three closures spanning May, June and November in the Cape Hatteras Special Research/Hatteras Shelf Area and one closure in the mid-Atlantic Bight Canyons (three separate areas) during October, along with the current Mid-Atlantic closure. Fishermen may decide to move south into the South Atlantic region instead of dealing with numerous closures.
b. It is unclear how NMFS utilized their plots of PLL effort and the historic distribution of PLL sets to redistribute effort. A good way to utilize this information would be to redistribute effort based on the history of catch locations and cost of travel on a spatial scale (i.e., 1 degree grid cells as used in the Amendment), to see where redistributed effort would be concentrated in the remaining open areas (Hiddink et al. 2006). For example, this could show that fishing effort may be redistributed to the outskirts of a closed area, which would have significant implications for migrating species such as the dusky shark. It appears, according to Appendix A, that NMFS only redistributed effort proportional to the CPUE of other species into the entire open area and not to specific locations within that open area.
c. NMFS assumes that effort in the open areas will remain the same as prior to the closure and not change (i.e., increase or decrease) once all of the effort is redistributed (Powers and Abeare 2009).
d. A reduction in the CPUE of target species with the addition of new effort to the open area has not been accounted for (Powers and Abeare 2009). The percentage of hooks used inside the hot spots, compared to the remaining open areas of that region, range from only 16% in Alternative B3d to as much as 70% in B3b and B3h. Redistributing up to 70% of the total effort in a single area to the remaining open area could lead to competition amongst fishers, leading to decreased catch rates for target species (Rijnsdorp et al. 2001). It is also possible that some of the open areas cannot sustain the increased effort that is being redistributed to it (i.e., the Charleston Bump area). This could also force fishermen to move to another location, leave the

fishery or wait until the closures are over and the impact of this on dusky shark interactions is unknown.

e. Redistribution does not account for fisher behavior based on the cost of relocating to new fishing locations within the redistribution model (cost analysis is done separately) (Chakravorty and Nemoto 2000; Powers and Abeare 2009). Analyses related to cost appear to have been done separately.

5. NMFS's model does not account for movement of dusky sharks into/out of the closed area. These time/area closures are quite small and it is highly likely that a highly mobile species such as the dusky shark will move out of these closed areas into open areas. For example, in the Gulf of Mexico movement data from tagging has shown dusky sharks can move as far as 2,799 km (1,511 nm) in 89 days and can have a home range of 1,817-24,013 km^2 (981-12,960 nm^2) (50% utilization) to 9,477-124,991 km^2 (5,117-67,490 nm^2) (95% utilization) (Hoffmayer et al. 2011). The smallest and largest proposed closures are 1,085 km^2 (586 nm^2) and 23,960 km^2 (12,944 nm^2) respectively. Movement of sharks into and out of area closures has been identified as an issue for other species of sharks (Robbins et al. 2006; Knip et al. 2012). For example, some research has shown that fishers will remain on the outskirts of closures such as these (Murawski et al. 2005), meaning dusky sharks that leave the closed areas would still be susceptible to fishing. Therefore, the benefits of small closures are often negated with highly migratory species (Powers and Abeare 2009).
6. The full effect of redistributing effort could take years to occur as fishers investigate new areas to fish and the fishery reaches a state of equilibrium (Apostolaki et al. 2002; Powers and Abeare 2009) and time (i.e., years) is not included in this model.
7. NMFS fails to consider several other factors that are critical to understanding the effectiveness of the proposed closures:
   a. What is the potential impact to dusky sharks if fishers begin fishing in areas not previously fished?
   b. What is the impact in the closed areas once they are opened to fishing again (i.e., does effort increase compared to before the closure)? Fishermen may just decide to fish more during the open season (Rijnsdorp et al. 2001) and we do not know how this would impact dusky shark bycatch rates. If this were to happen, the basic assumptions NMFS has relied on with regard to fishing effort and redistribution will not be accurate.
   c. How important are changes to the water temperature, food availability, etc. in these hot spot closures over time – both in terms of annual variability, and longer term shifts related to climate change and how will these impact dusky shark migrations? Without additional information about these habitat factors, NMFS does not know enough to assume they are going to use these hot spots year after year.

d. There is no discussion about differences in the fishing depth between all of the fishing sets samples. This could impact the number of dusky sharks that are caught both inside and outside of the areas. However, it is possible this data is not collected by the PLL and reported in the HMS logbooks.

