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DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration

[Docket No. 130213133-4463-02]

RIN 0648-XC508

Endangered and Threatened Wildlife and Plants; Notice of 12-Month Finding on Petitions to List the Great Hammerhead Shark as Threatened or Endangered Under the Endangered Species Act (ESA)

AGENCY: National Marine Fisheries Service (NMFS), National Oceanic and Atmospheric Administration (NOAA), Commerce.

ACTION: Notice of 12-month finding and availability of status review document.

SUMMARY: We, NMFS, announce a 12-month finding on two petitions to list the entire population of great hammerhead shark (Sphyrna mokarran), the northwest Atlantic population, or any distinct population segments (DPSs) of great hammerhead sharks, as threatened or endangered under the Endangered Species Act (ESA). We have completed a comprehensive status review of the great hammerhead shark in response to these petitions. Based on the best scientific and commercial information available, including the status review report (Miller et al., 2014), we have determined that the species is not comprised of DPSs and does not warrant listing at this time. We conclude that the great hammerhead shark is not currently in danger of extinction throughout all or a significant portion of its range and is not likely to become so within the foreseeable future.

DATES: This finding was made on [INSERT DATE OF PUBLICATION IN THE FEDERAL

REGISTER].

ADDRESSES: The status review document for the great hammerhead shark is available electronically at: http://www.nmfs.noaa.gov/pr/species/fish/greathammerheadshark.htm. You may also receive a copy by submitting a request to the Office of Protected Resources, NMFS, 1315 East-West Highway, Silver Spring, MD 20910, Attention: Great Hammerhead Shark 12-month Finding.

FOR FURTHER INFORMATION CONTACT: Maggie Miller, NMFS, Office of Protected Resources, (301) 427-8403.

SUPPLEMENTARY INFORMATION:

Background

On December 21, 2012, we received a petition from WildEarth Guardians (WEG) to list the great hammerhead shark (Sphyrna mokarran) as threatened or endangered under the ESA throughout its entire range, or, as an alternative, to list any identified DPSs as threatened or endangered. The petitioners also requested that critical habitat be designated for the great hammerhead under the ESA. On March 19, 2013, we received a second petition from Natural Resources Defense Council (NRDC) to list the northwest Atlantic DPS of great hammerhead shark as threatened, or, as an alternative, to list the great hammerhead shark range-wide as threatened, and to designate critical habitat. On April 26, 2013, we published a positive 90-day finding (78 FR 24701), announcing that the petitions presented substantial scientific or commercial information indicating the petitioned action of listing the species may be warranted and explained the basis for that finding. We also announced the initiation of a status review of the species, as required by Section 4(b)(3)(a) of the ESA, and requested information to inform the agency's decision on whether the species warranted listing as endangered or threatened under the ESA.

Listing Species Under the Endangered Species Act

We are responsible for determining whether great hammerhead sharks are threatened or endangered under the ESA (16 U.S.C. 1531 et seq.). To make this determination, we first consider whether a group of organisms constitutes a "species" under Section 3 of the ESA, then whether the status of the species qualifies it for listing as either threatened or endangered. Section 3 of the ESA defines species to include "any subspecies of fish or wildlife or plants, and any distinct population segment of any species of vertebrate fish or wildlife which interbreeds when mature." On February 7, 1996, NMFS and the U.S. Fish and Wildlife Service (USFWS; together, the Services) adopted a policy describing what constitutes a DPS of a taxonomic species (61 FR 4722). The joint DPS policy identified two elements that must be considered when identifying a DPS: (1) the discreteness of the population segment in relation to the remainder of the species (or subspecies) to which it belongs; and (2) the significance of the population segment to the remainder of the species (or subspecies) to which it belongs.

Section 3 of the ESA defines an endangered species as "any species which is in danger of extinction throughout all or a significant portion of its range" and a threatened species as one "which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range." Thus, in the context of the ESA, the Services interpret an "endangered species" to be one that is presently at risk of extinction. A "threatened species" is not currently at risk of extinction, but is likely to become so in the foreseeable future. The key statutory difference between a threatened and endangered species is the timing of when a species may be in danger of extinction, either now (endangered) or in the foreseeable future (threatened).

The statute also requires us to determine whether any species is endangered or threatened as a result of any one or a combination of the following five 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; or other natural or manmade factors affecting its continued existence (ESA, section 4(a)(1)(A)-(E)). Section 4(b)(1)(A) of the ESA requires us to make listing determinations based solely on the best scientific and commercial data available after conducting a review of the status of the species and after taking into account efforts being made by any State or foreign nation or political subdivision thereof to protect the species. In evaluating the efficacy of existing protective efforts, we rely on the Services' joint Policy on Evaluation of Conservation Efforts When Making Listing Decisions ("PECE"; 68 FR 15100; March 28, 2003). The PECE provides direction for considering conservation efforts that have not been implemented, or have been implemented but not yet demonstrated effectiveness.

Status Review

We convened a team of agency scientists to conduct the status review for the species and prepare a report. The status review report of the great hammerhead shark (Miller et al., 2014) compiles the best available information on the status of the great hammerhead shark as required by the ESA, provides an evaluation of the discreteness and significance of populations in terms of the DPS policy, and assesses the current and future extinction risk for the great hammerhead shark, focusing primarily on threats related to the five statutory factors set forth above. We appointed a contractor in the Office of Protected Resources Endangered Species Division to undertake a scientific review of the life history and ecology, distribution, abundance, and threats to the great hammerhead shark. Next, we convened a team of biologists and shark experts (hereinafter referred to as the Extinction Risk Analysis (ERA) team) to conduct an extinction risk analysis for the great hammerhead shark, using the information in the scientific review. The ERA team was comprised of a fishery management specialist from NMFS' Highly Migratory Species Management Division, two research fishery biologists from NMFS' Southeast Fisheries Science Center and Pacific Island Fisheries Science Center, and a fishery biologist contractor with NMFS' Office of Protected Resources. The ERA team had group expertise in shark biology and ecology, population dynamics, highly migratory species management, and stock assessment science. The status review report presents the ERA team's professional judgment of the extinction risk facing the great hammerhead shark but makes no recommendation as to the listing status of the species. The status review report is available electronically at http://www.nmfs.noaa.gov/pr/species/fish/greathammerheadshark.htm.

The status review report was subjected to independent peer review as required by the Office of Management and Budget Final Information Quality Bulletin for Peer Review (M-05-03; December 16, 2004). The status review report was peer reviewed by three independent specialists selected from the academic and scientific community, with expertise in shark biology, conservation and management, and knowledge of great hammerhead sharks. The peer reviewers were asked to evaluate the adequacy, appropriateness, and application of data used in the status review as well to evaluate the findings made in the "Assessment of Extinction Risk" section of the report. All peer reviewer comments were addressed prior to dissemination of the final status review report and publication of this determination.

We subsequently reviewed the status review report, its cited references, and peer review comments, and believe the status review report, upon which this 12-month finding is based, provides the best available scientific and commercial information on the great hammerhead shark. Much of the information discussed below on great hammerhead shark biology, distribution, abundance, threats, and extinction risk is attributable to the status review report. However, in making the 12-month finding determination, we have independently applied the statutory provisions of the ESA, including evaluation of the factors set forth in Section 4(a)(1)(A)-(E); our regulations regarding listing determinations; and our DPS policy.

Life History, Biology, and Status of the Petitioned Species

Taxonomy and Species Description

All hammerhead sharks belong to the family Sphyrnidae and are classified as ground sharks (Order Carcharhiniformes). Most hammerhead sharks belong to the Genus Sphyrna with one exception, the winghead shark (E. blochii), which is the sole species in the Genus Eusphyra. The hammerhead sharks are recognized by their laterally expanded head that resembles a hammer, hence the common name "hammerhead." The great hammerhead shark (Sphyrna mokarran) is the largest of the hammerhead shark species and is distinguished from other hammerhead sharks by a nearly straight anterior margin of the head and median indentation in the center in adults. The shark has strongly serrated teeth, strongly falcate first dorsal and pelvic fins, and a high second dorsal fin with a concave rear margin (Compagno, 1984; Bester, n.d.). The body of the great hammerhead shark is fusiform, with the dorsal side colored dark brown to light grey or olive that shades to white on the ventral side (Compagno, 1984; Bester, n.d.). Fins of adult great hammerhead sharks are uniform in color, whereas the tip of the second dorsal fin of juveniles may appear dusky (Bester, n.d.).

Current Distribution

The great hammerhead shark is a circumtropical species that lives in coastal-pelagic and semi-oceanic waters from latitudes of 40° N to 31° S (Compagno, 1984; Stevens and Lyle, 1989; Cliff, 1995; Denham et al., 2007). It occurs over continental shelves as well as adjacent deep waters, and may also be found in coral reefs and lagoons (Compagno, 1984; Denham et al., 2007; Bester, n.d.).

Movement and Habitat Use

Great hammerhead sharks are generally solitary and highly mobile (Compagno, 1984; Cliff, 1995; Denham et al., 2007; Hammerschlag et al., 2011; Bester, n.d.). In a review of shark tagging studies, Kohler and Turner (2001) examined three studies that looked at migrations of great hammerhead sharks (n = 220) and found maximum distance travelled to be 1,180 km and a maximum time at liberty of 4 years. A more recent study tracked a great hammerhead shark migrating an even greater distance, with a minimum distance of 1,200 km in 62 days, as it appeared to follow the Gulf Stream Current from the Florida Keys to 500 km off the coast of New Jersey (Hammerschlag et al., 2011). Some great hammerhead shark populations are thought to make poleward migrations following warm water currents, such as those found off Florida's coast (Heithaus et al., 2007; Hammerschlag et al., 2011), while others are thought to be residential populations with only seasonal incursions into cooler waters due to range expansions (not true migrations) (Taniuchi, 1974; Stevens and Lyle, 1989; Cliff, 1995).

Diet

The great hammerhead shark is a high trophic level predator (trophic level = 4.3; Cortés,

1999) and opportunistic feeder with a diet that includes a wide variety of teleosts, cephalopods, and crustaceans, with a preference for stingrays and other batoids (Compagno, 1984; Strong et al., 1990; Denham et al., 2007). Sphyrna mokarran has been observed to use its uniquely shaped head, or 'cephalofoil,' to pin down and prey upon stingrays. This type of prey handling may be unique to this species, but very few observations of predation events of great hammerhead sharks or other Sphyrnidae have been made (Strong et al., 1990; Chapman and Gruber, 2002). Stomach analysis of S. mokarran suggests that the species primarily feeds at or near the seafloor (Stevens and Lyle, 1989; Cliff, 1995; Bester, n.d.).

Reproduction

Compared to the other hammerhead species, Sphyrna mokarran has a faster growth rate and thus matures at an earlier age, between 5 and 8.9 years (Piercy et al., 2010; Harry et al., 2011a; Piercy and Carlson, unpublished data). In terms of size, females attain maturity generally around 210-300 cm total length (TL) while males reach maturity at smaller sizes (generally around 187 – 269 cm TL) (see Table 1 in Miller et al., 2014). Female great hammerhead sharks are viviparous (i.e., give birth to live young) with a yolk-sac placenta and breed only once every 2 years (Stevens and Lyle, 1989), with a gestation period of 10-11 months (Stevens and Lyle, 1989; Bester, n.d.). In terms of size, females attain maturity generally around 210-230 cm (TL at 50 percent maturity – L50) while males reach maturity at smaller sizes (L50 estimated around 187 – 230 cm TL). Litter sizes range from 6 to 42 pups, with size at birth estimated at 500-700 mm TL. Parturition occurs in the late spring or summer in the northern hemisphere (Ebert and Stehman, 2013). In the southern hemisphere, birthing occurs between October and November off eastern Australia, and between December and January off northern Australia (Stevens and

Lyle, 1989; Harry et al., 2011a). Although young of the year and juveniles may occasionally be found utilizing shallow inshore and coastal waters, nursery areas have yet to be identified for this species and it is thought that pupping occurs farther offshore (Hueter and Tyminski, 2007; Harry et al., 2011a).