<u>Preferred Alternative B5 and B6 – Bottom Longline Effort Controls</u>

Alternative B5 proposes to modify the start/end date for the current Mid-Atlantic BLL time/area closure to allow North Carolina fishermen to begin fishing for sharks in state waters at the same time as fishermen in other states. This should have a negligible impact, positive or negative, on dusky shark fishing mortality rates.

Alternative B6 would modify the BLL shark research fishery with the intended goal of reducing dusky shark interactions by a minimum of 62%. During 2010, 8 vessels, out of 213 vessels with directed permits, caught 198 dusky sharks (100% observer coverage) in this fishery (Hale et al. 2011; NOAA 2012a). NMFS has listed several options that have a good possibility of reducing interactions but the degree of these reductions is unknown. The options include limiting soak times and/or the number of hooks deployed per set, additional time/area restrictions once dusky shark interactions have occurred (a similar technique is used in the NE to protect right whales) or instituting a dusky shark bycatch cap limit that would result in shutting down the fishery. It is difficult to evaluate the potential success of this Alternative in achieving at a minimum a 62% reduction in interactions because all NMFS has done is identify potential measures and present some preliminary data. NMFS must set forth in more detail the specific measures it plans to adopt for the BLL shark research fishery to substantiate its claim that the proposed measures will significantly reduce dusky shark mortality.

<u>Non-preferred Alternatives</u>

Alternative A4

This alternative included a closure of the recreational fishery once a pre-specified quota was reached. This may be a good addition to Alternative A3.

Alternative 2

This alternative would institute soak time restrictions in the BLL non-sandbar fishery. Placing a restriction on the total soak time (i.e., 8 hours) would be a good option. Research has suggested links between soak time and mortality rates for other species (Morgan and Carlson 2009).

Alternative 3

This alternative looked at hook restrictions in the BLL non-sandbar fishery, such as the type and amount used. Research should be conducted in this fishery to determine if these techniques would be beneficial.

Conclusion

The NMFS has been tasked with a difficult task of identifying management strategies to further protect dusky sharks, for which there is already a landings prohibition, and allow them to recover from an overfished state and rebuild. Preferred Alternatives A2, B5 and B6, and B3a-h will likely reduce fishing mortality of dusky sharks in the recreational, PLL, and BLL shark research fisheries to some extent; but there is no indication that these measures will result in a reductions of ~37% (the reduction necessary to reach F_{msy}, ending overfishing), 58% (the reduction necessary to rebuild the stock within the proposed timeline), or 62% (NMFS's stated reduction goal).

First, as the TACs and quotas NMFS proposes in Preferred Alternative A2 are aimed at rebuilding scalloped hammerhead and blacknose shark populations, they have not been evaluated to determine their impacts on dusky shark rebuilding. Given that they are set at or close to recent annual averages for targeted species, they will likely be ineffective at reducing, and will possibly increase, dusky shark bycatch, depending on the relationship between dusky shark bycatch and targeted species.

Second, NMFS fails to propose any specific measures to reduce fishing mortality in the BLL shark research fishery (Preferred Alternative B6), instead simply describing the available measures and stating that it plans to implement some of them to reduce dusky shark bycatch and bycatch mortality. NMFS must set forth in more detail the specific measures it plans to adopt for the BLL shark research fishery to substantiate its claim that it will reduce fishing mortality enough to provide a reasonable probability of ending overfishing, let alone rebuilding the dusky shark fishery.