Size and Growth

The great hammerhead shark can reach lengths of over 610 cm TL (Compagno, 1984); however, individuals greater than 400 cm TL are rare (Stevens and Lyle, 1989). Piercy et al. (2010) estimated the oldest female and male great hammerhead sharks to be 44 and 42 years, respectively, with corresponding lengths of 398 cm TL (female) and 379 cm TL (male). Passerotti et al. (2010) aged two male great hammerhead sharks using bomb radiocarbon aging methods, and found the sharks to be 42 years old (corresponding to 391 cm TL) and 36 years old (corresponding to 360 cm TL). Male great hammerhead sharks are thought to grow faster than females (with a growth coefficient, k, of 0.16/year for males and 0.11/year for females) but reach a smaller asymptotic size (335 cm TL for males versus 389 cm TL for females). Using life history parameters from the northwest Atlantic Ocean, Cortés (unpublished) estimated productivity of the great hammerhead shark, determined as intrinsic rate of population increase (r), to be 0.096 $year^{-1}$ (median) within a range of 0.078-0.116 (80 percent percentiles).

Although there are very few age/growth studies for great hammerhead sharks, the available data indicate that great hammerhead sharks are a long-lived species (at least 20 – 30 years) and can be characterized as having rather low productivity (based on the Food and Agriculture Organization of the United Nations (FAO) productivity indices for exploited fish species, where $r < 0.14$ is considered low productivity), making them generally vulnerable to depletion and potentially slow to recover from overexploitation.

Current Status

Great hammerhead sharks can be found worldwide, with no present indication of a range contraction. Although rare and generally not targeted, they may be caught in many global fisheries including bottom and pelagic longline tuna and swordfish fisheries, purse seine fisheries, coastal gillnet fisheries, and artisanal fisheries. Due to their large fins with high fin needle content (a gelatinous product used to make shark fin soup), they are valuable as incidental catch for the international shark fin trade (Abercrombie et al., 2005; Clarke et al., 2006a). To a much lesser extent, hammerhead sharks are utilized for their meat, with Colombia, Japan, Kenya, Mexico, Mozambique, Philippines, Seychelles, Spain, Sri Lanka, China (Taiwan), Tanzania, Trinidad and Tobago, Uruguay, and Venezuela identified as countries that consume hammerhead meat (Vannuccini, 1999; CITES, 2010; F. Arocha, personal communication).

In 2007, the International Union for Conservation of Nature (IUCN) considered the great hammerhead shark to be endangered globally, based on an assessment by Denham et al. (2007) and its own criteria (A2bd and 4bd), and placed the species on its "Red List." Under criteria A2bd and 4bd, a species may be classified as endangered when its "observed, estimated, inferred or suspected" population size is reduced by 50 percent or more over the last 10 years, any 10 year time period, or three generation period, whichever is the longer, and where the causes of reduction may not have ceased, be understood, or be reversible based on an index of abundance appropriate to the taxon and/or the actual or potential levels of exploitation. IUCN justification for the categorization is based on suspected declines due to the lack of available species-specific data. IUCN notes that the species vulnerability to depletion, low survival at capture, high value for the fin trade, regional recognition of declines, and absence of recent records gives cause to suspect that the population has decreased by over 50 percent and meets the criteria for Endangered globally. The prior IUCN assessment of the species in 2000 categorized the great hammerhead shark as “data deficient.” As a note, the IUCN classification for the great hammerhead shark alone does not provide the rationale for a listing recommendation under the ESA, but the sources of information that the classification is based upon are evaluated in light of the standards on extinction risk and impacts or threats to the species.

Distinct Population Segment Analysis

As described above, the ESA’s definition of “species” includes “any subspecies of fish or wildlife or plants, and any distinct population segment of any species of vertebrate fish or wildlife which interbreeds when mature.” The ERA team was asked to evaluate whether any population of great hammerhead shark qualifies as a DPS based on the elements of discreteness and significance as defined in the DPS policy. According to the ERA team, the best available information does not indicate that any population segment of the great hammerhead shark would qualify as a DPS under the DPS policy because there was no population segment that met the policy’s “discreteness” criterion. There is very little available information regarding discreteness based on genetic differences. The ERA team reviewed an abstract (Testerman and Shivji, 2013) but was not provided access to any further information or details regarding the results presented in the abstract (due to pending publication for a student’s thesis). Although the abstract made mention of possible genetic partitioning between and within oceanic basins, this was a general statement and no further information was provided on the specific geographic patterns of this genetic structure. Therefore, we could not use this abstract to identify discrete great hammerhead populations based on genetic differences. The ERA team also examined a study by Naylor et al. (2012) that suggested that there are two distinct clusters of great hammerhead sharks: one comprised of great hammerhead sharks from the Atlantic, and a second comprised of great hammerhead sharks from Australia and Borneo. However, as the ERA team points out, the analysis was based on 22 specimens from 4 locations, with only 6 of the samples collected outside of the Atlantic Ocean (Naylor et al., 2012). Given that the species has a global distribution and the sample size was small and only from a limited number of locations, we agreed with the ERA team that this does not provide sufficient evidence of discreteness based on genetic differences. The ERA team also evaluated the information in the petitions regarding DPSs but did not find evidence that would support discreteness based on genetic, geographical, or regulatory differences (Miller et al., 2014). We reviewed the ERA team's analysis and agree with its findings.

As stated in the joint DPS policy, Congress expressed its expectation that the Services would exercise authority with regard to DPSs sparingly and only when the biological evidence indicates such action is warranted. Based on our evaluation of the best available scientific information, we do not find biological evidence that would indicate that any population segment of the great hammerhead shark would qualify as a DPS under the DPS policy.

Assessment of Extinction Risk

The ESA (Section 3) defines endangered species as "any species which is in danger of extinction throughout all or a significant portion of its range." Threatened species are "any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range." Neither we nor the USFWS have developed any formal policy guidance about how to interpret the definitions of threatened and endangered. We consider a variety of information and apply professional judgment in evaluating the level of risk faced by a species in deciding whether the species is threatened or endangered. We evaluate both demographic risks, such as low abundance and productivity, and threats to the species including those related to the factors specified by the ESA Section 4(a)(1)(A)-(E).

Methods

As we have explained, we convened an ERA team to evaluate extinction risk to the species. This section discusses the methods used to evaluate threats and the overall extinction risk to the species. As explained further down in this notice, we have separately taken into account other conservation efforts which have the potential to reduce threats identified by the ERA team.

For purposes of the risk assessment, an ERA team comprised of fishery biologists and shark experts was convened to review the best available information on the species and evaluate the overall risk of extinction facing the great hammerhead shark now and in the foreseeable future. The term "foreseeable future" was defined as the timeframe over which threats could be reliably predicted to impact the biological status of the species. After considering the life history of the great hammerhead shark, availability of data, and type of threats, the ERA team decided that the foreseeable future should be defined as approximately 3 generation times for the great hammerhead shark, or 50 years. (A generation time is defined as the time it takes, on average, for a sexually mature female great hammerhead shark to be replaced by offspring with the same spawning capacity). This timeframe (3 generation times) takes into account the time necessary to provide for the conservation and recovery of the species. As a late-maturing species, with slow growth rate and low productivity, it would likely take more than a generation time for any conservative management action to be realized and reflected in population abundance indices.

In addition, the foreseeable future timeframe is also a function of the reliability of available data regarding the identified threats and extends only as far as the data allow for making reasonable predictions about the species' response to those threats. Since the main threats to the species were identified as fisheries and inadequacy of existing regulatory measures that manage these fisheries, the ERA team felt that they had the background knowledge in fisheries management and expertise to confidently predict the impact of these threats on the biological status of the species within this timeframe.

Often the ability to measure or document risk factors is limited, and information is not quantitative or very often lacking altogether. Therefore, in assessing risk, it is important to include both qualitative and quantitative information. In previous NMFS status reviews, Biological Review Teams and ERA teams have used a risk matrix method to organize and summarize the professional judgment of a panel of knowledgeable scientists. This approach is described in detail by Wainright and Kope (1999) and has been used in Pacific salmonid status reviews as well as in the status reviews of many other species (see http://www.nmfs.noaa.gov/pr/species/ for links to these reviews). In the risk matrix approach, the collective condition of individual populations is summarized at the species level according to four demographic risk criteria: abundance, growth rate/productivity, spatial structure/connectivity, and diversity. These viability criteria, outlined in McElhany et al. (2000), reflect concepts that are well-founded in conservation biology and that individually and collectively provide strong indicators of extinction risk.

Using these concepts, the ERA team estimated demographic risks by assigning a risk score to each of the four demographic criteria. The scoring for the demographic risk criteria correspond to the following values: 1 – no or low risk, 2 – moderate risk, and 3 – high risk. Detailed definitions of the risk scores can be found in the status review report.

The ERA team also performed a threats assessment for the great hammerhead shark by ranking the effect that the threat was currently having on the extinction risk of the species. The levels ranged from "no effect on extinction risk" to "significant effect" and included an "unknown" category for instances when there was not enough information to determine the effect (if any) that the treat was having on the species' extinction risk. The ERA team adopted the "likelihood point" (FEMAT) method for ranking the threat effect levels to allow individuals to express uncertainty. For this approach, each team member distributed 10 'likelihood points' among the threat effect levels. This approach has been used in previous NMFS status reviews (e.g., Pacific salmon, Southern Resident killer whale, Puget Sound rockfish, Pacific herring, and black abalone) to structure the team's thinking and express levels of uncertainty when assigning risk categories. The scores were then tallied (mode, median, range) and summarized for each threat, and considered in making the overall risk determination.

Guided by the results from the demographics risk analysis as well as the threats assessment, the ERA team members were asked to use their informed professional judgment to make an overall extinction risk determination for the great hammerhead shark now and in the foreseeable future. For this analysis, the ERA team defined five levels of extinction risk: 1 – no or very low risk, 2 – low risk, 3 – moderate risk, 4 – high risk, and 5 – very high risk. Detailed definitions of these risk levels can be found in the status review report. Again, the ERA team adopted the FEMAT method, distributing 10 ‘likelihood points’ among the five levels of extinction risk. Although this process helps to integrate and summarize a large amount of diverse information, there is no simple way to translate the risk matrix scores directly into a determination of overall extinction risk. Other descriptive statistics, such as mean, variance, and standard deviation, were not calculated as the ERA team felt these metrics would add artificial precision or accuracy to the results. The scores were then tallied (mode, median, range) and summarized.

Finally, the ERA team did not make recommendations as to whether the species should be listed as threatened or endangered. Rather, the ERA team drew scientific conclusions about the overall risk of extinction faced by the great hammerhead shark under present conditions and in the foreseeable future based on an evaluation of the species’ demographic risks and assessment of threats.

Evaluation of Demographic Risks

Abundance

There is currently a lack of reliable estimates of population size for the great hammerhead shark, with most of the available information indicating that the species is naturally low in abundance. Great hammerhead sharks are rarely recorded in fisheries data but are thought to have experienced possible localized population declines over the past few decades (Dudley and Simpfendorder, 2006; Diop and Dossa, 2011; Dia et al., 2012). Given the lack of data, however, the extent of the decline and the current status of the global population are unclear.

Unlike the scalloped hammerhead shark stock in the northwest Atlantic Ocean, we have not yet conducted (or accepted) a stock assessment on the great hammerhead shark population.

The ERA team reviewed two species-specific stock assessments for the northwest Atlantic population of great hammerhead sharks by Hayes (2008) and Jiao et al. (2011), but found that these studies had high degrees of uncertainty. Both assessments found significant catches in the early 1980s, over two orders of magnitude larger than the smallest catches, but Hayes (2008) suggested that these large catches, which correspond mostly to the NMFS Marine Recreational Fishery Statistics Survey (MRFSS), are likely overestimated. Hayes (2008) also identified other data deficiencies that added to the uncertainty surrounding these catch estimates including: misreporting of the species, particularly in recreational fisheries, leading to overestimates of catches; underreporting of commercial catches in early years; and unavailable discard estimates for the U.S. pelagic longline fishery for the period of 1982-1986. In terms of abundance trends, the Hayes (2008) stock assessment found the models to have wide confidence intervals and be highly sensitive to the inclusion or exclusion of relative abundance indices, with depletion estimates ranging from 57 to 96 percent.

The Jiao et al. (2011) stock assessment, which used a more complex Bayesian hierarchical surplus production model, examined the likelihood of overfishing of the great hammerhead shark and found that after 2001, the risk of overfishing of great hammerhead sharks was very low. However, similar to the Hayes (2008) caveats, Jiao et al. (2011) warned that the results should be viewed as illustrative rather than as conclusive evidence of the present status of great hammerhead sharks. Due to the significant uncertainty surrounding the results from these stock assessment models, neither we, nor the ERA team, could confidently draw conclusions regarding the demographic risk to the great hammerhead shark from current abundance levels.