Third, the accuracy of the assumptions made in Preferred Alternative B3a-h, namely those concerning the redistribution of fishing effort of the PLL fishery and lack of dusky shark movement into/out of the closed areas, are imperative in predicting the effectiveness of these closures at ending overfishing and rebuilding the fishery (Apostolaki et al. 2002). In my opinion, the assumptions are insufficiently documented and unwarranted and therefore mortality reductions resulting from the closed areas may fall significantly short of those projected by NMFS. More appropriate models should be used to verify these projections before the proposed time/area closures are put into place. Scientists have suggested more generally that time/area closures for highly migratory species are less useful than other management techniques (Hilborn et al. 2004) because these species can easily move into and out of protected areas. While some shark species that show high site fidelity can benefit from marine protected areas or reserves

(Garla et al. 2006; Chapman et al. 2009; Knip et al. 2012), this is likely not the case for dusky sharks. The time/area closures presented in Amendment 5 are quite small and it is very likely that a highly mobile species such as the dusky shark will move out of these closed areas into open areas. This has been identified as an issue for other species of sharks (Robbins et al. 2006; Knip et al. 2012). Some research has shown that fishers will remain on the outskirts of closures such as these (Murawski et al. 2005) and that the benefits of small closures are negated with highly migratory species (Powers and Abeare 2009). To similar effect, there is no information in draft Amendment 5 to support the assumption that dusky sharks will continue to use the proposed hot spots year after year in the same way they did (in aggregate) over the period from 2008 through 2010. Data from the Apex Predator Program supports the assumption that catch rates of dusky sharks in specific areas can vary significantly from year to year. Draft Amendment 5 does not indicate relative use of the areas in the individual years between 2008 and 2010, and, in any event, three years is too short a period to support long-term use patterns. Especially in the context of ongoing ecological shifts related to climate change, changes to water temperature, food availability, and other habitat factors in these hot spot closures over time are more than likely to influence use of the proposed hot spot areas by dusky sharks (and other species).

In the absence of additional information, NMFS's apparent determination that the proposed hot spot areas combined with Preferred Alternatives A2, B5 and B6 will together stop dusky sharks from being subject to overfishing and result in rebuilding is unreasonable.

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Morgan, A., Cooper, P., Curtis, T. and Burgess, G. 2009. An overview of the United States East Coast Bottom Longline Shark-Fishery, 1994-2003. Marine Fisheries Review 71:23-38

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National Atmospheric and Oceanic Administration (NOAA). 2012b. Predraft of Amendment 5 to the consolidated Atlantic highly migratory species fishery management plan: Highly Migratory Species Management Division, Office of Sustainable Fisheries, Washington, D.C. 71 p.

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Appendix B. Curriculum Vitae: Dr. Alexia Morgan

Alexia C. Morgan

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Belfast, ME 04915
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352-262-3368

Education:

University of Florida, Ph.D., Fisheries and Aquatic Sciences, December 2008

Dissertation: Effects of temporal closures and gear modifications on the population of dusky sharks in the northwestern Atlantic Ocean.

Nova Southeastern University, Oceanographic Center (FL), M.S., Marine Biology, December 2000

Thesis: Analysis of shark fisheries and management in the US Atlantic Ocean with recommendations for changes to current management plans.

Lake Forest College (IL), B.A., Biology, May 1997

The Mercersburg Academy (PA), Diploma, June 1993

Professional Experience:

Associate Research Faculty, Department of Marine Sciences, University of New England, Biddeford, Maine (June 2012-present): Ecosystem modeling of interactions between spiny dogfish and other marine taxa specific to the southern New England region; develop models to predict catches of spiny dogfish based on a variety of fishery specific factors.

Science Consultant, Omega Protein Inc. (December 2011-June 2012): Conduct statistical analyses of aerial and spotter plane survey data.

Science Consultant, Mickelson Barnet, P.C. (September 2011-August 2012): Scientific Advisor

Consultant, New England Aquarium, Boston, Massachusetts (April 2010-present): Enter and maintain information in a database dedicated to bycatch reduction techniques in commercial fisheries (www.bycatch.org).

Science Consultant, Pew Environment Group, Washington, D.C. (January 2010-present): Critical research, preparation and writing of documents relevant to the Global Shark and Tuna Campaigns goals. Attend Regional Fishery Management Organizations science meetings as a scientific advisor to the Global Shark and Tuna Campaigns.