In addition to these stock assessment studies, the ERA team examined more recent abundance data from the U.S. commercial bottom longline (BLL) fishery, the NMFS Mississippi BLL survey, and the Mote Marine Laboratory gillnet survey (see Miller et al., 2014). Using a generalized linear modeling (GLM) approach, a relative abundance index for great hammerhead sharks was derived using observer data (from 1994 to 2011) from the U.S. commercial BLL fishery operating in the Atlantic Ocean and Gulf of Mexico (Carlson et al., 2012; Carlson, unpublished). Trends in abundance indicated a nine percent increase over the length of the time series. However, data from the NMFS Mississippi Laboratory fishery independent BLL survey indicated no clear trend, likely owing to the low number of observations in the data series (Adam Pollock, personal communication). The abundance of juvenile great hammerhead sharks captured in an inshore fishery independent survey conducted by Mote Marine Laboratory from 1995 to 2004 showed a slight decline over the time series.

In other areas of the great hammerhead shark range, specific abundance data are absent, rare, or presented as a hammerhead complex. Only one study, off the coast of South Africa, provided a substantial time-series analysis of fishery-independent data specific to great hammerhead sharks (Dudley and Simpfendorfer, 2006). The study, which used data collected by the KwaZulu-Natal beach protection program, showed that catch per unit effort (CPUE) of S. mokarran in beach protection nets decreased by 90 percent from 1978 to 2003. Most of the other scientific information that we and the ERA team reviewed presented data on other species of hammerheads or the entire hammerhead complex (see Miller et al., 2014). However, as the ERA notes, to use a hammerhead complex or other hammerhead species as a proxy for great hammerhead abundance is erroneous because of the large difference in the proportions they make up in commercial and artisanal catch. Usually great hammerhead sharks comprise < 10 percent of the sphyrnid catch (Amorim et al., 1998; Castillo-Geniz et al., 1998; Román Verdesoto and Orozco-Zöller, 2005; Dudley and Simpfendorfer, 2006; White et al., 2008; Doukakis et al., 2011; Robinson and Sauer, 2011; Dia et al., 2012). Although higher great hammerhead proportions have been identified in a few other fisheries datasets (like the Venezuelan longline fleet bycatch data – 47 percent, Arocha et al., 2002; observed U.S. BLL catch – 32 percent from 1994-2011, Carlson, personal communication; and Australia's observed Northern Territory Offshore Net and Line bycatch – 34 percent; Field et al., 2013), the majority of the sphyrnid catch remains dominated by the scalloped hammerhead shark, a hammerhead species whose greater abundance and schooling behavior makes it more susceptible to being caught in large numbers by fishing gear.

Based on the very limited abundance information available, from both fishery-independent and -dependent surveys, and its general rarity in fisheries catch, the ERA team concluded that the great hammerhead shark has likely declined from historical numbers as a result of fishing mortality but is also naturally low in abundance. The ERA team was concerned that the species' low abundance levels may pose a risk to its continued existence if faced with other demographic risks or threats. However, at present, there is no evidence to suggest that the species is at a risk of extinction due to environmental variation, anthropogenic perturbations, or depensatory processes based on its current abundance levels.

Growth rate/productivity

Similar to abundance, the ERA team expressed some concern (through its voting score of moderate risk) regarding the effect of the great hammerhead shark's growth rate and productivity on its risk of extinction. Sharks, in general, have lower reproductive and growth rates compared to bony fishes; however, great hammerhead sharks exhibit life-history traits and population parameters that are intermediary among other shark species. Productivity, determined as intrinsic rate of population increase, has been estimated at 0.096 per year (median) within a range of 0.078-0.116 (80 percent percentiles) (Cortés, unpublished). These demographic parameters place great hammerhead sharks towards the moderate to faster growing sharks along a "fast-slow" continuum of population parameters that have been calculated for 38 species of sharks by Cortés (2002, Appendix 2). However, primarily based on the fact that most species of elasmobranchs take many years to mature, and have relatively low fecundity compared to teleosts, these life history characteristics could pose a risk to this species in combination with threats that reduce its abundance.

Spatial structure/connectivity

The ERA team did not see habitat structure or connectivity as a potential risk to this species. Habitat characteristics that are important to this species are unknown, as are nursery areas. The sharks inhabit a range of environments with varying complexity (from coral reefs and lagoons to coastal waters over continental shelves and adjacent deep waters). The species is also highly mobile (with tracked distances of up to 1,200 km) with no data to suggest it is restricted to any specific coastal area. There is no evidence of female philopatry and there is little known about specific migration routes. As previously mentioned, some great hammerhead shark populations are thought to make poleward migrations following warm water currents (Heithaus et al., 2007; Hammerschlag et al., 2011), while others are thought to be residential populations (Taniuchi, 1974; Stevens and Lyle 1989; Cliff, 1995). It is also unknown if there are source-sink dynamics at work that may affect population growth or species' decline. Thus, there seems to be insufficient information that would support the conclusion that spatial structure and connectivity pose significant risks to this species. As such, the ERA team viewed these demographic factors as having no or very low risk, meaning that they are unlikely to pose a significant risk to the species' continued existence.

Diversity

There is no evidence that the species is at risk due to a substantial change or loss of variation in genetic characteristics or gene flow among populations. This species is found in a broad range of habitats and appears to be well-adapted and opportunistic. There are no restrictions to the species' ability to disperse and contribute to gene flow throughout its range, nor is there evidence of a substantial change or loss of variation in life-history traits, population demography, morphology, behavior, or genetic characteristics. Based on this information, the ERA team concluded, and we agree, that diversity is unlikely to pose a significant risk to the species' continued existence.

Summary of Factors Affecting the Great Hammerhead Shark

As described above, section 4(a)(1) of the ESA and NMFS implementing regulations (50 CFR 424) state that we must determine whether a species is endangered or threatened because of any one or a combination of the following 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; inadequacy of existing regulatory mechanisms; or other natural or man-made factors affecting its continued existence. The ERA team evaluated whether and the extent to which each of the foregoing factors contributed to the overall extinction risk of the global great hammerhead population. This section briefly summarizes the ERA team's findings and our conclusions regarding threats to the great hammerhead shark. More details can be found in the status review report (Miller et al., 2014).

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

The ERA team evaluated habitat destruction as a potential threat to the great hammerhead shark, but did not find evidence to suggest that it is presently contributing significantly to its risk of extinction. Currently, great hammerhead sharks are found worldwide, residing in coastal warm temperate and tropical seas, from latitudes of 40°N to 31°S (Compagno, 1984; Stevens and Lyle, 1989; Cliff, 1995; Denham et al., 2007). They occur over continental shelves as well as adjacent deep waters, and may also be found in coral reefs and lagoons (Compagno, 1984; Denham et al., 2007; Bester, n.d.). Great hammerhead sharks appear to prefer water temperatures above 20° C (Cliff, 1995; Taniuchi, 1974; Hueter and Manire, 1994); however, little else is known regarding specific habitat preferences or characteristics.

In the U.S. exclusive economic zone (EEZ), the Magnuson-Stevens Fishery Conservation and Management Act (MSA) requires NMFS to identify and describe essential fish habitat (EFH) in fishery management plans (FMPs), minimize the adverse effects of fishing on EFH, and identify actions to encourage the conservation and enhancement of EFH. Towards that end, NMFS has funded two cooperative survey programs intended to help delineate shark nursery habitats in the Atlantic and Gulf of Mexico. The Cooperative Atlantic States Shark Pupping and Nursery Survey and the Cooperative Gulf of Mexico States Shark Pupping and Nursery Survey are designed to assess the geographical and seasonal extent of shark nursery habitat, determine which shark species use these areas, and gauge the relative importance of these coastal habitats for use in EFH determinations. Results from the surveys indicate the importance of coastal waters off the Atlantic east coast, from New Jersey to the Florida Keys and eastern Puerto Rico, throughout the west coast of Florida, and scattered in the Gulf of Mexico from Alabama to Texas (NMFS, 2009). As a side note, insufficient data are available to differentiate EFH by size classes for the great hammerhead shark; therefore, EFH is the same for all life stages. Since the great hammerhead shark EFH is defined as the water column or attributes of the water column, NMFS determined that there are minimal or no cumulative anticipated impacts to the EFH from gear used in U.S. Highly Migratory Species (HMS) and non-HMS fisheries, basing its finding on an examination of published literature and anecdotal evidence (NMFS, 2006).

Likewise, great hammerhead shark habitat in other parts of its range is assumed to be similar to that in the northwest Atlantic and Gulf of Mexico, comprised of open ocean environments occurring over broad geographic ranges and characterized primarily by the water column attributes. As such, large-scale impacts, such as global climate change, that affect ocean temperatures, currents, and potentially food chain dynamics, may pose a threat to this species. The threat of global climate change was investigated specifically for great hammerhead sharks on Australia's Great Barrier Reef (GBR). Chin et al. (2010) conducted an integrated risk assessment for climate change to assess the vulnerability of great hammerhead sharks, as well as a number of other chondrichthyan species, to climate change on the GBR. The assessment examined individual species but also lumped species together in ecological groups (such as freshwater and estuarine, coastal and inshore, reef, shelf, etc.) to determine which groups may be most vulnerable to climate change. The assessment took into account the in situ changes and effects that are predicted to occur over the next 100 years in the GBR and assessed each species' exposure, sensitivity, and adaptive capacity to a number of climate change factors including:

water and air temperature, ocean acidification, freshwater input, ocean circulation, sea level rise, severe weather, light, and ultraviolet radiation. Of the 133 GBR shark and ray species, the assessment identified 30 as being moderately or highly vulnerable to climate change. The great hammerhead shark, however, was not one of these species. In fact, the great hammerhead shark was ranked as having a low overall vulnerability to climate change, with low vulnerability to each of the assessed climate change factors.

Additionally, the great hammerhead shark is highly mobile throughout its range. Although there is very little information on habitat use, and little is known about pupping and nursery areas, there is no evidence to suggest its access to suitable habitat is restricted. The species does not participate in natal homing, which would essentially restrict the species to specific nursery grounds, and based on a comparison of S. mokarran distribution maps from 1984 (Compagno, 1984) and 2014 (IUCN, 2014), the range of the great hammerhead shark has not contracted.

Overall, the ERA team concluded that the effect that habitat destruction, modification, or curtailment is having on the species' extinction risk cannot be determined at this time, acknowledging that while habitat specificity is not well defined for the species, there may be other natural and anthropogenic impacts to the environment that could have some effect on its pelagic habitat. Based on the best available information, we conclude that the current evidence does not indicate that there exists a present or threatened destruction, modification, or curtailment of the great hammerhead shark's habitat or range.

Overutilization for Commercial, Recreational, Scientific or Educational Purposes

The ERA team identified overutilization for commercial and/or recreational purposes as a threat with a moderate effect on the extinction risk of the species, which means it is likely increasing the species' extinction risk but only in combination with other threats or factors.

Great hammerhead sharks are caught in many global fisheries including bottom and pelagic longline fisheries, purse seine fisheries, coastal gillnet fisheries, and artisanal fisheries. As a primarily warm water species, the great hammerhead shark is most often seen in the catches of tropical fisheries (Dudley and Simpfendorfer, 2006; Zeeberg et al., 2006). It is generally not a target species, but due to its large fins, it is valuable as incidental catch for the international shark fin trade (Abercrombie et al., 2005; Clarke et al., 2006a).

There is very little information on the historical abundance, catch, and trends of great hammerhead sharks, with only occasional mentions in fisheries records. Although more countries and regional fisheries management organizations (RFMOs) are working towards better reporting of fish catches down to species level, catches of great hammerheads have gone and continue to go unrecorded in many countries outside the United States. Also, many catch records that do include hammerhead sharks do not differentiate between the Sphyrna species or shark species in general. These numbers are also likely under-reported in catch records, as many records do not account for discards (example: where the fins are kept but the carcass is discarded) or reflect dressed weights instead of live weights. Thus, the lack of catch data for great hammerhead sharks makes it difficult to estimate rates of fishing mortality or conduct detailed quantitative analyses of the effects of fishing on the great hammerhead populations.