Contractor, Blue Ocean Institute, East Norwich, New York (January 2009-present): Conduct species research and rankings that contribute to recommendations published in Blue Ocean Institute's Seafood Guide. Species research and ranking duties included: 1) research and interpretation of scientific literature, technical reports, fishery management plans, etc. 2) analysis of information according to internally established criteria for evaluating fisheries and aquaculture 3) writing reports based on research and ranking species using quantitative scoring system 4) edit following internal and external peer review and 5) communication with external reviewers.

Research Biologist, Florida Program for Shark Research, University of Florida (May 2005-December 2008): Responsible for development and oversight of research projects on large coastal sharks. Organized fishery independent trips with commercial fishing vessels in the bottom longline fishery, performed at sea data collection, biological sampling (for life history research), and deployment of PAT tags. Responsible for oversight of project budget and agency reports, obtained federal permits for sampling, development, data entry, editing and management of Microsoft Access database, statistical analysis, publication of work in peer-reviewed journals, submitting grant proposals, presenting research at scientific meetings and supervising employees at sea and in the laboratory.

Coordinator, Commercial Shark Fishery Observer Program (CSFOP), Florida Program for Shark Research, University of Florida (June 2002- April 2005): Coordinated the placement of fishery observers aboard commercial bottom longline fishing vessels. Developed and taught semi-annual training sessions in marine safety, data collection, and species identification. Oversaw development, data entry, management and quality control of the CSFOP Microsoft Access database, performed statistical analysis, interpretation and report writing for government, public and media sources. Standardized data collection and entry into Microsoft Access database. Oversaw development of bycatch picture database and developed bycatch ID cards for use by observers at sea. Developed at-sea data collection forms (species identification, vessel safety, biological data, fishery specific etc.) and protocols. Obtained federal permits for sampling, oversaw project budget ($300,000+), presented research at scientific meetings, supervised many employees, and student volunteers, taught "Project Shark Awareness" and performed administrative, personnel and other operations associated with the program.

Assistant, International Shark Attack File, Florida Program for Shark Research, University of Florida (December 2001- November 2007): Responsible for data entry, editing, management and development of the International Shark Attack File Microsoft Access database. Analysis of data for government, public and media sources; interviewed shark attack victims, supervised employees, student volunteers and Independent Study students and taught "Project Shark Awareness".

Fisheries observer (Commercial Shark Fishery Observer Program), Florida Program for Shark Research, University of Florida (December 2001-May 2002): Performed at sea data collection including: species identification, disposition, size and sex of target and by-catch species, while living aboard bottom long-line vessels for 2-6 days, data entry and editing in Access database.

Fisheries Observer (California drift gillnet), Frank Orth and Associates, Long Beach, CA (August 2001- November 2001): Performed at sea data collection on marine mammals, sea turtle and target species including: species identification, disposition, size, sex and biological sampling for life history studies on marine mammals, sea turtles, sharks, and billfish, while living aboard drift gillnet boats for 7-10 days.

Recreational Fisheries Interviewer, Quantech, various locations in ME (summer 2001): Interviewed recreational fishermen throughout mid-coast Maine, responsible for species identification and dock side data collection.

Sea Turtle Conservationist and Field Worker, Ft. Lauderdale, FL (1998-2000): Patrolled Broward County beaches for nesting sea turtles, responsible for relocating nests and safe release of hatchlings, data collection and educating the public on sea turtle protection issues.

Laboratory Assistant, Bimini, Bahamas (spring, 1998): Responsible for using gillnets and longline fishing gear to capture immature lemon sharks, removed tissue for genetic analysis, attached PIT tags and transmitters surgically to sharks, behavioral observations *in situ*, and acoustically tracked sharks.

Publications:

***Peer Reviewed Papers*:**

A. Morgan and G. Burgess. 2007. At-Vessel Fishing Mortality for Six Species of Sharks Caught in the Northwest Atlantic and Gulf of Mexico. Gulf and Caribbean Fisheries Research 19:123-131

A. Morgan, P. Cooper, T. Curtis and G. Burgess. 2009. An overview of the United States East Coast Bottom Longline Shark-Fishery, 1994-2003. Marine Fisheries Review 71:23-38

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A. Morgan, T. Ford, L. Siceloff, L. Hale, G. Burgess, M. Allen, J. Carlson. 2010. Temporal and spatial distribution of finfish bycatch in the U.S. Atlantic bottom longline shark fishery. Marine Fisheries Review 72:34-38