In the Northwest Atlantic, where some species-specific fisheries data are available, the great hammerhead population size has appeared to decline, likely due to historical overfishing of the species (see Abundance section; Hayes (2008), Jiao et al. (2011)). However, since 2005 (the last year of the fisheries data from the Jiao et al. (2011) and Hayes (2008) stock assessments), the trend is unclear, with some evidence that the population may be stable or increasing (Carlson et al., 2012; Carlson, unpublished). In addition, the ERA team voiced concerns about the accuracy of species identification in historical fisheries data. Hayes (2008) notes that the relative proportion of great hammerhead sharks in the hammerhead catch has changed significantly since the early 1980s, decreasing from around 50 percent in 1982 to < 30 percent in 2005; however, the ERA team noted that species identification for hammerhead sharks in landings data prior to 2007 was highly inaccurate, and does not believe these percentages are valid. (Since January 1, 2007, the HMS Management Division has required all U.S. Atlantic pelagic longline, bottom longline, and gillnet vessel owners who hold shark permits and operators of those vessels to attend a Protected Species Safe Handling, Release, and Identification Workshop; and all Federally permitted shark dealers are required to attend Atlantic Shark Identification workshops.) Hayes (2008) also identifies many data deficiencies that have increased the uncertainty in his estimates, including the misreporting of the species, particularly in recreational fisheries, which has likely led to overestimations of catches. In other studies that discriminate between hammerhead species, great hammerheads tend to comprise < 10 percent of the total hammerhead complex (see Abundance section of this notice). Only recently has identification of sharks, down to species level, become a priority for national and international fishery managers (including many RFMOs), with the publication of shark and fin guides available for fishermen in order to more accurately report shark catches down to the species level.

The threat of overutilization in other areas of the great hammerhead shark's range was also difficult to assess due to the lack of available fisheries survey and catch data. For example, in Central America and the Caribbean, many reports of the overfishing of hammerhead sharks and subsequent declines are based on personal observations and do not distinguish between hammerhead shark species (Denham et al., 2007). One of the few datasets that provides specific catches of great hammerhead sharks is the Venezuelan Pelagic Longline Observer Program. Off Venezuela, observers note that great hammerhead sharks are mostly concentrated around the oceanic islands and near the edge of the continental shelf (Tavares and Arocha, 2008). In observed catches of the Venezuelan longline fleet from 1994 to 2003, great hammerhead sharks were the 4th most common species. Over the time series, CPUE for the species declined and ranged between 8.70 sharks/1000 hooks and 1.33 sharks/1000 hooks, with an average of 2.9 (± 1.58) sharks/1000 hooks; however, the decline in CPUE was not statistically significant (Tavares and Arocha, 2008).

In the Southwest Atlantic, annual landings of hammerhead sharks have fluctuated over the years. In the ports of Rio Grande and Itajai, Brazil, reported landings in 1992 were ~ 30 mt but increased rapidly to 700 mt in 1994. From 1995 to 2002, catches decreased and fluctuated between 100 and 300 mt (Baum et al., 2007). Information from surface longline and bottom gillnet fisheries targeting hammerhead sharks off southern Brazil indicates declines of more than 80 percent in CPUE from 2000 to 2008, with the targeted hammerhead fishery abandoned after 2008 due to the rarity of the species (FAO, 2010). However, when the fisheries data identify the hammerhead sharks down to species, it appears that great hammerhead sharks are seldom caught in this area. For example, in a study on the removal of shark species by São Paulo State tuna longliners off the coast of Brazil, Amorim et al. (1998) documented significant catches of smooth and scalloped hammerhead sharks from 1974 – 1997 (mainly on the southern continental slope). However, great hammerhead sharks were only very rarely caught by these Santos, São Paulo longliners, and represented ≤ 5 percent of the hammerhead species catch. In a follow up study, conducted from 2007-2008, Amorim et al. (2011) found no records of S. mokarran in the São Paulo State surface longline data, although 376 smooth and scalloped hammerhead sharks were recorded as caught.

In the Eastern Atlantic, great hammerhead sharks can be found off the coast of West Africa. They were once documented ranging from Mauritania to Angola, with periods of high abundance observed in October in waters off Mauritania, and from November to January in waters off Senegal (Cadenat and Blache, 1981). However, with the targeted exploitation of shark species, especially in the Senegalese and Gambian fisheries, there has been a significant and ongoing decrease in shark landings in these waters. According to Diop and Dossa (2011), shark fishing has occurred in the Sub Regional Fisheries Commission (SRFC) member countries (Cape-Verde, Gambia, Guinea, Guinea-Bissau, Mauritania, Senegal, and Sierra Leone) for around 30 years. Shark fisheries and trade in this region first originated in Gambia, but soon spread throughout the region in the 1980s and 1990s, as the development and demand from the worldwide fin market increased. From 1994 to 2005, shark catch reached maximum levels, with a continued increase in the number of boats, better fishing gear, and more people entering the fishery, especially in the artisanal fishing sector. Before 1989, artisanal catch was less than 4,000 mt (Diop and Dossa, 2011). However, from 1990 to 2005, catch increased dramatically from 5,000 mt to over 26,000 mt, as did the level of fishing effort (Diop and Dossa, 2011). Including estimates of bycatch from the industrial fishing fleet brings this number over 30,000 mt in 2005 (however, discards of shark carcasses at sea were not included in bycatch estimates, suggesting bycatch may be underestimated) (Diop and Dossa, 2011). In the SRFC region, an industry focused on the fishing activities, processing, and sale of shark products became well established. However, since 2005, there has been a continual decrease in shark landings, with an observed extirpation of some species, and a scarcity of others, such as large hammerhead sharks (Diop and Dossa, 2011), indicating overutilization of the resource. From 2005 to 2008, shark landings dropped by more than 50 percent (Diop and Dossa, 2011).

In terms of hammerhead-specific information, the majority of data is attributed to hammerhead sharks in general or scalloped hammerhead sharks in particular. According to Senegal's annual fisheries reports, hammerhead shark landings have decreased by more than 50 percent from 2006 to 2010. Dia et al. (2012) provide data from landings and scientific surveys conducted in Mauritanian waters that show CPUE and yields of scalloped hammerhead sharks fluctuating over the years, but since 2006, showing a downward trend (with a note that the trend is the same for great hammerhead sharks). In 2009, the total catch of sharks in Mauritanian waters was 2,010 mt, with great hammerheads constituting 1.15 percent of the shark catch (or 23 mt) (Dia et al., 2012).

There are also reports of juvenile scalloped hammerhead sharks being caught in large quantities by artisanal fishermen using driftnets and fixed gillnets in this region (CITES, 2010); however, similar reports for great hammerheads are absent. This is likely due to the more solitary nature of the species, making it less susceptible to be caught in large numbers. In addition, great hammerhead shark nursery grounds are currently unknown so the extent of overutilization on neonates and juveniles, which could affect recruitment success, appears to be minimal.

In an effort to evaluate the vulnerability of specific shark stocks to pelagic longline fisheries in the Atlantic Ocean, Cortés et al. (2012) conducted an Ecological Risk Assessment using observer information collected from a number of fleets operating under the International Commission for the Conservation of Atlantic Tunas (ICCAT – which is the RFMO responsible for the conservation of tunas and tuna-like species in the Atlantic Ocean and its adjacent seas). Ecological Risk Assessments are popular modeling tools that take into account a stock's biological productivity (evaluated based on life history characteristics) and susceptibility to a fishery (evaluated based on availability of the species within the fishery's area or operation, encounterability, post capture mortality and selectivity of the gear) in order to determine its overall vulnerability to overexploitation (Cortés et al., 2012; Kiska, 2012). Productivity and susceptibility scores are normally plotted on an x-y scatter plot and an overall vulnerability or risk score is calculated as the Euclidean distance from the origin of x-y scatter plot. For example, a species with low productivity and high susceptibility would be at a high risk to overexploitation by the fishery. In this way, vulnerability scores can be ranked and compared between species. Ecological Risk Assessment models are useful because they can be conducted on a qualitative, semi-quantitative, or quantitative level, depending on the type of data available for input.

Results from the Cortés et al. (2012) Ecological Risk Assessment indicate that great hammerhead sharks face a relatively low risk in ICCAT fisheries. Out of the 20 assessed shark stocks, great hammerhead sharks ranked 14th in terms of their susceptibility to pelagic longline fisheries in the Atlantic Ocean. The population's estimated productivity value ($r = 0.070$) ranked 10th; however, this was based on older life history information and recent data suggest great hammerhead sharks are more productive. Overall vulnerability ranking scores (using three different calculation methods, and ranked on a scale of 1 to 20 where 1 = highest risk) ranged from 10 to 14, indicating that great hammerhead sharks have moderately low vulnerability and face a relatively low risk to overexploitation by ICCAT pelagic longline fisheries (Cortés et al., 2012).

In the Indian Ocean, there are currently no quantitative stock assessments or basic fishery indicators available for great hammerhead sharks, and thus the level of great hammerhead shark utilization is highly uncertain. Results from an Ecological Risk Assessment that examined the impact of artisanal fisheries of the Southwest Indian Ocean on mammals, sea turtles, and elasmobranchs indicate that scalloped and great hammerhead sharks face a high risk (most vulnerable) in drift gillnet fisheries (based on their low productivity scores and high susceptibility scores) and a more moderate risk in bottom set gillnets, beach seines and handlines (Kiszka, 2012). Although great hammerhead sharks may be at greater risk from overexploitation by coastal artisanal fisheries, the available data do not show extensive utilization of this species by these fisheries. For example, data from artisanal fisheries operating off Madagascar show that S. mokarran are rarely caught. These artisanal fisheries are known for targeting sharks primarily for their fins, fishing in shallow waters with little regulation. Of the Sphyrnidae landings from these fisheries, S. lewini is the most commonly represented species, comprising more than 96 percent of the hammerhead shark landings (Doukakis et al., 2011; Robinson and Sauer, 2011). Although these artisanal fisheries are largely unregulated and motivated by the fin trade, which increases the likelihood of overutilization of hammerhead species, the fact that great hammerhead sharks are extremely rare in the artisanal catch and landings data indicates that the minimal utilization of the species by these fisheries is not likely to significantly contribute to the species' risk of extinction.

In Australian waters, much of the data are not identified down to hammerhead species. According to Heupel and McAuley (2007), significant reductions in hammerhead catches in the 'northern shark fisheries' (the state-managed Western Australia North Coast Shark Fishery (WANCSF) and the Joint Authority Northern Shark Fishery (JANSF)) occurred between 1996 and 2005. The northern shark fisheries have targeted a variety of species including sandbar, blacktip, and lemon sharks, and historically used demersal longline gear and pelagic gillnetting in the JANSF. Based on an analysis of the CPUE data from 1996-2005, Hepuel and McAuley (2007) suggest declines of 58 to 76 percent in hammerhead abundance in Australia's northwest marine region. Although hammerhead sharks were never targeted in this fishery, they were retained, but it is unclear what proportion of this hammerhead catch was S. mokarran. In addition, although the data suggest that hammerhead population abundance has declined since the late 1990s, recent management measures and regulations have essentially halted operations in this fishery (see The Inadequacy of Existing Regulatory Mechanisms section below), thereby greatly minimizing the threat of overutilization that this fishery poses to the population when in this region.

The Australian Northern Territory Offshore Net and Line (NTONL) fishery, which targets blacktip sharks and grey mackerels, operates off the coastline of Australia's Northern Territory and uses longlines or pelagic set nets (bottom set nets are prohibited). Other shark species, including hammerhead sharks, are recorded as bycatch. Based on NTONL observer data from 2002 to 2007 (during 49 days at sea), great hammerhead sharks constituted 1.6 percent of the total catch of elasmobranch species (Field et al., 2013). Their relative abundance was calculated at 1.51 individuals per day (Field et al., 2013). In 2011, hammerhead sharks constituted 12 percent of the total bycatch (141 mt), exceeding the trigger reference point established for byproduct species. Because of this, the management advisory committee for the fishery will review the trigger breach and provide advice to the Executive Director of Fisheries for necessary action (Northern Territory Government, 2012). It is unclear how many great hammerhead sharks were caught as the estimates were for all Sphyrna spp. However, based on the observer data (Field et al., 2013), the ratio of scalloped hammerheads to great hammerheads in the bycatch is approximately 1.8:1.

Information on hammerhead shark utilization in the Western Pacific is also mainly available from Australian fisheries operating in these waters. Hammerhead sharks are specifically caught in a number of fisheries operating off the eastern coast of Australia, including the New South Wales Ocean Trap & Line fishery, the East Coast Tuna and Billfish Fishery as well as the West Coast Tuna and Billfish Fishery. Fisheries-independent data from protective shark meshing programs in this region were assessed by the ERA team in an attempt to extract additional temporal patterns of great hammerhead catch. From the Queensland Shark Control Program (QSCP) dataset, the ERA team reconstructed estimates of the great hammerhead shark catch for the time period of 1985 to 1996. The results show a decline in great hammerhead shark catch during the 1980s and 1990s followed by an apparent increase over the more recent decade; however, in general, great hammerhead sharks are relatively rare in both the reconstructed results and the raw data (fewer than 35 individual sharks caught per year). The ERA team also notes that this is a pattern of catch only, and not a measure of abundance such as CPUE; however, based on the very few historical and current catches, which supports the assumption of a naturally rarely occurring species, and evidence of a recent increase in beach net captures, it does not appear that the great hammerhead shark population is at the point where depensatory processes are placing it at an increased risk of extinction.

Similarly, data from a 3-year observer survey of small-scale commercial gillnet vessels in the East Coast Inshore Finfish Fishery (which operates in the Great Barrier Reef World Heritage Area off Queensland) also suggests that S. mokarran are not commonly caught in the inshore coastal areas of this region. Out of the total number of elasmobranchs observed in the gillnet catch (n = 6,828), great hammerhead sharks comprised only 1.5 percent of the catch (n=102) (Harry et al., 2011b). This is in contrast to the scalloped hammerhead shark, which is likely the most abundant hammerhead species off the coast of Queensland (Taylor et al., 2011), and was the 4th most abundant elasmobranch in the gillnet catch (making up 8.8 percent of the total catch, n=604) (Harry et al., 2011b).

In the tropical waters of the Pacific, there are very limited data available on the threat of overutilization of great hammerhead sharks by fisheries operating in this region. One study that examined operational-level logsheet and observer data of fleets operating in the Republic of the Marshall Islands EEZ found only three reports of observed S. mokarran individuals from 2005-2009 (although estimates of total annual longline catches of sharks ranged from 1,583 to 2,274 mt/year) (Bromhead et al., 2012). Again, the rarity of the species in observer and catch data does not necessarily indicate overutilization of the species, but rather may likely be a product of the species' naturally low and diffuse abundance, infrequent occurrence in common fishing grounds, and low susceptibility to certain fisheries.

Based on the information from the Eastern Pacific, the extent of utilization of great hammerhead sharks is also very minimal. While S. lewini has been documented as an important shark species that was routinely caught off the Pacific coast of Mexico and in the Gulf of California, with studies that have shown its importance in artisanal fisheries (Pérez-Jiménez et al., 2005; Bizzarro et al., 2009; Smith et al., 2009), reports of S. mokarran in the fisheries data are extremely rare. For example, in the Gulf of Tehuantepec, S. lewini is the second most important species in the shark fishery, comprising around 29 percent of the total shark catch from this area, whereas S. mokarran is ranked 11th (out of 21 species) and comprises < 4.7 percent of the catch (when grouped with other shark species) (INP, 2006). Similarly, in studies off Costa Rica and Ecuador, records of great hammerhead sharks in fisheries data are very rare, whereas S. lewini and other hammerhead shark species are documented in observer and catch data (Whoriskey et al., 2011).

The ERA team also assessed whether the shark fin trade could be a threat driving overutilization of the great hammerhead shark. Based on Hong Kong fin trade auction data from 1999 – 2001 and species-specific fin weights and genetic information, Clarke et al. (2006b) estimated that around 375,000 great hammerhead sharks (range: 130,000 to 1.1 million), with an equivalent biomass of around 21,000 mt, are traded annually. Great hammerhead sharks comprised approximately 1.5 percent of the total fins traded annually in the Hong Kong market (Clarke et al., 2006a). The lack of estimates of the global, or even regional, population makes it difficult to put these numbers into perspective. As a result, the effect at this time of the removals (for the shark fin trade) on the ability of the overall population to survive is unknown.

Overall, the ERA team concluded that overutilization in combination with other factors, such as demographic risks, is likely increasing the species' risk of extinction. However, due to the paucity of available data, the ERA team expressed its uncertainty in assessing the contribution of the threat of overutilization to the extinction risk of the great hammerhead shark by placing 23 percent of its votes in the "unknown" risk level and distributing votes over a large range of effect levels, from "no effect" to "significant effect." As results from the Cortés et al. (2012) Ecological Risk Assessment demonstrated, the threat of overutilization of great hammerhead sharks may be tempered by the species' relatively low vulnerability to certain fisheries, a likely condition of them having diffuse and naturally low abundance, wide range, and rare presence on common fishing grounds. Given the above analysis and best available information, we do not find evidence that overutilization, by itself, is a threat that is currently placing the species at an increased risk of extinction. The severity of the threat of overutilization is dependent upon other risks and threats to the species, such as its abundance (as a demographic risk) as well as its level of protection from fishing mortality throughout its range; but, at this time, there is no evidence to suggest the species is at or near a level of abundance that places its current or future persistence in question due to overutilization.

Disease or Predation

The ERA team evaluated disease and predation as potential threats to the great hammerhead shark, but did not find evidence to suggest that either is presently contributing significantly to its risk of extinction. In terms of disease, the ERA team noted that since the species prefers benthic prey (example: sting rays), it might be susceptible to contaminants that accumulate on the sea floor. Hammerhead sharks may accumulate brevotoxins, heavy metals, and polychlorinated biphenyls in their liver, gill, and muscle tissues; however, the lethal concentration limit of these toxins and metals is currently unknown (Lyle, 1984; Storelli et al., 2003; Flewelling et al., 2010). It is hypothesized that these apex predators can handle higher body burdens of these anthropogenic toxins due to the large size of their livers which "provides a greater ability to eliminate organic toxicants than in other fishes" (Storelli et al., 2003) or may even be able to limit their exposure by sensing and avoiding areas of high toxins (like during K. brevis red tide blooms) (Flewelling et al., 2010). Currently, the impact (and prevalence) of toxin and metal bioaccumulation in great hammerhead shark populations is unknown.

Great hammerhead sharks also likely carry a range of parasites, such as external copepods (Alebion carchariae, A. elegans, Nesippus crypturus, N. orientalis, Eudactylina pollex, Kroyerina gemursa, and Nemesis atlantic)(Bester, n.d.); however, no data exist to suggest these parasites are affecting S. mokarran abundance.

Predation is also not thought to be a factor influencing great hammerhead abundance numbers. The most significant predator on great hammerhead sharks is likely humans, although larger sharks, including adult S. mokarran, are known to prey upon injured or smaller great hammerheads. However, the extent of predation of juveniles in nursery areas is currently unknown. In addition, because great hammerhead sharks are apex predators and opportunistic feeders, with a diet composed of a wide variety of items, including teleosts, cephalopods, crustaceans, and rays (Compagno, 1984; Bester, n.d.), it is unlikely that they are threatened by competition for food sources. Although there may be some prey species that have experienced population declines, no information exists to indicate that depressed populations of these prey species are negatively affecting great hammerhead shark abundance.

Therefore, based on the best available information, the ERA team concluded, and we agree, that neither disease nor predation is increasing the species' extinction risk.

The Inadequacy of Existing Regulatory Mechanisms

The ERA team evaluated existing regulatory mechanisms to determine whether they may be inadequate to address threats to the great hammerhead shark. Existing regulatory mechanisms may include Federal, state, and international regulations. Below is a brief description and evaluation of current and relevant domestic and international management measures that affect the great hammerhead shark. More information on these domestic and international management measures can be found in the status review report (Miller et al., 2014).

In the northwest Atlantic, the U.S. Atlantic HMS Management Division within NMFS (HMS Management Division) develops regulations for Atlantic HMS fisheries, and primarily coordinates the management of Atlantic HMS fisheries in Federal waters (domestic) and the high seas (international), while individual states establish regulations for HMS in state waters. The NMFS Atlantic HMS Management Division currently manages 39 species of sharks (excluding spiny dogfish, which is managed jointly by the New England and Mid-Atlantic Fishery Management Councils, and smooth dogfish, which will be managed by the HMS Management Division) under the Consolidated HMS FMP (NMFS, 2006). The management of these sharks is divided into four species groups: large coastal sharks (LCS), small coastal sharks (SCS), pelagic sharks, and prohibited sharks. The LCS complex is further divided into sandbar sharks, Aggregated LCS, and hammerhead sharks, with different management measures for each group. The hammerhead shark management group includes scalloped, smooth, and great hammerhead sharks.

In 2011, the HMS Management Division made an "overfished" and "overfishing" status determination of the scalloped hammerhead stock (76 FR 23794; April 28, 2011) and was mandated to implement additional conservation and management measures by 2013 to protect the scalloped hammerhead shark stock from overexploitation. These measures, which were finalized in July 2013 with publication of Amendment 5a to the Consolidated HMS FMP (78 FR 40318; July 3, 2013), included separating the commercial hammerhead shark quotas from the aggregated LCS management group quotas, linking the Atlantic hammerhead shark quota to the Atlantic aggregated LCS quotas, and linking the Gulf of Mexico hammerhead shark quota to the Gulf of Mexico aggregated LCS quotas. In other words, if either the aggregated LCS or hammerhead shark quota is reached, then both the aggregated LCS and hammerhead shark management groups will close. These quota linkages were implemented as an additional conservation benefit for the hammerhead shark complex due to the concern of hammerhead shark bycatch and additional mortality from fishermen targeting other sharks within the LCS complex. The separation of the hammerhead species for quota monitoring purposes from other sharks within the LCS management unit will allow us to better manage the specific utilization of the hammerhead shark complex, which includes great hammerhead sharks.

One way that the HMS Management Division controls and monitors this commercial harvest is by requiring U.S. commercial Atlantic HMS fishermen who fish for or sell great hammerhead sharks to have a Federal Atlantic Directed or Incidental shark limited access permit. These permits are administered under a limited access program, and the HMS Management Division is no longer issuing new shark permits. Currently, 220 U.S. fishermen are permitted to target sharks managed by the HMS Management Division in the Atlantic Ocean and Gulf of Mexico, and an additional 265 fishermen are permitted to land sharks incidentally. A directed shark permit allows fishermen to retain 36 LCS sharks, which includes great hammerhead sharks, per vessel per trip. An incidental permit allows fishermen to retain up to 3 LCS sharks, which includes great hammerhead sharks, per vessel per trip. These limits apply to all gear; however, starting in 2011, fishermen using pelagic longline (PLL) gear and operating in the Atlantic Ocean, including the Caribbean Sea, and dealers buying from vessels that have PLL gear onboard, have been prohibited from retaining onboard, transshipping, landing, storing, selling, or offering for sale any part or whole carcass of hammerhead sharks of the family Sphyrnidae (except for S. tiburo) (76 FR 53652; August 29, 2011). (This prohibition was promulgated to carry out ICCAT Recommendation 10-08, which is discussed in further detail below.) In addition to permitting and trip limit requirements, logbook reporting or carrying an observer onboard may be required for selected commercial fishermen. The head may be removed and the shark may be gutted and bled, but the shark cannot be filleted or cut into pieces while onboard the vessel and all fins, including the tail, must remain naturally attached to the carcass through offloading.

Great hammerhead sharks may be retained by recreational Atlantic HMS fishermen using either rod and reel or handline gear, as long as tunas, swordfish, or billfish are also not retained (76 FR 53652; August 29, 2011, promulgated to carry out ICCAT Recommendation 10-08). Great hammerheads that are kept in the recreational fishery must have a minimum size of 78 inches (1.98 m; 6.5 feet) fork length to ensure that primarily mature individuals are retained, and only one shark, which could be a great hammerhead, may be kept per vessel per trip. Since 2008, recreational fishermen have been required to land all sharks with their head, fins, and tail naturally attached.