T. Storai, L. Zinzula, S. Repetto, M. Zuffa, A. Morgan and J. Mandelman. 2011. Bycatch of large elasmobranchs in the traditional tuna traps (tonnare) of Sardinia from 1990 to 2009. Fisheries Research 109:74-79

J.K. Carlson, L.F. Hale, A. Morgan and G. Burgess. 2012. Relative abundance and size of coastal sharks from the northwest Atlantic Ocean derived from commercial shark longline catch and effort data. Journal of Fish Biology 80:1749-1764

J.A. Sulikowski, B.K. Prohaska, A.E. Carlson, A.M. Cicia, C.T. Brown, and A.C. Morgan 2013. Observations of neonate spiny dogfish, *Squalus acanthias*, in southern New England: a first account of a potential pupping ground in the Northwestern Atlantic. Fisheries Research 137:59-62

***Book Chapters*:**

Fishery dependent sampling: total catch, effort and catch composition, pp. 182-200. In: Musick, J.A. and R. Bonfil (eds.), Elasmobranch Fisheries Management Techniques, APEC Fisheries Working Group, Singapore. (G.H. Burgess as co-author)

***Technical Reports and other publications*:**

2012

Sulikowski, J., Morgan, A., Carlson, A. and Butterworth, D. 2012. Inferences from aerial surveys on the abundance of Atlantic menhaden from outside the normal fishery range: implications for improved management of this resource. Atlantic States Marine Fisheries Commission, June 25, 2012.

2011

Cosandrey-Godin, A. and Morgan A. 2011. Fisheries bycatch of sharks: options for mitigation. Ocean Science Division, Pew Environment Group, Washington, DC. Online: http://www.pewenvironment.org/news-room/reports/fisheries-bycatch-of-sharks-options-for-mitigation-85899365907

Morgan, A. 2011. Fish aggregating devices (FADs) and tuna: Impacts and management options. Ocean Science Division, Pew Environment Group, Washington, DC.

2010

Conserving Atlantic bluefin tuna with spawning sanctuaries. Pew Science Brief, Pew Environment Group. Online: http://www.pewtrusts.org/our_work_detail.aspx?id=963

Morgan, A. 2010. Sharks-the state of the science. Ocean Science Division, Pew Environment Group. Online: http://www.pewtrusts.org/our_work_report_detail.aspx?id=59157&category=140

Carlson, J., Hale, L., Morgan, A. and Burgess, G. 2010. Standardized catch rates of sandbar, dusky and blacknose sharks from the commercial shark fishery longline observer program, 1994-2009. SEDAR21-DW-01. 37 p.

2008
G. Burgess and Morgan, A. 2008. The capture depth, time, and hooked survival rate for bottom longline caught large coastal sharks: Year 2 continuation. Semi-annual Report, U.S. National Marine Fisheries Service, Cooperative Research Program, 5 pp.

G. Burgess and Morgan, A. 2008. The capture depth, time, and hooked survival rate for bottom longline caught large coastal sharks: Year 2 continuation. Semi-annual Report, U.S. National Marine Fisheries Service, Cooperative Research Program, 10 pp.

G. Burgess and Morgan, A. 2008. The capture depth, time, and hooked survival rate for bottom longline caught large coastal sharks: Year 2. Final Report, U.S. National Marine Fisheries Service, Cooperative Research Program, 18 pp.

2007
G. Burgess and Morgan, A. 2007. The capture depth, time, and hooked survival rate for bottom longline caught large coastal sharks. Semi-annual Report, U.S. National Marine Fisheries Service, Cooperative Research Program, 12 pp.

G. Burgess and Morgan, A. 2007. The capture depth, time, and hooked survival rate for bottom longline caught large coastal sharks. Final Report, U.S. National Marine Fisheries Service, Cooperative Research Program, 23 pp.

G. Burgess and Morgan, A. 2007. The capture depth, time, and hooked survival rate for bottom longline caught large coastal sharks: Year 2 continuation. Semi-annual Report, U.S. National Marine Fisheries Service, Cooperative Research Program, 12 pp.