Individual state fishery management agencies have authority for managing fishing activity in state waters, which usually extends from zero to three nautical miles (5.6 km) off the coast in most cases, and zero to nine nautical miles (16.7 km) off Texas and the Gulf coast of Florida. Federally permitted shark fishermen along the Atlantic coast and in the Gulf of Mexico and Caribbean are required to follow Federal regulations in all waters, including state waters. To aid in enforcement and reduce confusion among fishermen, in 2010, the Atlantic States Marine Fisheries Commission, which regulates fisheries in state waters from Maine to Florida, implemented a Coastal Shark Fishery Management Plan that mostly mirrors the Federal regulations for sharks, including great hammerhead sharks. States in the Gulf of Mexico and territories in the Caribbean Sea have also implemented regulations that are mostly the same as the Federal regulations for sharks, including great hammerhead sharks. However, the State of Florida, which has the largest marine recreational fisheries in the United States and the greatest number of HMS angling permits, recently went even further than Federal regulations to protect the great hammerhead shark by prohibiting the harvest, possession, landing, purchasing, selling, or exchanging any or any part of a hammerhead shark (including scalloped, smooth, and great hammerheads) caught in Florida's waters by Florida fishermen (Florida Fish and Wildlife Conservation Commission, effective January 1, 2012).

In addition, the HMS Management Division recently published an amendment to the Consolidated HMS FMP that specifically addresses Atlantic HMS fishery management measures in the U.S. Caribbean territories (77 FR 59842; Oct. 1, 2012). Due to substantial differences between some segments of the U.S. Caribbean HMS fisheries and the HMS fisheries that occur off the mainland of the United States (including permit possession, vessel size, availability of processing and cold storage facilities, trip lengths, profit margins, and local consumption of catches), the HMS Management Division implemented measures to better manage the traditional small-scale commercial HMS fishing fleet in the U.S. Caribbean Region. Among other things, this rule created an HMS Commercial Caribbean Small Boat (CCSB) permit, which: allows fishing for and sales of big-eye, albacore, yellowfin, and skipjack tunas, Atlantic swordfish, and Atlantic sharks within local U.S. Caribbean market; collects HMS landings data through existing territorial government programs; authorizes specific gears; is restricted to vessels less than or equal to 45 feet (13.7 m) length overall all; and may not be held in combination with any other Atlantic HMS vessel permits. However, at this time, fishermen who hold the CCSB permit are prohibited from retaining Atlantic sharks, and are restricted to fishing with only rod and reel, handline, and bandit gear under the permit. Both the CCSB and Atlantic HMS regulations will help protect great hammerhead sharks while in the northwest Atlantic Ocean, Gulf of Mexico, and Caribbean Sea.

In other parts of the great hammerhead shark range, the ERA team noted that regulations specific to great hammerhead sharks are lacking. For example, in Central America and the Caribbean, management of shark species remains largely disjointed, due in large part to the number of sovereign states found in this region (Kyne et al., 2012). Some countries are missing basic fisheries regulations whereas other countries lack the capabilities to enforce what has already been implemented. The Organization of the Fisheries and Aquaculture Section of the Central American Isthmus (OSPECA) was formed to address this situation by assisting with the development and coordination of fishery management measures in Central America. OSPECA recently approved a common regional finning regulation for eight member countries from the

Central American Integration System (SICA) (Belize, Costa Rica, Dominican Republic, El Salvador, Guatemala, Honduras, Nicaragua, and Panama). The regulation specifically requires sharks to be landed with fins still attached for vessels fishing in SICA countries or in international waters flying a SICA country flag. If fins are to be traded in a SICA country, they must be accompanied by a document from the country of origin certifying that they are not the product of finning (Kyne et al., 2012). Other Central American and Caribbean country-specific regulations include the banning or restriction of longlines in certain fishing areas (Bahamas, Belize, Panama), seasonal closures (Guatemala), shark fin bans (Colombia, Mexico, Venezuela) and the prohibition of shark fishing (Bahamas and Honduras). Unfortunately, enforcement of these regulations is weak, with many reports of illegal and unregulated fishing activities (WildAid, 2003; Lack and Sant, 2008; Agnew et al., 2009; Kyne et al., 2012; NMFS, 2013a).

In South America, Brazil has also banned finning and currently has regulations limiting the extension of pelagic gillnets and prohibiting trawls in waters less than 3 nautical miles (5.6 km) from the coast; however, heavy industrial fishing off the coast of Brazil, with the use of drift gillnets and longlines, remains largely unregulated, as does the intensive artisanal fishery which accounts for about 50 percent of the fishing sector.

In Europe, the European Parliament recently passed a regulation prohibiting the removal of shark fins by all vessels in EU waters and by all EU-registered vessels operating anywhere in the world. Many individual European countries had previously implemented measures to stop the practice of finning and conserve shark populations. For example, England and Wales banned finning in 2009 and no longer issue special permits for finning exceptions. France prohibits on-board processing of sharks, and Spain recently published Royal Decree Nº139/2011 in 2011, adding hammerhead sharks to their List of Wild Species under Special Protection (Listado de Especies Silvestres en Régimen de Protección Especial). This listing prohibits the capture, injury, trade, import and export of hammerhead sharks, including great hammerhead sharks, with a periodic evaluation of their conservation status. Given that Spain is Europe's top shark fishing nation, accounting for 7.3 percent of the global shark catch, and was the world's largest exporter of shark fins to Hong Kong in 2008, this new regulation should provide significant protection for great hammerhead sharks from Spanish fishing vessels.

Although regulations in Europe appear to be moving towards the sustainable use and conservation of shark species, these strict and enforceable regulations do not extend farther south in the Eastern Atlantic, where great hammerhead sharks are more frequently observed. Some western African countries have attempted to impose restrictions on shark fishing; however, these regulations either have exceptions, loopholes, or poor enforcement. For example, Mauritania has created a 6,000 km^2 coastal sanctuary for sharks and rays, prohibiting targeted shark fishing in this region; however, sharks, such as the great hammerhead shark, may be caught as bycatch in nets. Many other countries, such as Namibia, Guinea, Cape-Verde, Sierra Leone, and Gambia, have shark finning bans, but even with this regulation, great hammerhead sharks may be caught with little to no restrictions on harvest numbers. Many of these state-level management measures also lack standardization at the regional level (Diop and Dossa, 2011), which weakens some of their effectiveness. For example, Sierra Leone and Guinea both require shark fishing licenses; however, these licenses are much cheaper in Sierra Leone, and as a result, fishermen from Guinea fish for sharks in Sierra Leone (Diop and Dossa, 2011). Also, although many of these countries have recently adopted FAO recommended National Plans of Action – Sharks, their shark fishery management plans are still in the early implementation phase, and with few resources for monitoring and managing shark fisheries, the benefits to sharks from these regulatory mechanisms (such as reducing overutilization) have yet to be realized (Diop and Dossa, 2011).

In 2010, ICCAT adopted Recommendation 10-08 prohibiting the retention of hammerheads caught in association with ICCAT-managed fisheries. Each Contracting Party to ICCAT is responsible for implementing this recommendation, and currently there are approximately 47 contracting parties (including the United States, the EU, Brazil, Venezuela, Senegal, Mauritania, and many other Central American and West African countries). ICCAT Recommendation 10-08 also includes a special exception for developing coastal States, allowing them to retain hammerhead sharks for local consumption provided that they report their catch data to ICCAT, endeavor not to increase catches of hammerhead sharks, and take the necessary measures to ensure that no hammerhead parts enter international trade. As this exception allows hammerhead sharks to be retained under certain circumstances, it may provide a lesser degree of protection for hammerhead sharks when in the Atlantic Ocean. However, based on the nominal catch data from ICCAT, it does not appear that great hammerhead sharks have been or are currently caught in large numbers by ICCAT vessels. Prior to Recommendation 10-08, average reported great hammerhead catch was approximately 2 mt per year (range: 0 to 19 mt; 1992 – 2010). In 2012, only fleets operating under the Nigerian and St. Lucia flags reported catches of great hammerhead sharks (total = 14 mt). These low numbers reported by ICCAT vessels are likely a reflection of the low susceptibility of great hammerhead sharks to ICCAT fisheries (see the Cortes et al. (2012) Ecological Risk Assessment). Therefore, in addition to the overall low vulnerability (susceptibility and productivity) of great hammerhead sharks to ICCAT fisheries, further regulations prohibiting the retention (and international trade as part of the exception) of hammerhead sharks will greatly minimize the threat of overutilization of this species within the Atlantic.

The RFMOs that cover the Indian and Pacific Oceans, including the Indian Ocean Tuna Commission (IOTC), the Western and Central Pacific Fisheries Commission (WCPFC), and the Inter-American Tropical Tuna Commission (IATTC), require the full utilization of any retained catches of sharks, with a regulation that onboard fins cannot weigh more than 5 percent of the weight of the sharks. These regulations are aimed at curbing the practice of shark finning, but do not prohibit the fishing of sharks. In addition, these regulations may not be as effective in stopping finning of sharks compared to those that require fins to be naturally attached, as a recent study found many shark species, including the great hammerhead shark, to have an average wet-fin-to-round-mass ratio of less than 5 percent (Biery and Pauly, 2012). In other words, fishing vessels operating in these RFMO convention areas may be able to land more shark fins than bodies and still pass inspection. However, these RFMOs do encourage the release of live sharks, especially juveniles and pregnant females that are caught incidentally and are not used for food and/or subsistence in fisheries, and request the submission of data related to catches of sharks, down to the species level where possible. Although there are no great hammerhead-specific RFMO regulations in this part of its range, based on observer data from these RFMOs, catches of great hammerhead sharks are negligible (SPC 2010; H. Murua, personal communication).

Countries within the Indian Ocean that have specific measures to prevent the waste of shark parts and discourage finning include Oman, Seychelles, Australia, South Africa, and

Taiwan. The Maldives have even designated their waters as a shark sanctuary. In Australia, the states and territories have implemented various shark regulations that are likely to protect the species when inside Australia's EEZ. For example, finning bans exist in all waters of Australia, although the strictness of the ban (i.e., based on fin ratio or requirement to leave fins attached) varies by state. In May 2012, the state of New South Wales listed S. mokarran as a vulnerable species, making it illegal to catch and keep, buy, sell, possess or harm the great hammerhead shark without a specific permit, license or other appropriate approval. In Australia's northern shark fisheries (JANSF and WANCSF), hammerhead catches saw a significant decline from their peak in 2004/05 following the implementation of stricter management regulations in 2005 (including area closures and longline and gillnet restrictions in WANCSF). In 2008, the JANSF's export approval was revoked over concerns about the ecological sustainability of the fishery. In 2009, the WANCSF export approval expired. As such, no product from either fishery can currently be legally exported. As the northern shark fisheries rely upon shark fin exports for the majority of their income, these export losses have effectively shut down the fisheries, and, consequently, from 2009-2011 there was no reported activity in the northern shark fisheries (McAuley and Rowland, 2012).

Other shark fishing countries in the Indian and Pacific Oceans include Indonesia, India, Taiwan, and Costa Rica. Indonesia, which is the top shark fishing nation in the world, currently has no restrictions pertaining to shark fishing. In fact, Indonesian small-scale fisheries, which account for around 90 percent of the total fisheries production, are not required to have fishing permits (Varkey et al., 2010), nor are their vessels likely to have insulated fish holds or refrigeration units (Tull, 2009), increasing the incentive for shark finning by this sector (Lack and Sant, 2012). Although Indonesia adopted an FAO recommended shark conservation plan (National Plan of Action—Sharks) in 2010, due to budget constraints, it can only focus its implementation of key conservation actions in one area, East Lombok (Satria et al., 2011). The current Indonesian regulations that pertain to sharks are limited to those needed to conform to international agreements (such as trade controls for certain species listed by the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) (e.g., whale shark) or prescribed by RFMOs) (Fischer et al., 2012). However, with the new CITES listing of hammerhead sharks on Appendix II (discussed below), Indonesia will need to implement CITES trade rules for hammerhead sharks and ensure that international trade in these species will not be detrimental to their survival.

A number of countries have also enacted complete shark fishing bans, with the Bahamas, Marshall Islands, Honduras, Sabah (Malaysia), and Tokelau (an island territory of New Zealand) adding to the list in 2011, and the Cook Islands in 2012. Shark sanctuaries can also be found in the Eastern Tropical Pacific Seascape (which encompasses around two million km^2 of national waters, coasts, and islands of Colombia, Costa Rica, Ecuador, and Panama, including the Galapagos, Cocos, and Malpelo Islands), and in waters off the Maldives, Mauritania, Palau, and French Polynesia.

In terms of legal international trade in the species, the ERA team noted that in March 2013, at the CITES Conference of the Parties meeting in Bangkok, member nations, referred to as “Parties,” voted in support of listing three species of hammerhead sharks (scalloped, smooth, and great hammerhead sharks) in CITES Appendix II – an action that means increased protection, but still allows legal and sustainable trade. CITES is an international agreement between governments that regulates international trade in wild animals and plants. It encourages a proactive approach and the species covered by CITES are listed in appendices according to the degree of endangerment and the level of protection provided. Appendix I includes species threatened with extinction; trade in specimens of these species is permitted only in exceptional circumstances. Appendix II includes species not necessarily threatened with extinction, but for which trade must be controlled to avoid exploitation rates incompatible with species survival. Appendix III contains species that are protected in at least one country, which has asked other CITES Parties for assistance in controlling the trade.

The CITES hammerhead shark listings will go into effect on September 14, 2014. At that time, export of their fins, or any other part of the animal, will require permits that ensure the products were legally acquired and that the Scientific Authority of the State of export has advised that such export will not be detrimental to the survival of that species. Guyana and Yemen have entered reservations, which means that they are not bound by CITES requirements when trading in these species with countries not a party to CITES. Japan has also taken a reservation but has stated that it will comply voluntarily with the CITES requirements for export permits. Canada has also entered reservations but this is temporary until they are able to implement domestic regulations.

As a substantial lack of data, especially catch and trade data specific to great hammerhead sharks, was noted as contributing to the significant uncertainty in evaluating threats and the extinction risk of the species, this CITES listing and subsequent management measures to implement CITES trade regulations, should help decrease this uncertainty, support sustainable trade in the species, and provide a greater understanding of the extinction risk faced by the species.

The ERA team also expressed concerns regarding finning and illegal harvest of great hammerhead sharks for the international shark fin trade, but noted that the situation appears to be improving due to current regulations and trends, and may not be as severe a threat to great hammerhead sharks compared to other species. For example, unlike the scalloped hammerhead shark, which schools and may be caught in large numbers by vessels fishing illegally, the great hammerhead shark is less susceptible to overutilization from illegal harvest due to its solitary behavior and diffuse abundance. Although many of the reports of illegal fishing in the status review document do not identify fins down to species (see Miller et al., 2014 for details), the illegal fishing occurred in known "hot spots" of scalloped hammerhead sharks. These are areas where large numbers of scalloped hammerheads have been known to aggregate and school, such as around the Galapagos, Malpelo, Cocos and Revillagigedo Islands in the Eastern Tropical Pacific (Hearn et al., 2010; Bessudo et al., 2011). Thus, it is likely that many of the illegally obtained fins belonged to S. lewini. The status review report also mentions a study that examined a small collection of illegal fins confiscated from fishermen in northern Australian waters, and found that the number of fins identified as scalloped hammerhead sharks were almost double those that belonged to great hammerhead sharks (Lack and Sant, 2008). In fact, the scalloped hammerhead shark was the second highest source of illegal fins (behind the Whitecheek shark – Carcharhinus dussumieri). In 2007, a sting operation that confiscated 19,018 illegal fins at the border between Ecuador and Peru also identified the fins down to species, and found that the fins represented four species of sharks: bigeye thresher, pelagic thresher, sandbar, and scalloped hammerhead sharks (O'Hearn-Gimenez, 2007). Based on the location of many reported illegal fishing occurrences, and the representation of S. lewini in identified fin hauls, it seems likely that the vast majority of hammerhead sharks that are harvested by illegal fishing vessels are the schooling scalloped hammerhead shark.

Also, as discussed above (with further details in Miller et al., 2014), finning bans have been implemented by a number of countries, as well as by nine RFMOs. These finning bans range from requiring fins remain attached to the body to allowing fishermen to remove shark fins provided that the weight of the fins does not exceed 5 percent of the total weight of shark carcasses landed or found onboard. These regulations are aimed at stopping the practice of killing and disposing of shark carcasses at sea and only retaining the fins. Although they do not prohibit shark fishing, they work to decrease the number of sharks killed solely for the international shark fin trade, with some more effective than others.

In addition to these finning bans, there has also been a recent push to decrease the demand of shark fins, especially for shark fin soup. Already, many hotels, restaurants, and supermarkets in Asia, where shark fins are a top commodity for shark fin soup, have agreed to stop serving shark fin products. For example, in Taiwan, the W Taipei, the Westin Taipei, and the Silks Palace at National Palace Museum have stopped serving shark fin dishes as part of their menus. In November of 2011, the Chinese restaurant chain South Beauty removed shark fin soup from its menus, and in 2012, the luxury Shangri-La Hotel chain joined this effort, banning shark fin from its 72 hotels, most of which are found in Asia. Effective January 1, 2012, the Peninsula Hotel chain (which covers Chinese restaurant and banqueting facilities in Hong Kong, Shanghai, Beijing, Tokyo, Bangkok, and Chicago) stopped serving shark fin and related products. Many supermarket chains in Asia also vowed to halt the sale of shark fin products. In 2011, ColdStorage, a chain with several outlets in Singapore, banned the sale of shark fin from its stores, and in 2012, the Singapore supermarket chains FairPrice and Carrefour stated they would also stop selling shark fin in outlets in the city-state. Most recently, China, a large consumer of shark fins, prohibited shark fins at all official reception dinners (Ng, 2013). Clarke et al. (2007) documented that shark fin traders cite hammerheads as the sources of the best quality fin needles for consumption at banquets, so these prohibitions could work to decrease the global demand for hammerhead fins. In the United States, for example, exports of dried Atlantic shark fins significantly dropped after the passage of the Shark Finning Prohibition Act (which was enacted in December of 2000 and implemented by final rule on February 11, 2002; 67 FR 6194), and again in 2011 (decreased by 58 percent), with the passage of the 2010 Shark Conservation Act and the ban on possession and trade of shark fins passed in several U.S. states (NMFS, 2012; NMFS, 2013b). Also in 2011, the price per kg of shark fin reached its highest (~$100/kg) and, as such, one would expect an increase in exports (due to the increase in product price); however, as mentioned above, the opposite was true, suggesting that these types of finning bans and fin trade regulations are likely effective at discouraging U.S. fishermen from fishing for sharks solely for the purpose of the international fin trade. In 2012, the value of fins decreased indicating that perhaps the worldwide demand for fins is also on a decline (NMFS, 2012; NMFS 2013b).

Thus, although great hammerhead fins are one of the most prized in the international shark fin trade (Abercrombie et al., 2005), the extent of legal and illegal harvest on great hammerhead sharks for this trade was not viewed as significant enough to decrease the species' abundance to the point where it may be at risk of extinction due to environmental variation, anthropogenic perturbations, or depensatory processes. Additionally, as the demand for shark fins continues to decline (as demonstrated by the increase in finning bans, decrease in shark fin food products, and decrease in shark fin price), so should the threat of finning and illegal harvest.

Based on the above review of regulatory measures (in addition to the regulations described in Miller et al., 2014) the ERA team concluded that these existing regulations have a small to moderate effect on the species' extinction risk. The team noted that some areas of the species' range do have adequate measures in place to prevent overutilization, such as in the Northwest Atlantic where U.S. fishery management measures to rebuild the scalloped hammerhead populations are helping to monitor the catch of great hammerheads, preventing any further population declines. These U.S. conservation and management measures (as previously summarized with additional details in Amendment 5a to the Consolidated HMS FMP (78 FR 40318; July 3, 2013)) are viewed as adequate in decreasing the extinction risk to the great hammerhead shark by minimizing demographic risks (preventing further abundance declines) and the threat of overutilization (strictly managing and monitoring sustainable catch rates) currently and in the foreseeable future. Although regulations specific to great hammerhead sharks are lacking in other parts of its range, fishery interactions are rare and thus the effects of the current regulatory measures do not appear to be significantly increasing the species' risk of extinction. This species is not observed or caught in large numbers by global fisheries and it is uncertain whether overutilization of the species is a significant threat (see Overutilization for Commercial, Recreational, Scientific or Educational Purpose section discussed earlier in this notice). Therefore, based on the best available information, we find that the threat of inadequate current regulatory mechanisms is likely having a small effect on the species' risk of extinction; however, improvements are needed in the monitoring and reporting of fishery interactions.

Other Natural or Man-Made Factors Affecting Its Continued Existence

The ERA team identified biological vulnerability in the form of high at-vessel fishing mortality as a potential factor that may increase the species' risk of extinction. Great hammerhead sharks are obligate ram ventilators and suffer very high at-vessel fishing mortality in bottom longline fisheries (Morgan and Burgess, 2007; Morgan et al., 2009). From 1994-2005, NMFS observers calculated that out of 178 great hammerheads caught on commercial bottom longline vessels in the northwest Atlantic and Gulf of Mexico, 93.8 percent were dead when brought aboard. Size did not seem to be a factor influencing susceptibility, whereas soak time of the longline had a positive effect on the likelihood of death, and bottom water temperature had a negative effect (Morgan and Burgess, 2007). Morgan et al. (2009) also documented over 90 percent at-vessel mortality rates for great hammerhead sharks for soak times ranging anywhere from < 4 hours to over 24 hours.

In a study that examined the physiological stress responses to being caught in fishing gear and post-release survival, great hammerhead sharks were once again found to be extremely vulnerable to capture stress and mortality (Gallagher et al., in press). The study specifically compared five shark species (blacktip, bull, lemon, great hammerhead, and tiger) and their responses to being caught on drum lines. Fight times on the hooks were recorded, blood samples taken, reflexes tested, and satellite tags were deployed on a select number of sharks. Results from the study showed that blood lactate levels (which were positively correlated with fight time) were significantly higher in great hammerhead sharks compared to the other species (Gallagher et al., in press). Previous studies have demonstrated a positive relationship between blood lactate levels and likelihood of post-release mortality, with lactate values of around 16-20 mmol/l associated with moribund sharks (Gallagher et al., in press). In great hammerhead sharks, the blood lactate values averaged 17.00 mmol/l (±2.78) after fight times of 17-131 minutes (Gallagher et al., in press). One tagged great hammerhead, which had a 24-minute fight time and lactate value of 19 mmol/l, was released alive but died after less than 10 minutes. Compared to the other shark species, the great hammerhead also had the lowest tag reporting rate, which the authors suggest could be an indication of low post-release survival (Gallagher et al., in press).

After an evaluation of the above information, the ERA team noted that the extent of this vulnerability on the species' extinction risk is unknown and hard to quantify. Fisheries information is lacking and it is likely that most of the fishing mortality on this species is through capture in gillnets, where its biological vulnerability would not present an issue as the species would not likely be released after capture. However, given the uncertainties, the ERA team placed 53 percent of their likelihood votes in the "Unknown" threat effect level. The effect level that received the second highest number of votes was the "Small effect" category as the team acknowledged that there may be some concern that its biological vulnerability could exacerbate extinction risk when coupled with other threats or demographic risks.

Significant Portion of Its Range

The definitions of both "threatened" and "endangered" under the ESA contain the term "significant portion of its range" (SPOIR) as an area smaller than the entire range of the species which must be considered when evaluating a species risk of extinction. The phrase has never been formally interpreted by NMFS. With regard to SPOIR, the Services have proposed a "Draft Policy on Interpretation of the Phrase 'Significant Portion of Its Range' in the Endangered Species Act's Definitions of 'Endangered Species' and 'Threatened Species'" (76 FR 76987;

December 9, 2011), which is consistent with our past practice as well as our understanding of the statutory framework and language. While the Draft Policy remains in draft form, the Services are to consider the interpretations and principles contained in the Draft Policy as non-binding guidance in making individual listing determinations, while taking into account the unique circumstances of the species under consideration.

The Draft Policy provides that: (1) if a species is found to be endangered or threatened in only a significant portion of its range, the entire species is listed as endangered or threatened, respectively, and the Act's protections apply across the species' entire range; (2) a portion of the range of a species is "significant" if its contribution to the viability of the species is so important that, without that portion, the species would be in danger of extinction; (3) the range of a species is considered to be the general geographical area within which that species can be found at the time FWS or NMFS makes any particular status determination; and (4) if the species is not endangered or threatened throughout all of its range, but it is endangered or threatened within a significant portion of its range, and the population in that significant portion is a valid DPS, we will list the DPS rather than the entire taxonomic species or subspecies.