G. Burgess and Morgan, A. 2007. The capture depth, time, and hooked survival rate for bottom longline caught large coastal sharks: Year 2 continuation. Semi-annual Report, U.S. National Marine Fisheries Service, Cooperative Research Program, 10 pp.

2006
G. Burgess and Morgan, A. 2006. The capture depth, time, and hooked survival rate for bottom longline caught large coastal sharks. Semi-annual Report, U.S. National Marine Fisheries Service, Cooperative Research Program, 21 pp.

G. Burgess and Morgan, A. 2006. The capture depth, time, and hooked survival rate for bottom longline caught large coastal sharks. Semi-annual Report, U.S. National Marine Fisheries Service, Cooperative Research Program, 11 pp.

2005
G. Burgess and Morgan, A. 2005. The Commercial Shark Fishery Observer Program history: collection methodology and summary statistics 1994-2005(1). National Marine Fisheries Service Shark SEDAR Data Workshop Document LCS05/06-DW-10, 32 p.

E. Cortes, A. Morgan and G. Burgess 2005. Standardized catch rates of large coastal sharks from the Commercial Shark Fishery Observer Program 1994-2004. National Marine Fisheries Service Shark SEDAR Data Workshop Document LCS05/06-DW-17, 14 p. (with E. Cortes and G. H. Burgess)

G. Burgess and Morgan, A. 2005. Commercial Shark Fishery Observer Program. Monitoring the directed bottom longline shark fishery in the Atlantic Ocean and Gulf of Mexico off the mid- and southeastern United States, 2005 fishing season 1. Final Report, U.S. National Marine Fisheries Service, Highly Migratory Species Management Division Award NFFKF000-4-00009, 15 p.

G. Burgess and Morgan, A. 2005. Commercial Shark Fishery Observer Program. Continuation of monitoring the directed bottom longline shark fishery in the Atlantic Ocean and Gulf of Mexico of the mid-and southern United States. Final Report, U.S. National Marine Fisheries Service, Highly Migratory Species Management Division Award NA03NMF4540075, 15 p.

2004

G. Burgess and Morgan, A. 2004. Commercial Shark Fishery Observer Program. Support for an Observer Program Monitoring the Directed Commercial Shark Fishery in the Atlantic Ocean and Gulf of Mexico off the Mid- and Southeastern United States. Semiannual Report, U.S. National Marine Fisheries Service, Highly Migratory Species Management Division Award NA03NMF4540075, 2 p.

2003

G. Burgess and Morgan, A. 2003. Commercial Shark Fishery Observer Program. Renewal of an observer program to monitor the directed commercial shark fishery in the Gulf of Mexico and South Atlantic Semiannual Report: 2003(2) fishing season. Semiannual Report, U.S. National Marine Fisheries Service, Highly Migratory Species Management Division Award NA03NMF4540075, 11 p.

G. Burgess and Morgan, A. 2003. Commercial Shark Fishery Observer Program. Renewal of an observer program to monitor the directed commercial shark fishery in the Gulf of Mexico and South Atlantic: 2002(2) and 2003(1) fishing season. Final Report, U.S. National Marine Fisheries Service, Highly Migratory Species Management Division Award NA16FM1598, 15 p.

2002

G. Burgess and Morgan, A. 2002. Commercial Shark Fishery Observer Program. Support for an observer program monitoring the directed commercial shark fishery in the eastern Gulf of Mexico and Atlantic Ocean. Final Report, U.S. National Marine Fisheries Service, Highly Migratory Species Management Division Award NA06FM0194, 15 p. (with G.H. Burgess as co-author)

G. Burgess and Morgan, A. 2002. Commercial Shark Fishery Observer Program. Renewal of an observer program to monitor the directed commercial shark fishery in the Gulf of Mexico and South Atlantic: 1999 fishing seasons. Final Report, U.S. National Marine Fisheries Service, Highly Migratory Species Management Division Award NA97FF0041, 36 p.