After a review of the best available information, the ERA team concluded, and we agree, that the data do not indicate any portion of the great hammerhead shark's range as being more significant than another. Great hammerhead sharks are highly mobile, with a global distribution and very few restrictions governing their movements. Although there was preliminary evidence of possible genetic partitioning between ocean basins, this was based on an abstract with no accompanying data or information that we could evaluate, and a study with a limited sample size (see <u>Distinct Population Segment Analysis</u> section above for more information). Based on these deficiencies, we did not find that the best available information supported a conclusion that the loss of genetic diversity from one portion (such as loss of an ocean basin population) would result in the remaining population lacking enough genetic diversity to allow for adaptations to changing environmental conditions. Similarly, we did not find that loss of any portion would severely fragment and isolate the great hammerhead population to the point where individuals would be precluded from moving to suitable habitats or have an increased vulnerability to threats. As previously mentioned, the great hammerhead shark is highly mobile, with diffuse abundance, and no known barriers to migration. Loss of any portion of its range would not likely isolate the species to the point where the remaining populations would be at risk of extinction from demographic processes. In fact, we found no information that would suggest that the remaining populations could not repopulate the lost portion. Areas exhibiting source-sink dynamics, which could affect the survival of the species, were not evident in any part of the great hammerhead shark range. There is also no evidence of a portion that encompasses aspects that are important to specific life history events but another portion that does not, where loss of the former portion would severely impact the growth, reproduction, or survival of the entire species. There is little to no information regarding nursery grounds or other important habitats utilized by the great hammerhead sharks that could be considered limiting factors for the species' survival. In other words, the viability of the species does not appear to depend on the productivity of the population or the environmental characteristics in any one portion. Overall, we did not find any evidence to suggest that any specific portion of its range had increased importance over another with respect to the species' survival. As such, when we considered the overall extinction risk of the species, we considered it throughout the species' entire range.

Overall Risk Summary

Guided by the results from the demographic risk analysis and threats assessment, the ERA team members used their informed professional judgment to make an overall extinction risk determination for the great hammerhead shark now and in the foreseeable future. The ERA team concluded that the great hammerhead shark is currently at a low risk of extinction; however, they expressed significant uncertainty, due to data limitations from the best available information, by almost equally distributing likelihood points in two other risk categories. Likelihood points attributed to the current level of extinction risk categories were as follows: No or Very Low Risk (13/40), Low Risk (15/40), Moderate Risk (11/40), High Risk (1/40). None of the team members placed a likelihood point in the "Very high risk" category, indicating their strong certainty that the species is not currently at a very high risk of extinction. The ERA team reiterated that the great hammerhead shark is likely naturally low in abundance and there is no evidence to suggest depensatory processes are currently at work. The species is found globally, throughout its historical range, appears to be well-adapted and opportunistic, and is not limited by habitat. The team noted that only one scientifically-robust study has shown large declines in the population using fisheries-independent data; however, this study was conducted in a small, localized area (off a beach in South Africa – Dudley and Simpfendorfer, 2006) and does not represent the global population status. As discussed previously, there were flaws in the other studies cited within the status review report, including questionable species discrimination within the datasets (as only recently has more attention been paid to accurately identifying hammerhead sharks down to species), models that are highly sensitive to data series, differences in the complexity of models, large error bars in results data, short time series or small number of observations used in the studies. Even after taking into consideration the flaws within the datasets, the ERA team found the results do not demonstrate that the great hammerhead shark is at risk of extinction due to its current abundance. Throughout the species' range, observations of its abundance are variable, with reports of increasing, decreasing, and stable or no trends. The species is also rare in fisheries data, either due to lack of reporting or simply not present in common fishing grounds (or susceptible to fishing gear, see Ecological Risk Assessment results). As the main threat that the ERA team identified was overutilization due to fisheries (with references to historical overutilization), the absence of the species in fisheries data suggests that this threat is either being minimized by existing regulations or is not significantly contributing to the extinction risk of the species at this time (as the abundance data do not indicate that the species has been fished to near extinction).

In evaluating the extinction risk through the foreseeable future, the ERA team had increased confidence that the risk of extinction would remain low, or further decrease, placing 85 percent of their likelihood points in the "No or Very Low Risk" and "Low Risk" categories. Likelihood points attributed to each risk category in the foreseeable future are as follows: No or Very Low Risk (16/40), Low Risk (18/40), Moderate Risk (6/40). None of the team members placed a likelihood point in the "High risk" or "Very High Risk" categories for the overall level of extinction risk in the foreseeable future, indicating their strong certainty that the species will not be strongly influenced by stochastic or depensatory processes that place its future survival into question. The available information indicates that most of the observed declines occurred in the 1980s, before any significant management regulations. Since then, current regulatory measures in many parts of the great hammerhead shark's range are minimizing the threat of overutilization. For example, the comprehensive science-based management and enforceable and effective regulatory structure within the U.S. Northwest Atlantic will help monitor and prevent further declines of great hammerhead sharks while in these waters, and the implementation of ICCAT Recommendation 10-08 will provide increased protection for great hammerhead sharks throughout the entire Atlantic Ocean into the foreseeable future. In the rest of the species' range, rare fisheries interactions seem to imply that existing management measures (such as RFMO recommendations, national shark fishing measures, and shark fin bans) may be effective at minimizing overutilization of the species, with trends that are moving toward more restrictive trade and decreased demand in shark fin products, which indicate a decreased likelihood of extinction of the global population in the foreseeable future. Thus, the ERA team predicted that in the foreseeable future, the species will unlikely be at risk of extinction due to trends in its abundance, productivity, spatial structure, or diversity or influenced by stochastic or depensatory processes.

Similarity of Appearance Listing

Section 4 of the ESA (16 U.S.C. 1533(e)) additionally provides that the Secretary may treat any species as an endangered or threatened species even though it is not listed pursuant to Section 4 of the ESA when the following three conditions are satisfied: (1) such species so closely resembles in appearance, at the point in question, a species which has been listed pursuant to such section that enforcement personnel would have substantial difficulty in attempting to differentiate between the listed and unlisted species; (2) the effect of this substantial difficulty is an additional threat to an endangered or threatened species; and (3) such treatment of an unlisted species will substantially facilitate the enforcement and further the policy of this chapter (16 U.S.C. 1533(e)(A)-(C)).

The WEG petition requested that we also consider listing the great hammerhead shark as threatened or endangered based on its similarity of appearance to the scalloped hammerhead shark. Four DPSs of scalloped hammerhead shark have been proposed for listing under the ESA (78 FR 20717; April 5, 2013). Although the great hammerhead shark and scalloped hammerhead shark share similar features (such as the unique head shape), we have not found evidence that enforcement personnel would have substantial difficulty in differentiating the two species. The great hammerhead shark is the largest of the hammerhead shark species, reaching lengths of up to 610 cm TL (Compagno, 1984) but more commonly observed as > 400 cm TL (Miller et al., 2014) and averaging over 500 pounds (230 kg) (Bester, n.d.). On the other hand, observed maximum sizes of scalloped hammerhead sharks range from 331-346 cm TL (Stevens and Lyle, 1989; Chen et al., 1990) with a maximum recorded weight of 336 pounds (152.4 kg) (Bester, n.d.). In addition to their sizes, the shapes of their head are also distinctive and aid in the differentiation of the two species. In the great hammerhead shark, the front margin of the head is nearly straight, forming a "T-shape," with a shallow notch in the middle, whereas the scalloped hammerhead shark has a broadly arched head, with distinct indentations in the center as well as on either side of the middle notch (Bester, n.d.).

The fins of these two species can also be distinguished without difficulty. The great hammerhead shark has a very tall, distinctive, crescent-shaped first dorsal fin whereas the first dorsal fin of a scalloped hammerhead shark is shorter and has a rounded apex (Abercrombie et al., 2013). According to a genetic study that examined the concordance between assigned Hong Kong market categories and the corresponding fins, the great hammerhead market category "Gu pian" had an 88 percent concordance rate, indicating that traders are able to accurately identify and separate great hammerhead shark fins from the other hammerhead species (Abercrombie et al., 2005; Clarke et al., 2006a). In addition, many RFMOs and national and international fishery managers have started distributing shark and fin guides for fishermen in order to help with increased accuracy in reporting shark catches down to the species level.

Given the distinctive head and body characteristics of the great hammerhead shark and the scalloped hammerhead shark, and evidence that fins of the species can also be accurately identified and separated, we conclude that enforcement personnel would not have substantial difficulties in attempting to differentiate between the great hammerhead shark and the scalloped hammerhead shark. Therefore, we are not considering a similarity of appearance listing at this time.

Final Determination

Section 4(b)(1) of the ESA requires that NMFS make listing determinations based solely on the best scientific and commercial data available after conducting a review of the status of the species and taking into account those efforts, if any, being made by any state or foreign nation, or political subdivisions thereof, to protect and conserve the species. We have independently reviewed the best available scientific and commercial information including the petition, public comments submitted on the 90-day finding (78 FR 24701; April 26, 2013), the status review report (Miller et al., 2014), and other published and unpublished information, and have consulted with species experts and individuals familiar with great hammerhead sharks. We considered each of the statutory factors to determine whether it presented an extinction risk to the species on its own. We also considered the combination of those factors to determine whether they collectively contributed to the extinction of the species. As required by the ESA, Section 4(b)(1)(a), we also took into account efforts to protect great hammerhead sharks by states, foreign nations and others and evaluated whether those efforts provide a conservation benefit to the species. As previously explained, no portion of the species' range is considered significant and we did not find biological evidence that would indicate that any population segment of the great hammerhead shark would qualify as a DPS under the DPS policy. Therefore, our determination set forth below is based on a synthesis and integration of the foregoing information, factors and considerations, and their effects on the status of the species throughout its entire range.

We conclude that the great hammerhead shark is not presently in danger of extinction, nor is it likely to become so in the foreseeable future throughout all of its range. We summarize the factors supporting this conclusion as follows: (1) the species is made up of a single population over a broad geographic range, with no barrier to dispersal; (2) its current range is indistinguishable from its historical range and there is no evidence of habitat loss or destruction; (3) while the species possesses life history characteristics that increase its vulnerability to harvest, it has been found to be less susceptible to pelagic longline fisheries compared to other shark species (based on results from Ecological Risk Assessments), decreasing the chance of substantial fishing mortality from this common fishery that operates throughout its range; (4) the best available information indicates that abundance is naturally low and variable across the species' range, with reports of localized population declines but also evidence of stable and/or increasing abundance estimates; (5) based on the ERA's assessment, the current population size, while it has likely declined from historical numbers, is sufficient to maintain population viability into the foreseeable future; (6) the main threat to the species is fishery-related mortality from global fisheries; however, information on harvest rates is inconclusive due to poor species discrimination and significant uncertainties in the data, with the best available information indicating low utilization of the species (rare in fisheries records and minor component of illegal fin hauls); (7) there is no evidence that disease or predation is contributing to increasing the risk of extinction of the species; (8) existing regulatory mechanisms throughout the species' range appear effective in addressing the most important threats to the species (harvest), but it is unknown if they will remain so if harvest increases because many of the regulations are not specific to hammerhead shark utilization; and, (9) while the global population has likely declined from historical numbers, there is no evidence that the species is currently suffering from depensatory processes (such as reduced likelihood of finding a mate or mate choice or diminished fertilization and recruitment success) or is at risk of extinction due to environmental variation or anthropogenic perturbations.

Based on these findings, we conclude that the great hammerhead shark is not currently in danger of extinction throughout all or a significant portion of its range nor is it likely to become so within the foreseeable future. Accordingly, the great hammerhead shark does not meet the definition of a threatened or endangered species and our listing determination is that the great hammerhead shark does not warrant listing as threatened or endangered at this time.

References

A complete list of all references cited herein is available upon request (see FOR FURTHER INFORMATION CONTACT).

Authority

The authority for this action is the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq.).

Dated: June 5, 2014.

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Samuel D. Rauch III,

Deputy Assistant Administrator for Regulatory Programs,

National Marine Fisheries Service.

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