Grants:

Commercial Fisheries Research Foundation – "Temporal aspects of habitat utilization and interspecies competition: defining the ecological impacts of spiny dogfish in structuring the ecosystem dynamics of Southern New England". Co-PI with James Sulikowski, 2010, $150,000

NMFS- Cooperative Research Program- "The capture depth, time and hooked survival rate for bottom longline caught coastal sharks: Year 2 Continuation". Co-PI with G. Burgess, 2006, $98,680

NMFS- Cooperative Research Program- "The capture depth, time and hooked survival rate for bottom longline caught coastal sharks: Co-PI with G.H. Burgess (FLMNH), 2005, $144,264

NMFS- Highly Migratory Species Management Division- "The Commercial Shark Fishery Observer Program: Monitoring the directed bottom longline shark fishery in the Atlantic Ocean and Gulf of Mexico off the Mid and Southeastern United States, 2005 fishing season". Co-PI with G.H. Burgess (FLMNH), 2005, $96,346

NMFS- Highly Migratory Species Management Division- "The Commercial Shark Fishery Observer Program: Continuation of monitoring the directed bottom longline shark fishery in the Atlantic Ocean and Gulf of Mexico off the Mid and Southeastern United States". Co-PI with George Burgess (FLMNH), 2004, $319,090

Oral Presentations:

American Elasmobranch Society, St. Louis Missouri, 2007. “Regional variation in non-targeted bycatch composition in the U.S. Atlantic bottom longline shark fishery”

Gulf and Caribbean Fisheries Institute, Belize City, Belize, 2006. “At-Vessel Fishing Mortality for Six Species of Sharks Caught in the Northwest Atlantic and Gulf of Mexico”.

American Elasmobranch Society, New Orleans, LA, 2006: “The capture depth, time and hooked survival rate for bottom longline caught sharks”

American Elasmobranch Society, Norman Oklahoma, 2004: “Monitoring the east coast bottom longline fishery through the Commercial Shark Fishery Observer Program”

International Observer Conference, Sydney Australia, 2004: “The Commercial Shark Fishery Observer Program: How observers balance data collection, compliance monitoring and promoting the worth of observer programs in commercial fisheries”

International Observer Conference, New Orleans LA, 2002: “The Commercial Shark Fishery Observer Program

Poster Presentations:

American Elasmobranch Society, Tampa Florida, 2005: “Regional bycatch composition of the commercial shark bottom longline fishery of the southeastern United States”

American Elasmobranch Society, Tampa Florida, 2005: “Geographical and temporal variation in length distributions of three species of shark taken in the bottom longline fishery off the southeastern United States”

American Elasmobranch Society, Norman Oklahoma, 2004: “At vessel mortality of large and small coastal sharks in the US Atlantic bottom longline fishery”

Invited Workshops and Scientific Meetings:

Inter-American Tropical Tuan Commission (IATTC) – 2nd Meeting of the Scientific Advisory Committee, 2nd Technical Meeting on Sharks

International Commission for the Conservation of Atlantic Tunas (ICCAT) – 2010, 2011 and 2012 Species Working Group Meeting, 2010 and 2011 Meeting of the Standing Committee on Research and Statistics, and 2011 Sharks data preparatory meeting to apply Ecological Risk Analysis

Highly Migratory Species (HMS) Southeast Data, Assessment, and Review (SEDAR) Pool member (March 2010-March 2013)

SEDAR Large Coastal Shark Data Workshop, NMFS Panama City, November 2005

Observer Safety Training Workshop, Galveston, Texas, January 2004

IUCN Shark Specialist Group - North American Meeting- Mote Marine Laboratory, June 2004

Small Boats Workshop, Seattle, Washington, March 2003

Grants, Journals and Book Reviews:

Charles Sobczak. 2007. Alligators, sharks & panthers. Indigo Press, Sanibel, FL
Richard M. Gaines. 2006. When Sharks Attack. Enslow Publishers inc., Berkeley Heights, NJ
Mary L. Peaching. 2003. The Complete Idiots Guide to Sharks. Alpha Books, Indianapolis, IN

Saltonstall-Kennedy Grant Program
Marine Fisheries Review
Aquatic Living Resources
Fisheries Research

Training, Certificates and Membership etc.:

SEDAR Pool
National Honors Society
American Elamobranch Society, AES
Marine Safety Drill Instructor
AMSEA marine safety trainer
Fluent German

References (available upon request)